

SPECIAL ISSUE

**Policy Implementation as an Instrument to Achieve Educational
Equity in the Community College Context**

education policy analysis
archives

A peer-reviewed, independent,
open access, multilingual journal



epaa | aape

Arizona State University

Volume 29 Number 29

March 8, 2021

ISSN 1068-2341

**The Influence of Policy Implementation in the Midwest:
How an SSTEM Program Broadens Participation and
Enhances Engineering Identity for Community College
Students**

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Citation: Rodriguez, S. L., Espino, M. L., Le, B., & Cunningham, K. (2021). The influence of policy implementation in the Midwest: How an SSTEM program broadens participation and enhances engineering identity for community college students. *Education Policy Analysis Archives*, 29(29).

<https://doi.org/10.14507/epaa.29.5429> This article is part of the special issue, *Policy Implementation as an Instrument to Achieve Educational Equity in the Community College Context*, guest edited by Eric R. Felix, H. Kenny Nienhuser, Ángel Gonzalez, Luz Burgos-López.

Journal website: <http://epaa.asu.edu/ojs/>

Facebook: /EPAAA

Twitter: @epaa_aape

Manuscript received: 3/27/2020

Revisions received: 1/18/2021

Accepted: 2/2/2021

Abstract: This qualitative research study describes how a Midwest community college's implementation of an Scholarships in Science, Technology, Engineering, and Mathematics (SSTEM) program influences engineering identity development for its students with financial need. Using a phenomenological approach, the study finds that the program enables community college students to have greater financial freedom and an ability to focus on engineering identity. In addition, the SSTEM program enhances student connections with STEM faculty, program staff, and peers. The study highlights the need for creating spaces for engineering identity development, developing connections between faculty, staff, and students, and enhancing transfer connections through different experiences. Future research might look to longitudinal designs and investigate additional contexts, engineering disciplines, gender differences, and programmatic structures to add nuance to these findings. The study suggests that practitioners might frame SSTEM and engineering experiences as opportunities for financial freedom and identity development and make further enhancements to transfer connections to four-year institutional partners. In terms of policy, the study suggests that policymakers consider identity development experiences an important aspect of funding SSTEM programs while enhancing programmatic support services available to students and placing greater emphasis on the collaborative actions, planned activities, and power dynamics between two- and four-year institutions funded by the SSTEM program.

Keywords: qualitative research; STEM Education; community colleges; engineering; identity; policy

La influencia de la implementación de políticas en el Midwest: Cómo un programa SSTEM amplía la participación y mejora la identidad de ingeniería para los estudiantes de colegios comunitarios

Resumen: Este estudio de investigación cualitativa describe cómo un colegio comunitario del Medio Oeste implementó un programa de Becas en Ciencia, Tecnología, Ingeniería y Matemáticas (SSTEM) y su influencia en el desarrollo de una identidad de ingeniería para estudiantes con necesidades financieras. Usando un enfoque fenomenológico, el estudio encuentra que el programa permite a los estudiantes de colegios comunitarios tener una mayor libertad financiera y la capacidad de enfocarse en la identidad de ingeniería. Además, el programa SSTEM mejora las conexiones de los estudiantes con los profesores, el personal del programa y los compañeros de STEM. El estudio destaca la necesidad de crear espacios para el desarrollo de la identidad de la ingeniería, creando conexiones entre profesores, personal y estudiantes, y mejorando las conexiones de transferencia a través de diferentes experiencias. En términos de política, el estudio sugiere que los formuladores de políticas consideren las experiencias para el desarrollo de la identidad como un aspecto importante del financiamiento de los programas SSTEM, y que pongan más servicios de apoyo a disposición de los estudiantes y pongan mayor énfasis en las acciones colaborativas, las actividades planificadas y la dinámica de poder entre dos - e instituciones de cuatro años financiadas por el programa SSTEM.

Palabras-clave: investigación cualitativa; Educación STEM; colegios comunitarios; ingeniería; identidad; política

A influência da implementação de políticas no Midwest: Como um programa SSTEM amplia a participação e melhora a identidade de engenharia para estudantes de faculdades comunitárias

Resumo: Este estudo de pesquisa qualitativa descreve como uma faculdade comunitária do Midwest implementou um programa de Bolsas de Estudo em Ciência, Tecnologia, Engenharia e Matemática (SSTEM) e sua influência no desenvolvimento de uma

identidade de engenharia para alunos com necessidades financeiras. Usando uma abordagem fenomenológica, o estudo descobriu que o programa permite que estudantes de faculdades comunitárias tenham maior liberdade financeira e a capacidade de se concentrar na identidade da engenharia. Além disso, o programa SSTEM melhora as conexões dos alunos com o corpo docente, equipe do programa e colegas STEM. O estudo destaca a necessidade de criar espaços para o desenvolvimento da identidade da engenharia, construindo conexões entre professores, funcionários e alunos e melhorando as conexões de transferência por meio de diferentes experiências. Em termos de política, o estudo sugere que os formuladores de políticas consideram as experiências para o desenvolvimento da identidade como um aspecto importante do financiamento de programas SSTEM, e que eles disponibilizam mais serviços de apoio aos alunos e colocam maior ênfase em ações colaborativas, atividades planejadas e dinâmica de poder entre dois - e instituições de quatro anos financiadas pelo programa SSTEM.

Palavras-chave: pesquisa qualitativa; Educação STEM; faculdades comunitárias; engenharia; identidade; política

The Influence of Policy Implementation in the Midwest: How an SSTEM Program Broadens Participation and Enhances Engineering Identity for Community College Students

Engineering continues to be a growing field in the United States and is projected to continue that growth into the future. A source of job growth, engineering disciplines will contribute more than 135,000 additional jobs to the current 1.6 million through 2026 (American Society for Engineering Education, 2018). As such, more incoming students are indicating an interest in engineering, and colleges and universities are answering the call to train greater numbers of engineers to join the workforce. The number of undergraduate engineering students increased 63% between 2006 and 2015 (National Center for Educational Statistics, 2018).

Community colleges (CCs) play an integral role in increasing access to and diversifying STEM higher education and the workforce (National Science Board, 2018). In fact, 47% of all STEM graduates completed at least some of their coursework at a CC (National Science Board, 2018). However, degree attainment remains a concern (National Center for Educational Statistics, 2018; President's Council of Advisors on Science and Technology, 2012). According to the Beginning Postsecondary Students ([BPS]'11-12), a nationally representative instrument that surveyed students at the end of their first year then followed up with students three and six years later, 43% of students were enrolled at a two-year institution (National Center for Educational Statistics, 2018). After three years, more than 45% of those students surveyed did not attain a degree or were no longer enrolled.

