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Examining the Self-Efficacy of Community College STEM Majors: Factors Related to Four-Year Degree Attainment

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Despite the awareness of the importance of self-efficacy, this concept has been studied in a limited sense among community college students (Collins & Bissell, 2004), but it has been shown to be significantly related to career decisions among enrollees (Kelly & Hatcher, 2013). The literature does not address what types of experiences can improve or enhance self-efficacy among college students as it relates to research and among community college students specifically. This study addresses the gap in the literature by examining what experiences can improve the self-efficacy of community college students as it relates to research and whether this has an impact on their long-term career plans to pursue a science, technology, engineering, and mathematics (STEM) career.

To continue to advance in science and technology and to thrive in a global economy, the United States will have to rely on well-trained scientists and engineers to develop innovative and high-value-added products and services, as well as to improve productivity through the use of technology-based tools (Babco, Chubin, & May, 2005). This pool of scientists and engineers, with its underrepresentation of women and underrepresented minorities (African Americans, American Indians or Alaskan Natives, and Hispanic Americans), is a critical concern for the U. S. (National Action Council for Minorities in Engineering, 2008). In 2010, the National Academy of Sciences reported that underrepresented minorities "embody a vastly underused resource and a lost opportunity for meeting our nation's technology needs" (p. 1). In light of tremendous challenges for sustainably generating energy, which is essential to life in modern society, it is even more critical for four-year institutions to reach out to pools of students comprising traditionally underrepresented groups in science and engineering programs.

One such pool is community college students pursuing math, chemistry, and physics courses that are transferrable to baccalaureate programs. With more resources being allocated to

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community colleges to stimulate student achievement in science, technology, engineering, and mathematics (STEM) fields, and community colleges serving many ethnic and racial minorities, community college students are uniquely positioned to strengthen the pool of STEM professionals. With enrollment in the nation's community colleges hitting an all-time high, students from these institutions are a rich source of the nation's future recipients of undergraduate and graduate degrees in STEM fields. The community college transfer pathway is a frequent choice for African American, Hispanic, and Native American STEM degree recipients, as well as low-income students. This is due to the lower cost of such a pathway ($36/unit) (California Community College Chancellor's Office, 2011). During the 2009–2010 academic year, California alone enrolled 2.7 million students. The California Community College System (CCCS) is the largest community college system in the U.S., serving 25% of the nation's community college students (California Post Secondary Education Commission, 2010). Of the students enrolled for 2009–2010, 40% were from National Science Foundation-categorized underrepresented minority backgrounds. In the fall 2009 semester, nearly 50,000 CCCS students transferred to University of California (UC) or California State University (CSU) campuses (California Post Secondary Education Commission, 2010).

Given these statistics, the University of California at Berkeley developed a summer research program for community college students that is catalyzed by early hands-on involvement in research projects that apply nanotechnology and biotechnology to address energy problems in a high-caliber research environment. The program, which adapts Bransford's (2000) framework, is comprised of knowledge-, learner-, assessment-, and community-centered activities to develop the self-efficacy of community college students that participate, specifically as it relates to research skills. This program provides community college students an eight-week research experience after being accepted into the program. This program includes on-campus housing, a weekly program that includes speakers and panel discussions, and placement in a lab where students work closely with a mentor to carry out their assigned tasks on the research project.

LITERATURE REVIEW

Previous research indicates that knowledge about the admissions process, as well as psychological factors, impact transfer to four-year institutions among community college students, and it shows that satisfaction with the advising process plays an important role (Gard, Paton, & Gosselin, 2012). In considering potential psychological factors that might impact rate of transfer, self-efficacy has been identified as an important concept when considering success and retention among underrepresented groups in STEM fields. Self-efficacy has been conceptualized as four domains: mastery experience, vicarious experience, social persuasion, and physiological reaction (Bandura, 1997; Gist & Mitchell, 1992; Pajares, 2005). Individuals receive information from each domain either through interaction with others or interaction as a result of different experiences and situations, impacting their behavior positively or negatively. Self-efficacy has been shown to influence decisions people make, how much effort they put forth, and the degree to which they persist in the face of adversity (Huchinson, Follman, Sumpter, & Bodner, 2006). Mastery experience is viewed as having previous experience or performance with a certain task, and it has been shown to be one of the most influential domains (Zeldin & Pajares, 2000). Vicarious experience is defined as learning by observing others perform a task. Social persuasion refers to assessments or feedback provided by others. In each of these domains, positive experiences will boost an individual's self-efficacy where negative experiences will diminish it. Physiological reaction is the fourth domain and refers to the emotional or physical state during a task. Ideally, individuals would want to be calm and composed instead of apprehensive or anxious about a given task (Bandura, 1986; Bandura, 1997; Schunk, 1994).