To be successful, it is important for community college engineering majors to see themselves as the type of person who "does" engineering (Rodriguez et al., 2019). A strong engineering identity can encourage students to continue building knowledge and skills as well as stay interested in the field despite challenges. As students perform and are recognized for their engineering identities, their understanding of their role within the engineering community becomes solidified. Students who do not see themselves in this engineering role are at higher risk of switching majors or dropping out of college altogether (Geisinger & Raman, 2013; Meyer & Marx, 2014).

For a variety of reasons, community college students may find it difficult to envision themselves as engineers. In particular, engineering students with financial need may lack support

from teachers, family, or friends for their educational pursuits, believe that engineering pursuits could have adverse costs for them, or feel as though their interests, values, or goals are not reflected in their peers or the larger engineering field (Major & Godwin, 2018). Community college students are also more likely to come from marginalized backgrounds (e.g. low-income, first-generation college student, racial/ethnic minority; Price & Tovar, 2014) and often attend college part-time while working, commuting, and taking care of a family (Cohen & Brawer, 2008; Gonzalez, 2000). As such, it can be difficult for community college students to get involved with extracurricular activities or access other resources (Pannoni, 2015).

The U.S. federal government and higher education institutions have attempted to support community college engineering students by implementing federally funded programs, such as the National Science Foundation's Scholarships in Science, Technology, Engineering, and Mathematics ([NSF-SSTEM]; National Science Foundation, 2021). The goals of NSF-SSTEM are to fund scholarships and support effective curricular and co-curricular activities in hopes of developing and diversifying STEM pathways for students. The SSTEM program addresses the need for the increased success of academically talented students with demonstrated financial need who are pursuing associate, baccalaureate, or graduate degrees in STEM. Specifically, our research site, Midwest Community College (a pseudonym), has an express desire to broaden participation and enhance engineering identity for students with financial need.

To date, little empirical, qualitative work has explored how federally funded programs implement policy in order to broaden participation and enhance engineering identity for community college students. This study utilized a phenomenological approach to examine the influence of how Midwest Community College implemented an SSTEM program to broaden participation and enhance engineering identity for their community college students with financial need.

Research Question

How does a community college's implementation of an SSTEM program influence engineering identity development for students with demonstrated financial need?

Background

While the need for a talented engineering workforce continues to grow in the United States, there has also been a significant movement by scholars, practitioners, and funding agencies to broaden participation in the field. Stakeholders have reached some consensus that engineers need to be diverse in order to understand complex problems and create a range of products. Prior research has shown that possessing a strong sense of engineering identity is important to one's ability to assume the role of engineer and be successful (e.g., Foor et al., 2007; Pierrakos et al., 2009). Engineering identity is defined as a student's ability to feel like the kind of person who is interested in, possesses the relevant knowledge and skills in, and engages in engineering practices (Godwin, 2016). Students with a strong sense of engineering identity establish and refine their engineering interests, build competence within this area, and perform their identities by utilizing various tools (Godwin, 2016; Godwin et al., 2013). These students are also recognized by themselves and others as the kind of individuals that engage in engineering (Godwin, 2016; Godwin et al., 2013).

However, students from traditionally marginalized backgrounds, including diverse socio-economic and income levels, may find it difficult to build and maintain engineering identities (Rodriguez et al., 2019). Students may find it difficult to see themselves in the role of an engineer due to perceived notions about engineering norms and values or explicit othering by engineering faculty

or peers. Students who do not possess a strong engineering identity risk feeling isolated from others within the engineering field or being pushed out of the role of engineer entirely (Tonso, 2006).

Historically, much engineering research has focused on the four-year university context, rather than the community college context. However, as a means to broaden participation in engineering, scholars have also sought to understand how to engage community college students and invest in pathways to and through the community college. Studies of community college students have found that clear STEM or engineering pathways, meaningful learning experiences, and faculty- and peer-mentoring, are essential to student persistence and transfer (e.g. Allen & Zhang, 2016; Wang, 2015). For studies that have looked specifically at engineering in the community college context (e.g. Allen & Zhang, 2016; Verdin et al., 2020), little research has focused on understanding the financial aid and funding experiences of engineering students, while none has connected issues of financial aid and funding experiences to the importance of implementing policies and programs that support engineering identity development. Policy aims to transform goals, actions, and strategies into changes that will address broad, complex social issues. Prior scholarship on policy implementation has acknowledged that “implementation is a decidedly complex endeavor” (Fixsen et al., 2005, p. 2). An important aspect of policy development is the act of engaging various stakeholders around these strategies and executing a meaningful series of steps for successful policy implementation (Brinkerhoff & Hoff, 2002; Khan, 2016). To do so, an understanding of educational stakeholder perspectives and values is important (VanIngenn-Dunn et al. 2016). Successful policy implementation is often dependent on creating strategies broad enough to have a significant impact yet tailored for context-specific issues that arise (Khan, 2016; Stewart et al., 2008). Prior studies have demonstrated the importance of a context-specific, thorough approach to implementation within the engineering context in order to make lasting changes (e.g. Friedensen et al, 2020; Rodriguez et al., 2020).

Utilizing elements of role theory and policy implementation, this qualitative research study seeks to fill a gap in the literature which, until now, has not explored how a community college’s implementation of an SSTEM program influenced engineering identity development for students with financial need. In doing so, this research addresses a scholarly need, and, more importantly, provides a foundation for understanding how key stakeholders, including policymakers, might consider the interplay between funding and engineering identity.

Conceptual Framework

This study examined the literature and conceptual elements of engineering identity development and policy implementation to understand how a community college’s implementation of a SSTEM program influenced engineering identity development for students with demonstrated financial need (Khan, 2016; Stewart et al., 2008; Stryker & Burke, 2000). Student experiences were analyzed using engineering identity development literature and theory, emphasizing the major elements of identifying as an engineer. Role identity theory addresses the meanings that individuals attach to the context of their social and cultural roles and recognizes that some identities, such as engineering identity, become more or less salient, depending on the circumstances in which an individual finds themselves (Stryker & Burke, 2000). One’s meaning making and understanding of the role that one plays influences the development of an engineering identity in several ways. Across psychology, sociology, science education, and engineering education, three interrelated conceptual factors (recognition, interest, and performance/competence) have been shown to influence the way in which identity develops.

First, recognition (or students' perception of how others view them) influences how students view themselves. Although early recognition from parents and teachers has been deemed important to early engineering identity development, recognition from faculty and engineering peers has also been seen as a key part of engineering identity development during college (Mannon & Schreuders, 2010; Strayhorn, 2010). Second, interest (often discussed as students' preferences or affinity toward a subject) influences how students will understand and be motivated to take on the role of an engineer (Dunst & Raab, 2012; Geisinger & Raman, 2013; Lent et al., 1994; Vygotsky et al., 2012). Third, performance (or competence) refers to the way in which students understand the knowledge and skills of their discipline and see themselves as the type of individual who is capable of participating in the discipline. These concepts play an important role in the self-efficacy beliefs of a student and influences engineering persistence (Marra et al., 2009; Mau, 2003).

This study also analyzed student experiences through the understanding of policy implementation within this Midwest CC educational context (Khan, 2016; Stewart et al., 2008). At its foundation, policy represents a statement of goals, actions, and strategies to address a social issue (in this case, broadening participation in STEM, particularly for students with demonstrated financial need). Policy implementation can be thought of as a key part of the policy-making process involving a series of educational stakeholders engaging with each other in order to achieve a specified goal (Khan, 2016). Successful policy outcomes are the result of not only well-designed policies but well-managed policy implementation (Brinkerhoff and Hoff, 2002). In order to address complex social issues such as these, policy is highly dependent on stakeholders' ability to successfully implement policy in a meaningful, context-specific way (Khan, 2016; Stewart et al., 2008). Analysis of student experiences enabled the researchers to understand how specific implementation policies (e.g., educational practices, interactions with affiliated SSTEM faculty and staff) contributed to engineering identity development and provided an opportunity to create recommendations for improving policy implementation.

Methods

Midwest CC Research Site

This study took place at a large, predominantly white urban public community college in the Midwest region of the United States. Manufacturing, healthcare, retail, and education are the predominant industries of the region, and, within the last 10 years, the institution's state has made considerable efforts towards statewide support of STEM economic development. The institution serves 35,000+ full- and part-time students at six campuses over a 22-county area and offers over 200 certificates, technical, pre-professional, and transfer degrees. Preparing students for STEM pathways has been a major focus area for this community college as evidenced by the number of enrolled STEM majors and a commitment by the organization to funding institutionalized STEM-specific leadership positions and participating in various STEM initiatives.

SSTEM Program

The community college within this study is involved in a multi-year, federally funded National Science Foundation Scholarships in Science, Technology, Engineering, and Mathematics (NSF-SSTEM) program. At the federal level, the SSTEM program is charged with increasing the success of low-income academically talented students with demonstrated financial need who are pursuing associate, baccalaureate, or graduate degrees in STEM. Per NSF guidelines, in order to be eligible for this scholarship program, students must: (1) be US citizens, US nationals, admitted as refugees, or admitted to the US for permanent residence (does not include Deferred Action for Childhood Arrivals [DACA] individuals), (2) be enrolled at least half-time (at this site for an associate's degree) in an SSTEM eligible discipline, (3) demonstrate academic ability or potential, (3)

be low-income as described by the institution, and (4) have demonstrated financial need as defined by the US Department of Education rules for need-based Federal financial aid Free Application for Federal Student Aid (FAFSA) (National Science Foundation, 2021). NSF relies on local standard financial aid policies to determine low-income status and academic ability or potential. In collaboration with a four-year university partner, the goal of the SSTEM program at this community college is to fund scholarships and support effective curricular and co-curricular activities in hopes of developing and diversifying STEM, and primarily CSE engineering, pathways for community college students. This goal targets enrollment, retention, and graduation numbers to increase the percentage of undergraduate women in CSE degree programs by doubling women enrollment to these programs.

Currently, this program serves 50 community college students interested in computer, software, and electrical (CSE) engineering pathways. SSTEM Scholars were 79% White, 13% Hispanic or Latino, 4% Black or African American, and 4% American Indian or Alaska Native. Only 10% of the scholars are women. Historically, only 15% of this community college students have indicated an interest in engineering pathways, and there have been few CC student transfers to the CSE engineering department at the four-year partner institution (it is the least popular transfer route of the 10+ engineering programs). However, the SSTEM work has increased attendance of women 19.4 percent since the collaboration started.

Through this program, the community college seeks to broaden engineering participation and enhance the engineering identity formation of community college students with demonstrated financial need. The program provided financial assistance to students (scholarships of \$1,000 and \$5,000 were offered), enhanced advising and mentoring by CC STEM faculty and staff (e.g. engineering specific CC advising, one-on-one mentoring by STEM faculty, group mentoring by SSTEM staff), and opportunities to interface with four-year university partners and students (e.g. meeting four-year SSTEM scholars, transfer and career fairs, specialized engineering admissions processes, transfer pathway advising, university engineering-specific campus visits).

In addition, the CC also partners with other concurrent STEM initiatives to enhance recruitment and retention of scholars, including the campus' Louis Stokes Alliances for Minority Participation (LSAMP) Program as well as the first-year engineering experience course. The CC's LSAMP Program seeks to broaden participation for racial and ethnic minority students who have traditionally been underrepresented in STEM, including African American, Hispanic American, American Indian, Alaska Native, Native Hawaiian, and Native Pacific Islander students. This partnership is currently still in development and hopes to encourage recruitment of racial and ethnic minority students into the SSTEM program. The CC's first-year engineering experience course (a one-hour weekly problem-solving and professional formation seminar) is a shared experience for the campus' engineering students and is taught by the SSTEM program's lead affiliated staff member. The SSTEM program has utilized this class as a means of recruitment for the SSTEM program and a way to build relationships with potential and current SSTEM scholars. Overall, the implementation of this SSTEM program at Midwest Community College intends to push students to develop interest, gain recognition, be able to perform and be competent in pursuing and developing as STEM students. Providing scholarships, advising and mentoring, and having collaboration with a four-year institution, while also being able to partake in other programs like LSAMP, enhances the opportunities for STEM students to prosper and engage in the implemented program.