Students with higher self-efficacy have been shown to persist to degree at higher rates and perform better in their course work than those with lower self-efficacy (Britner & Pajares, 2006; Pajares, 2005). Among first year engineering students, each of the four domains of self-efficacy have been shown to influence perceptions of their performance in coursework with mastery experiences, or their performance on course related tasks, being the most influential (Hutchinson, Follman, Sumpter, & Bodner, 2006). Self-efficacy beliefs change over the course of enrollment with vicarious experience, or comparison of personal performance to that of others; and they become more important as students progress through their coursework at the college level (Hutchinson-Green, Follman, & Bodner, 2008). Female engineering students tend to have lower self-efficacy than male peers, reporting that they perceived they were not able to perform as well as their peers (Hutchinson-Green et al., 2008). Self-efficacy has been shown to influence engineering students' self-regulated learning behaviors and grade point average (GPA) (Vogt, 2008). Faculty member's accessibility can influence self-efficacy, providing opportunities for faculty interaction; and feedback to students can reinforce positive experiences and build students' self-efficacy beliefs across domains (Vogt, 2008). The curriculum and the way it is taught can also impact students' self-efficacy; well-structured collaborative experiences and hands-on activities have been shown to have positive implications for self-efficacy (Ponton, Edmister, Ukeiley, & Seiner, 2001) across majority and minority students enrolled in an engineering major (Marra, Rodgers, Shen, & Bogue, 2009).

Despite the awareness of the importance of self-efficacy and the correlation that self-efficacy is related to career decisions among enrollees (Kelly & Hatcher, 2013; Rittmayer & Beier, 2008), limited research among community college students has been conducted (Collins & Bissell, 2004). The literature does not address what types of experiences can improve or enhance self-efficacy among college students as it relates to research and among community college student specifically. This study addresses the gap in the literature by examining what experiences can improve the self-efficacy of community college students as it relates to research and whether this has an impact on their long-term career plans to pursue a STEM career.

METHODOLOGY

A mixed-methods approach using formative and summative evaluation measures was used to assess the impact of the summer experience on students' self-efficacy, specifically as it pertains to an eight-week summer research experience at the University of California at Berkeley for California community college students. All of the 30 students that were accepted into and participated in the summer research experience during the summers of 2012 and 2013 comprised the sample for this study. Participants in the summer research experience are also referred to as an intern, and this term is used interchangeably with the word student and participant in the methodology, findings, and discussion of this paper. A presurvey was administered to the students one week prior to their arrival on the University of California at Berkeley's campus.

The survey asked students about their degree aspirations, knowledge about the admissions process for enrollment at a four-year institution, their confidence related to whether they thought they would be successful at a four-year institution, and their long-term career goals. Students' perceptions about whether they had the needed criteria for admittance to, and success at, a four-year institution were also solicited. Questions asked participants about their clarity of their academic and career goals. Participants were also asked to rate themselves on key skills in comparison to peers including leadership, research, critical thinking, teamwork, and communication skills. A series of questions was also designed to capture students' research self-efficacy and were based on the four domains associated with this construct. Demographics about participants were also collected including income level, race, and gender. Students were also asked to name the top three institutions that they wanted to apply to and asked why they wanted to participate in the summer research experience.

The postsurvey had similar questions as the presurvey so that gains over the summer could be measured in key areas that the program was designed to develop or enhance among participants. In addition, there were several questions that asked students about their experience over the summer and the satisfaction that they received in relation to mentoring and support from the program staff. Additional questions included an open-ended question that asked them what they learned over the summer.

In addition to the pre- and postsurvey, there were also weekly journals that students were required to complete. The journal entries were submitted each week to the program staff. Once all entries were collected for both cohorts (2012 and 2013), a content analysis was conducted to determine the degree to which self-efficacy might have improved among interns over the eight-week period and what experiences impacted their self-efficacy.