Recruitment & Study Participants

Students involved with the community college's SSTEM program were invited to participate in the research study. Students were sent an email invitation (and subsequent follow-ups) during the academic year to encourage their participation. All students who indicated interest were interviewed

for this study. All study participants were involved in the community college SSTEM program (eligibility described above) and over the age of 18. Participants ranged in age (18-27) and represented a range of engineering and computing majors (e.g. computer science, electrical engineering). Of the nine participants, five students had family yearly incomes of less than \$39,999 and four identified as first-generation college students. Three participants had family yearly incomes above \$60,000 and were eligible for the SSTEM program based upon NSF and institutional guidelines for demonstrated financial need. Six participants identified as men and three identified as women. All participants identified as White or Caucasian, with exception of one participant who identified as an underrepresented racial/ethnic minority student (information further masked for identifiability purposes). See Table 1 for more information.

Table 1

Study Participants

Name	Age	Major	Family Yearly Income	First Generation College Student	Gender	Race/Ethnicity
Ada	24	Computer Science (interest in possible engineering and computing pathway)	Under \$19,999	No	Woman	White
Bruce	21	Software Engineering	N/A	No	Man	White
Frank	25	Electrical Engineering or Mechanical Engineering (pending)	\$100,000+	Yes	Man	White
Jacob	20	Pre-Engineering	\$20,000-\$29,999	Yes	Man	Caucasian or White
James	18	Electrical Engineering	\$60,000-\$69,999	No	Man	Caucasian
John	26	Electrical Engineering	\$20,000-\$29,999	No	Man	White
Laurely	27	Engineering	Under \$19,999	Yes	Woman	URM
Noreen	22	Engineering	\$80,000-\$89,999	Yes	Woman	White
Rowan	19	Pre-Engineering	\$30,000-\$39,999	No	Man	White

Data Collection & Analysis

This research study utilized a qualitative, phenomenological approach to examine engineering identity development in the experiences of nine community college engineering students at a predominantly white public institution in the Midwest. Qualitative research has the potential to serve as a type of broad policy knowledge, including shaping how stakeholders frame policy problems, which audiences engage with the research, and how educational reform takes place (Dumas & Anderson, 2014). Phenomenology allowed for the discovery of meanings, exploration of experiences with engineering, and provided rich detail of the meaning making and essence of an individual's identity development (Moustakas, 1994). Phenomenology enabled us to explore meanings that CC students attached to their experiences and understand the essence of how students experienced attempts to broaden participation and enhance engineering identity development within the SSTEM program (Moustakas, 1994). The primary methods for data collection were: (1) pre-interview questionnaires and (2) phenomenological semi-structured interviews.

Pre-Interview Questionnaire

This study utilized a questionnaire which was administered to participants at the beginning of the study in order to gather demographic and background information. The questionnaire also had items addressing engineering experiences at the institution. Data received enabled the researchers to create greater understanding of the student participant profile for the group as well as to tease out any aspects of a student's experience that might need to be explored in more depth during the interview process.

Phenomenological Interviews

This study used Seidman's (2006) model for conducting phenomenological, individual in-depth interviews. Each student participated in one semi-structured interview. Interviews were conducted face-to-face at a mutually agreed upon location. Interviews lasted approximately one and a half hours and were digitally recorded and transcribed verbatim for analysis. Individual interviews allowed the researchers to delve more deeply into the participant's experience, particularly around engineering identity development and clarify issues which were unclear to the researcher. Throughout the interview process, students were encouraged to expand the conversation and address any other information that they feel might be relevant to their engineering experiences.

Analysis

Using a phenomenological analysis approach, the researchers engaged in a four-step data analysis process (Moustakas, 1994). In Step 1, the researchers set aside their beliefs about the phenomenon (epoche) which enabled them to be receptive to the meanings that students ascribed to engineering experiences. In Step 2, they read the transcripts to gain to their core understandings (eidetic reduction). In Step 3, they examined the meaning units that students created from their experiences and considered the phenomenon from a variety of standpoints (imaginative variation). Authors coded transcripts for meaningful units utilizing both a priori codes (e.g. derived from the literature and conceptual framing) as well as emerging codes. Once coded, the authors extracted these meaningful units to reports which were utilized to define the essence of the phenomenon in the following step. In Step 4, the authors utilized inductive analysis to integrate meanings and define the essence of the phenomenon utilizing raw transcript data to verify the results (synthesis and verification). These essences of the phenomenon were then used to create the three main themes presented within this study.

Trustworthiness & Researcher Positionalities

To ensure trustworthiness of the study, team members reviewed transcripts, exchanged ideas on coding and analysis, and engaged in memoing activities. Reading through the collected information allowed the researchers not only to review the collected data but also allowed the researchers to begin understanding participant experiences in more detail and begin drawing connections between the data. Each researcher wrote analytical memos throughout their research and analysis activities. Memoing allowed the researchers to capture initial perspectives on the data as well as pose possible patterns or additional questions (Saldaña, 2009).

Furthermore, each of the research team members explored their positionalities as related to the study. Each of the authors brought a range of perspectives as a result of their identities, backgrounds, and professional experiences. All of the authors experienced financial need during college. All of the authors have previously conducted research in broadening participation in STEM. The first and second authors maintain active research agendas focused on broadening participation in STEM, and the third and fourth authors are full-time practitioners working with STEM programming and initiatives. The first and fourth author attended and worked within community college settings, and the second author had the opportunity to take community college courses during their educational journey. These perspectives and experiences enabled the researchers have a foundational understanding of the community college context, which aided the design and execution of the research project. In addition, it also allowed the researchers to build trust and rapport with participants in order to encourage greater sharing of their experiences. Finally, these perspectives and experiences assisted the researchers with data analysis, interpretation, and contextualizing findings.

Limitations

This study had several key limitations. The most notable limitations of this study were the single-institution context, the number of participants in the study, and majority White or Caucasian research sample. While the single-institution context allowed for a rich understanding of the policy implementation within a particular environment, findings may not reflect the experiences of all community college students. In addition, while the relatively small number of participants in the study is in line with qualitative, phenomenological norms, a larger, more diverse sample of participants could illuminate different experiences that may enrich what we know about implementation of SSTEM programs. Finally, this study was limited by the majority White or Caucasian sample, which was reflective of the overall racial and ethnic makeup of the SSTEM program, engineering programs, and the Midwest community college setting. Incorporating more of these perspectives could add additional nuance in future research to our understandings of the unique experiences of these students.

Findings

Findings reveal that the implementation of an SSTEM program enabled student participants to have greater financial freedom and establish connections with STEM faculty and program staff. To improve further SSTEM policy implementation, students expressed a desire to have greater connections and partnerships with SSTEM program's four-year transfer partner university.

SSTEM Program Enables Greater Financial Freedom & Ability to Focus on Engineering Identity

One of the significant benefits of acceptance into this CC's SSTEM program was the scholarship awarded to each scholar. Scholarships were provided annually and renewable at two levels, \$5,000 and \$1,000. Disbursements were made early in the semester and were promptly applied to their student accounts by associated SSTEM staff members working in conjunction with financial aid staff members. This clear process facilitated student enrollment into the program and access to needed funds in a timely manner. Despite the broad range of yearly family income levels (<\$19,000 to \$100,000+) and subsequent need levels, students found the scholarship a benefit to their educational journey.

Participants within this study, particularly men, believed that the SSTEM program allowed them greater financial freedom which ultimately allowed them to better focus on investing in their engineering studies and identities. For example, the financial security that the SSTEM scholarship brings has allowed James (18, Electrical Engineering), who enrolled directly after high school, to envision himself in the role of an engineer:

I didn't want to go to school. I didn't want to spend the money...[The SSTEM scholarship] was a really huge blessing...It's really a relief not to have to worry about certain financial stuff, and it just took the stress off overall...it helps fund my education and it's really important. I'd rather not leave school with a bunch of debt and that really helps just with, not even in school, but later on...to have a financially sound engineering job...you're working in a field that isn't threatened...the amount of electrical components we're using isn't going down. It's increasing. (James)

While James did not initially want to attend college, the SSTEM scholarship provided the financial incentive to attend. Because he is not burdened with student loan debt concerns, he can more fully explore his engineering interests and understand how he will assume a future role in the engineering field. Other students, like Bruce (21, Software Engineering), echoed James' sentiments regarding financial freedom:

It's nice to be able to come out and not have to have that overhanging...It makes me feel sponsored, like I'm actually am getting this scholarship because I am an engineer, and I'm doing well. I'm getting it because I'm doing well in classes, and I'm going in as an engineer. (Bruce)

For Bruce, being a part of the SSTEM program not only allowed for financial security, but solidified his sense of engineering identity. The program recognized his engineering competence so he felt empowered to perform his engineering identity.

The SSTEM program within this study made the decision to offer fewer scholarships of larger amounts to students in order to create a greater impact on their financial aid packages. While this limited the number of SSTEM scholars the program could support, it enabled funded students to feel a sense of financial security and decreased stress. Participants also articulated the importance that the SSTEM program's financial support had on off-setting parental financial contributions. For Rowan (19, Pre-Engineering), a student from a low-income background who enrolled shortly after finishing high school, the scholarship addressed his father's need for him to bring in money and helped him to feel a sense of recognition as an engineer trained at a community college:

I was a little humiliated at first going to [my community college]...it's kind of frowned upon to start at the community college...Part of me wasn't sure if I was necessarily ready to go off to university – if I was set in my major. My greatest fear

was I was afraid that I would completely change majors and I'd spend a year of tuition and not want to do that...I think even being granted the scholarship made me pretty ecstatic actually because it's the first big one that I've gotten. I think it goes back to that idea of, "You need to bring in money," from my dad. This was a way I'm bringing in money. I've got some money now. I know it's not all about money and everything, but it really did help relieve that stress, constantly being told that you need to bring in money. (Rowan)

Simultaneously, Rowan felt a sense of humiliation from his enrollment at a community college and shame from his father for not contributing financially to his education. The SSTEM program enabled Rowan to be recognized as the kind of person who does engineering and addressed the pressure from his father to bring in funds.

In addition, leaders and staff members associated with the SSTEM program framed the program not only around demonstrated financial need, but utilized language around career exploration, educational equity, and a sense of honor. Notably, participants highlighted how the SSTEM program simultaneously supported and inspired a sense of responsibility about their engineering pursuits and engineering identity development.

For example, John (26, Electrical Engineering), a non-traditionally aged student from a low-income background, related how important it was to him to develop his engineering interests and identity:

A lot of [college] kids make their decision of going into engineering based off of money, rather than their interest. I see a lot of people in my classes that they aren't engineers. They're smart, don't get me wrong, but they are not interested in what they're doing. But they want to do it because they want to make money, not for the field or the engineering itself. (John)

He went on to describe how the SSTEM program has supported his ability to engage full-time on developing his engineering interests and perform as an engineer:

I didn't pay for anything for the school...it definitely helped me out as far as speeding up my college process. I'm able to take 16, 17, 18 credits because I don't have a job right now...It's definitely pushing me to keep going because I feel like I've been given this money, and it's kind of motivating to say hey they're supporting me, I need to perform...They're giving me this money, they're going out of their way to pay for it, [and] I want to be the best student I can be... (John)

Due to the financial support, John, a student from a low-income background, did not have to work in order to pay for his courses. Instead, he could take additional courses and get to his engineering content courses faster. This funding not only made him feel supported but also gave him a sense of responsibility about building and performing his engineering identity.

The SSTEM Program Enhances Connections with STEM Faculty, Program Staff, and Peers

Participants within the SSTEM program, particularly women, felt that their participation enhanced their connections with STEM faculty, program staff, and peers. To enhance connections with STEM faculty, program staff, and peers, the leaders of the program implemented several strategies around career exploration, mentorship, advising, and transfer connections. SSTEM program staff framed the scholar experience around career exploration as well as provided structured on-going opportunities for mentorship with STEM faculty members. In addition, SSTEM program staff created advising opportunities (beyond traditional modes of institutional advising) that

provided scholars with targeted engineering advising and collaborated with their four-year partner university to offer transfer student connections (e.g. transfer fairs, university engineering specific advising, meetings with four-year university SSTEM students).

Through their funding and participation in the program, women students were able to better understand their roles as engineers and develop their engineering identities with the support of program faculty and staff. For Ada (24, Computer Science), a student from a low-income background, the SSTEM program was a place where she could learn how to navigate her role as an engineer:

I didn't take a single computer class in high school...I had no realization that I was either a) good at the stuff, or b) interested in this stuff...Not thinking I was good in those, I didn't think computers would be something I could do...It's still kind of new-ish to me, but it's, a program that can help me figure out what I want to do to a certain extent and help give me the tools to go do it. Through the mentorship program, talking to different professors that have gone out and actually worked in the work force and have done the jobs that I potentially would be doing in the future, it's been really good...I think it's a support system for incoming engineers to make sure that we're getting the best out of what we're doing, and we have this backbone, and maybe that it's also so you can make these connections so when we transfer over ... 'cause it's gonna be hard to transfer over anyways. The classes are hard and it's gonna be a big adjustment, so you wanna make sure that you have resources. (Ada)

Ada was able to access the mentoring support systems that she needed as a new engineer and gain the resources that she needed to transfer. While she came to the community college with little knowledge and skills of engineering, the SSTEM program assisted with building her competence and allowing her the space to perform and be recognized for her engineering identity.