ANALYSIS

Mean scores were computed for the survey data for the four questions related to self-efficacy on both the pretest and posttest responses. Following the analysis of the survey data, the weekly journal entries for the 30 interns were analyzed using a content analysis for the entries (Stemler, 2001). An a priori coding scheme was used with the four identified self-efficacy domain areas serving as the initial codes. Following the initial coding process, new themes emerged and additional codes were assigned. Specifically, mastery experience served as the code when participants described gaining hands-on experience with a specific task they thought they would have to perform again. Vicarious experience served as the code for journal descriptions that identified learning by observing others doing a task they thought they would need to do. In the journal entries, writing that identified judgments or feedback provided by others was coded as social persuasion. The fourth code was comprised of physiological reaction, and it was used for descriptions of emotions and physical states including anxiety that writing passages detailed (Bandura, 1986, 1997; Schunk, 1994).

Writing passages were initially coded based on which theme emerged from the writing. Additional codes emerged according to what groups or experiences were influencing the self-efficacy domains and included mentors, the collaborative nature of the lab setting where the research internship was taking place, and the realization that the experiences had a real-life application. These themes were shown to have an impact on the community college students' self-efficacy as it relates to research and long-term interest in a STEM field.

RESULTS

Among the sample of 30 community college student participants, or interns, 10 were first generation college students; 7 were female, and 23 were male (see Table 1). In addition, there was diverse racial and ethnic representation (see Table 2).

Each of these participants met the minimum requirements for the summer program: 3.25 GPA or higher for science, engineering, and math courses; completed two calculus courses; and completed three science or engineering courses, one of which has a laboratory component. To date, as of the last longitudinal follow-up with the interns, 11 (36.7%) have transferred to, and are enrolled in, a four-year institution; 17 (56.7%) have applied, were admitted, and will transfer to a four-year institution in fall 2014; and 2 (6.7%) remain enrolled in STEM programs at the community college level.

Quantitative Results

When considering the survey results, there were noticeable gains in the self-efficacy of the community college participants over the course of the experience. Postsurvey results for each of

TABLE 1
Summary of Participants (N = 30)

	N *(%)*
Men	23 (76.6%)
Women	7 (23.3%)
Underrepresented Minority[1]	12 (40%)
Underrepresented Group[2]	19 (63.3%) (includes 2 veterans)

Notes. [1]Includes Native American, Pacific Islander, Black, Hispanic. [2]Includes women of all race/ethnicities, underrepresented minorities, and veterans.

TABLE 2
Racial and Ethnic Representation of Participants (N = 30)

Race/Ethnicity	N	*%*
American Indian	1	3.3
Black or African American		
Native Hawaiian or Other Pacific Islander		
Hispanic	6	20.0
White	12	40.0
Asian	8	26.6
Declined to State	3	10.0

TABLE 3
Results for Self-efficacy Related Items from Pre- and Postsurvey (N = 30)

Self-efficacy Related Items	*Mean (Standard Deviation) Pre*	*Mean (Standard Deviation) Post*
I have had experiences that made me confident in my ability to perform tasks that will allow me to succeed as a student in science and engineering.	3.81 (.92)	4.63 (.492)
I have had the opportunity to watch and work with others and have seen them perform tasks that I will need to perform in order to succeed as a student in science and engineering.	3.53 (.90)	4.62 (.571)
I have received positive feedback about tasks I expect I will need to perform in the future to succeed as a student in science and engineering.	3.73 (.96)	4.50 (.58)
I have experienced a lot of anxiety or nervousness about tasks that are related to success as a student in science and engineering.	3.11 (.995)	3.12 (1.24)

the four self-efficacy domain areas were higher following the experience. Students reported that they perceived they had more opportunities to have hands-on experiences doing tasks that made them feel confident in their science and engineering ability, watch others perform tasks they themselves would need to perform, and receive positive feedback on science and engineering tasks following the summer research experience. In terms of the question related to anxiety, students did not report a significantly higher sense of anxiety following participation in the summer research program. While mean scores were compared using paired samples t tests and showed significant differences between pre- and postscores, not all interns responded to all items. Therefore, having fewer than 30 responses on some items invalidates the t tests that were conducted (see Table 3).