Participants also articulated the ways in which the SSTEM program helped to address weaknesses in their engineering identities and connect them with STEM mentors and fellow engineering peers. The SSTEM program implemented a series of support activities that went beyond the scholarship funds made available to students. These support activities included meaningful interactions with STEM faculty and SSTEM scholars and program staff members, both at the CC and the four-year partner institution. SSTEM scholars had the opportunity to meet these individuals in one-on-one sessions (e.g. mentoring, advising) as well as in group settings (e.g. dinners, transfer fairs).

For example, Noreen's (22, Engineering) engineering identity was complicated by the shame associated with community college enrollment and not securing an engineering internship:

Community college 1) wasn't something I saw people doing and, 2) wasn't advertised a lot at my school. [Four-year institutions] were the places that people went if they got out of the small town...if I chose to go to a community college, some people would see that as a failure... I wasn't able to find an engineering internship for this summer...I felt like I wasn't really an engineer because of that. I'm still working at the same part-time job I had last year during school...every single time I'm struggling, there's a voice in my head... well maybe I'm not supposed to be in this field. Maybe it's so hard for me because this isn't what I'm meant to do. (Noreen)

Noreen's experiences as a first-generation college student continuously caused her to doubt her own competence and ability to be successful within the engineering field. However, her participation in

the SSTEM program enabled her to connect with STEM faculty, program staff, and peers to feel a greater sense of belonging within the engineering field and strengthen her engineering identity:

I get to go talk to the [SSTEM] scholars at [the four-year partner institution]. I also have this [SSTEM advisor] who's awesome, here at [my community college]. I just kind of got all these perks...I really like having multiple advisors...just being part of an engineering program makes you feel a little bit more like an engineer...you're gonna meet people that are also going through the same things you are, that are getting help, that are in your field of study, and you have something to talk about. And that helps you make relationships. Like, "oh how did you get here? Oh, you're in [SSTEM]? So am I. Are you gonna go to the dinner on the whatever, in the end of April to [the four-year partner institution]? Oh, awesome, we'll sit together, great. We have each other. (Noreen)

For Noreen, the SSTEM program expanded her networks and connected her with the mentoring and peer-to-peer experiences that she, as a first-generation college student, needed to feel more like an engineer. By interacting with program leadership and peers, she is able to build relationships over shared interests and have another space in which to perform and be recognized for her engineering identity.

Similarly, Laurely (27, Engineering), a first-generation college student from a low-income background, felt as though SSTEM helped her to refine her interests and facilitated her own self-recognition as an engineer:

I think really [the SSTEM Program] actually influences a lot my identity...being an [SSTEM Program] Scholar makes me proud...I see it's a great opportunity because you have the chance to actually be connected to people...There are all those groups of people around you who can help you figure out what you really want to do...even though you don't know what you want to do in engineering, those [SSTEM] instructors and everybody around it can help you figure out what you really want to do...For me, I can say [having an SSTEM mentor] maybe more helpful for me because I didn't grow up here...she's there for you to help you think things through, like for your four-year degree. (Laurely)

The SSTEM program's year-round commitment to faculty-, staff-, and peer- mentoring activities encouraged students to create and strengthen various connections within the program. Faculty and staff mentoring activities generally encouraged students to understand their engineering career options, learn about possible college academic pathways, and plan for their transfer to a four-year university. Laurely believed that the SSTEM program's focus on engineering identity development permeated her experience. As a first-generation college student from a low-income background and immigrant woman of color, having a mentor and supportive peers encouraged her to feel a sense of pride in her community college experience and understand her role in engineering.

The Need for Enhanced Transfer Connections to Strengthen Engineering Identity

The SSTEM program implemented several policies meant to encourage transfer pathways and connections with the four-year university partner. These policies included a range of elements from giving SSTEM scholars preferred status in their application for the four-year university's SSTEM program to structured touch-point meetings between CC and four-year university SSTEM scholars. In addition, the two SSTEM programs collaborated to bring SSTEM scholars to the four-year university transfer fair and provided targeted engineering specific advising to SSTEM students. Collaborators at the two institutions frequently shared information, met multiple times per year, and

were in regular contact with each other about opportunities to share information across contexts and bring CC students to the four-year campus. However, despite these implementation measures, SSTEM scholars still voiced transfer student concerns regarding accepted credits and educational pathways and worried whether they had the requisite skills necessary to be successful within an engineering program at the four-year institution.

Participants also articulated the need for enhanced two-year and four-year connections and partnerships in order to facilitate a smooth transfer process and continued strong sense of engineering identity. Students worried about the practical implications of their transfer credits in addition to questions as to whether they had the technical knowledge and relevant skills needed to be successful as an engineer. For example, Noreen (22, Engineering), a first-generation college student, who struggled with engineering self-doubt, praised her community college mentor, but desired to connect with the four-year institution advisors:

[My community college SSTEM mentor], who has a mathematics and engineering background, he has a really good idea of what I should be taking, but...I need to talk to my [four-year institution partner] advisor, because ultimately, I'm going to [the four-year institution]. I wanna make sure that I have what that college wants. So if I can compare those [advisors' advice], then that gives me a pretty good idea I'm on the right track. (Noreen)

While she may be developing a strong set of knowledge and skills at the community, Noreen recognizes the power that the four-year institution advisors have over her transfer process and ability to perform as an engineer. Rather than rely solely on the support of the community college, Noreen needs support and recognition from four-year institutional partners in order to feel as though she is on-track to transfer and assume the role of engineering student at the four-year institution.

In particular, participants worried as to whether they had the competence that would be required of a four-year engineering student. Although students learned various forms of knowledge and skills for their engineering success, they remained concerned as to how that competence might translate in the future. For example, Jacob (20, Pre-Engineering), a first-generation college student from a low-income background, worried about his prior computer and programming skills during the transfer process:

One thing I'm kind of worried about right now is my computer and programming skills. Like I'm kind of, I don't know, for my next semester. I know there's a part of transfer credits I'm confused on. I don't know if I need a programming background or just stuff cause right now I haven't taken any computer programming type classes, and I don't know if I need that... (Jacob)

Although he knows that computing skills are essential to the role of an engineer, he did not know how that translates to the actual requirements needed of him at the four-year institution. This type of uncertainty about what kinds of skills are needed complicate his ability to feel a strong sense of engineering identity and security about his transfer process.

Even though SSTEM scholars were provided with mentors at the CC and four-year institution, as well as advising opportunities, they desired additional advising and mentorship. Students described how appreciative they were of their community college mentors and staff but remained deeply concerned about institutional transfer requirements, the role of the engineering student at the four-year university (and the field), and whether they, as community college students, had what it took to successfully navigate this changing role. John (26, Electrical Engineering), a

student from a low-income background, wanted to see strengthened connections between the two-year and four-year institution so that he can get a better sense of the transfer process:

[My community college SSTEM mentor] is still learning how to be a mentor...I think I'm his first student that he's mentoring. So, it seems like it's still in the development phase. I'm not sure if there's people at [the four-year partner institution] that are part of the program, but meeting with them would be awesome. I feel like I have a thousand questions for a junior at [the four-year partner institution] right now in engineering. In the engineering field. I feel like I have a thousand questions I could ask and maybe some sort of connections [at the university]. (John)

While John appreciated his community college mentor, he recognized that this individual is new to the mentoring process, leading John to emphasize his desire to connect with the four-year university partners, particularly the students, to understand more about the transfer process and role of an engineering student. As described earlier, John feels a deep sense of connection with the role of an engineer, and it is through these continued connections that he hopes to sustain his engineering identity.

Discussion

Overall, the study revealed that implementation practices around financial investment, relationship-building, and transfer connections influenced engineering identity development for CC SSTEM students with demonstrated financial need. Similar to prior scholarship which has highlighted the complexity and need for well-designed implementation (Brinkerhoff & Hoff, 2002; Fixsen et al., 2005), this study showed how a CC could implement an SSTEM program that would not only provide financial freedom for students but also encouraged students to build and maintain their engineering identities. Furthermore, this research site's emphasis on stakeholder interactions and perspective sharing among SSTEM program staff, STEM faculty, advisors and staff, students, and four-year university partners in order to make context-specific, tailored engineering experiences for students is aligned with prior scholarship on effective implementation (Khan, 2016; Rodriguez et al., 2020; VanIngenn-Dunn et. al. 2016).

The study extends the literature by connecting implementation issues within engineering contexts to what scholars know about engineering identity development, particularly for CC students with demonstrated financial need. It revealed that implementing no restrictions on credit-taking levels, pushing for higher levels of support, and partnering with the financial aid office enabled students from varied income backgrounds to feel a sense of financial freedom. In particular, this study may also suggest that male students, especially those from low-income backgrounds, may feel less monetary stress and change their behaviors (e.g. going full-time, taking more credits) as a result of such implementation.

This research demonstrates the ability of the SSTEM program to encourage financial freedom and facilitate focus on engineering identity. Students, particularly men, believed that they could invest more deeply in their engineering identities and role. The SSTEM scholarship alleviated debt-related anxieties and allowed for the lifting of their previous shame of attending a community college. Men also believed that by attaining the SSTEM scholarship funding, they were bringing in income for their families, which pleased their fathers. Such an accomplishment meant that they could increase the speed and depth of their studies in order to grow their engineering interests and perform their engineering identities. While prior scholarship has demonstrated the importance of

financial aid enhancing a student's feelings of financial stress, freedom, and decision-making (e.g. Haughwout et al. 2015; Heckman et al. 2014; Rothstein & Rouse 2011), scholars have not connected this issue to the ability to develop an engineering identity. Similarly, scholars have long known that men, particularly college men, often seek status and financial stability in relationship to their sense of masculinities (O'Neil, 2008; Saenz et al., 2013). However, this study may be the first to connect this idea to the development of an engineering identity within community college men who may feel as though their institution is a low-prestige setting.

The current study also extends the literature on implementation practices for engineering contexts by highlighting the link between well-designed, relationship-based strategies and the benefits that women engineering students see in their engineering identity development. Women scholars benefited from the implementation strategies around career exploration, mentorship, advising, and transfer connections. Through this multipronged approach of support practices, women were able to explore their interests, build the needed knowledge and skills to be successful, and see themselves as future engineers. In particular, the mentoring and advising faculty and staff components gave women students an understanding of how to navigate their CC educational journey and engineering transfer process. Furthermore, the study suggests that these implementation practices may be especially important for women coming from marginalized backgrounds, including first-generation college students, students from low-income backgrounds, and students from immigrant backgrounds.

This study also demonstrates how the implementation of an SSTEM program enhances student connections with STEM faculty, program staff, and peers, particularly for women. The women within this study utilized the program not only for financial benefits, but also to form mentoring connections to enhance their engineering identities. Because many of the women participants were new to engineering, they were often concerned with self-doubt and needed mentorship to navigate their engineering interests and make sense of their identities. Despite the students' persistent questioning of shame around being at the community college, the SSTEM program encouraged students to feel more like engineers. Implementation of the program helped to define engineering identity and role, particularly if a student came from a traditionally marginalized background (e.g. women, rural, and/or immigrant backgrounds). In the past, scholarship has reiterated the importance of college student connections with faculty, staff, and peers (e.g., Rendon et al, 2011; Yosso, 2005). However, far less is known about how community college students in STEM navigate their STEM identities (e.g., Rodriguez et al., 2019), and even less known about the influence of financial aid on developing a STEM identity while at the two-year institution.

Finally, this research study complicates what we know about implementation of CC and four-year engineering partnerships and suggests additional examination of how implementation of transfer policy and practice can facilitate the development of an engineering identity. SSTEM program staff at the CC had implemented a wide range of policies and practices meant to encourage the success and engineering identity development of CC students with demonstrated financial need. However, students, particularly those who were first-generation college students or from low-income backgrounds, still had questions about transfer credit requirements, required knowledge, and the nature of the four-year university student experience.

The study suggests the need for enhanced transfer connections between community colleges and four-year institutions to strengthen college student engineering identity. While students within the study appreciated their SSTEM community college mentors, they craved the ability to be connected with university mentors and program staff. Students were unsure of the various forms of competence that were needed to successfully assume their engineering roles after transfer, which left them with considerable anxiety about the status of their engineering identity. Prior scholarship has shown that community college STEM students, particularly women, face challenges to upward

transfer to a four-year institution (e.g., Blaney, 2020; Jackson & Laanan, 2015). Additionally, while scholars know that STEM identity development is important for community college STEM students (e.g., Rodriguez et al., 2019), and that socio-economic status and finances are important factors for success (e.g., Major & Godwin, 2018), less is known about the connections that STEM identity, socio-economic status, and financial aid have in the development process for college students. Furthermore, this paper suggests the need to consider engineering identity across the transfer process, rather than discretely on either side of it. This research study suggests that students with demonstrated financial need, especially those from first-generation college student or low-income backgrounds, may experience even greater challenges related to building and maintaining engineering identities through the transfer process, including navigating multiple sets of expectations, people, and processes.

Implications

Implications for Future Research

This study has several key implications for future research. This study was focused on the SSTEM implementation context of one institution in the Midwest, but future research might seek to understand community college engineering identity experiences at other types of institutional locations or contexts. Investigating this phenomenon within differing contexts (e.g., Hispanic-serving Institutions [HSIs]) or other locations (e.g., southwestern United States) might result in differing experiences in implementation for SSTEM students. In addition, future research should seek to explore field or disciplinary differences (e.g. computer engineering, chemistry) or investigate subpopulations within the SSTEM program community college engineering population (e.g. low-income, first-generation college student, Latinx, Black), as many of these factors may influence how engineering identity is built and refined throughout college, including the transfer process. Scholars might also consider studies that delve more deeply into understanding the differences in specific SSTEM programmatic structures (e.g. mentoring, peer interactions, transfer connections) that are influential to supporting engineering identity components (i.e. interest, recognition, competence, performance). Finally, while this study represents one point in time, longitudinal studies of SSTEM engineering identity (particularly across the transfer process), may assist in understanding how programs like these can enable students to more easily make educational transitions while continuing to build and refine engineering identities.

Recommendations for Practice & Policy

Studies such as this one may provide scholars, administrators, and policymakers with a greater understanding of broadening participation efforts and challenge them to consider how programs and initiatives shape student engineering identity development. At the community college level, SSTEM programs might support engineering identity development so that community college students feel secure in their choice to attend the institution as well as their ability to be successful within an engineering role.

Creating Spaces for Engineering Identity Development

Community college SSTEM programs should consider: 1) providing spaces for engineering students to learn about new engineering concepts and career pathways, gaining the knowledge and experience with tools that they will need in the future (interest and competence building); 2) providing students with opportunities to put their knowledge and skills to work in order to give them real-life experiences with STEM opportunities (identity performance); and 3) providing students with opportunities to be recognized by others as the kind of people to “do” STEM,

including the chance to present, write, or interact with others in the STEM community (identity recognition). Currently, the Midwest CC involved in this study leverages a first-year engineering course for SSTEM recruitment and retention; this study suggests that spaces such as this could be transformative for encouraging engineering identity development. These engineering spaces could be created as stand-alone one-hour courses or leverage existing structures such as first-year experience courses by creating focused engineering cohorts and provide SSTEM scholars (and other engineering students) a space for exploring their engineering identities.

Developing Connections between Faculty, Staff, and Students

Practitioners should consider being more purposeful in encouraging students to view the SSTEM scholarship as a means of financial freedom that enables them ability to focus on engineering studies and explore engineering identities. Administrators can encourage multiple elements of engineering identity development by implementing meaningful connections and relationship-building within SSTEM programs, building in mentoring structures, and creating opportunities for peer-to-peer interactions. As practitioners and faculty have the opportunity to interact, mentor and support SSTEM students, it is important for the connections to be rooted with individuals that have training to work with various intersecting identities (e.g. gender, first-generation college student, students from low-income backgrounds). To do so, administrators should seek training of their SSTEM staff and community college faculty mentors (and greater faculty) on how to support engineering identity development, particularly for historically marginalized groups. Currently, training typically focuses on the ability to understand the engineering curriculum and non-curricular engagement opportunities to enhance the scholars' curricular experiences. However, we suggest to push that these trainings incorporate ways to further enhance and support engineering identity development, especially within marginalized groups. Lastly, this study suggests that practitioners should also focus on implementing better connections between SSTEM scholars and their program peers. These relationships have the ability to positively influence engineering identity by creating community and opportunities to reinforce engineering identities. However, SSTEM staff and faculty should take a meaningful approach to implementing these connections to ensure that they are positive interactions that encourage, rather than discourage, engineering identity.

Enhancing Transfer Connections through Different Engineering Experiences

Practitioners should consider enhancing transfer connections for community college SSTEM students, which may provide positive outcomes for both the community college and four-year students as well as both sets of SSTEM program staff, faculty, and students. In terms of practice, two- and four-year institutions should construct student, faculty, and staff experiences for greater socialization and meaningful interactions between the joint SSTEM community, including enhanced advising and mentoring opportunities. Initiatives such as this should benefit from educating our community about two-year pathways for engineering and eliminate the stigma of community college enrollment. This should be done in the form of highlighting initiatives, pathways, scholarships, or industry partnerships for community college students, making engineering pathways clearer, viable, and seamless for SSTEM students. At the four-year institution, the SSTEM program should work towards being more inclusive of community college students at partner institutions, providing incentives for SSTEM community college transfer students.

These findings are also relevant to federal policy discussions and funding decisions involving engineering and other SSTEM students, particularly those dealing with enhancing STEM pathways or professional identity formation. Policymakers should take into consideration the STEM identity experiences of students, especially given the growing research in the area. In addition, policymakers should consider issues of intersections of identity explicitly in approaches to funding, including how

requests for proposals ask potential grantees to address intersecting identities and dismantle oppressive structural issues in STEM. Finally, policymakers should seek greater clarity about the importance of two-year and four-year collaborations, including collaborative and planning needs, funding equity, and balanced power dynamics.

Conclusion

Through the implementation of this SSTEM program, CC students with demonstrated financial need engaged in a series of engineering opportunities and developed their engineering identity. SSTEM program implementation at this CC instilled a sense of financial freedom, created influential connections through mentorships with staff and faculty members, built community with other engineering students and provided transfer connections with a four-year institution. Through these practices, students with demonstrated financial need developed their engineering identities without the burden of financial stress and built lasting connections between themselves and the engineering communities at the CC and the four-year institution.

Acknowledgements

This research is based upon work supported for the National Science Foundation (NSF) [under award #1565130]. Any opinions, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of the NSF.

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SPECIAL ISSUE
**Policy Implementation as an Instrument to Achieve Educational
Equity in the Community College Context**

education policy analysis archives

Volume 29 Number 29

March 8, 2021

ISSN 1068-2341



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