Qualitative Results

Qualitative analysis of the interns' journal entries was designed to explore more specifically what aspects of the students' experiences led to these changes in self-efficacy. Several themes emerged from the qualitative analysis. Journal entries provided background on where students were at in terms of their self-efficacy prior to starting the summer program, how they developed in each self-efficacy domain, and factors linked to that development. In terms of mastery experience, this self-efficacy domain was identified by students as an important component related to influencing their confidence and facilitating their interest in a STEM career, especially one that allowed them to continue to perform research. While mastery experience is often identified as the most influential domain, vicarious experience and social persuasion were equally important in increasing student self-efficacy as it pertains to research. Across the journal entries, interns identified the mentoring they received as a positive influence that provided an opportunity to observe more experienced people perform tasks they anticipated they would need to perform and receive important verbal feedback. These two emerging domains are especially important in relation to pursuing future career goals. Interns described the physiological reaction they had as part of the summer experience. Themes that emerged identified the summer research experience as one that challenged them and made them feel some apprehension initially, but the mentoring they received diminished these negative feelings. Themes indicate that self-efficacy domains are closely linked to one another, and that positive vicarious experiences and social persuasion can offset negative physiological reactions, allowing students to consider future experiences conducting research and pursuing a career in STEM.

Background on self-efficacy

Students provided background information about where they were at in terms of their self-efficacy when they started the program. Initial journal entries of the interns explained that they lacked confidence. Lower self-efficacy was attributed to the lack of academic preparation and prior research experience as well as the lack of exposure that students had to peers, mentors, and faculty prior to arrival at the University of California at Berkeley. After meeting the people they would be working with in the lab, students realized that they had a great deal to learn in order to consider themselves on the same level as their coworkers. One intern explained it this way:

> These people are on a completely different level than I am. I imagine my expectations were that I would at least be at a similar level as them as far as knowledge and/or know how, but I was quite wrong.

Given their lack of exposure and academic preparation, many students mentioned that it was difficult entering into the lab setting. This was evident because many interns only had exposure to their community college where many of them were top students. One student wrote the following:

> It is hard going from the comfort of a community college where you feel more than competent, to a lab in the University of California at Berkeley's Physics department where everyone seems to be speaking a different [technical] language. I have to keep telling myself that the difference between us is not level of intelligence, but merely level of experience and exposure to the field.

Other students explained that while they were apprehensive, meeting the people in the lab where they would be working helped reduce their anxiety, "I know they are on a much higher level academically, so I wasn't sure how they would receive me. However, everyone was very nice and friendly. No one got frustrated or annoyed when I didn't understand something." Several of the students projected that this experience would help them in their future career and explained that this motivated them to persist: "I know this internship will be a difficult challenge, but I am sure it will be a great learning experience for my future career as a mechanical engineer."

As a whole, the participating students had no prior research experience. However, they indicated that they had related prior experiences upon which they could draw to help them meet different challenges. "As far as pursuing research as a career, this experience reminded me of many experiences I've had before where patience becomes a virtue and that is absolutely necessary when using very delicate machines and devices to obtain data."

Over the next several weeks through their journal entries, interns described the experiences that made them feel confident in their ability to perform tasks that allowed them to succeed as a student in science and engineering.

Mastery experience

Students' own recognition that they were gaining new knowledge and also recognizing real-world implications of their research helped them see how they might be successful. The interns explained that having experiences that led them to understand the degree to which the projects had real-world implications helped them build confidence. This is what one student intern wrote:

> I really like the environment that the lab presents because being surrounded by such phenomenal scientists that are working on a project that is slowly going to change the world, inspires me to work harder by challenging myself to learn something new this summer.

In addition to the realization that the projects would have real world implication, interns identified hands-on experiences with new equipment as serving to build self-efficacy. One intern explained this way:

> At times running the tests were monotonous, but then I would remember I was doing tests with $100,000 equipment at the University of California at Berkeley in a real lab—the answers are not in the back of the book—and would be excited, again.

As the experience continued, interns explained that opportunities that allowed them to demonstrate new knowledge that they gained from the experience was important in helping them build self-efficacy. Despite the acknowledged insignificance of their contribution, interns still explained the experience provided them with additional confidence. As one intern stated, "It affirmed the notion that all I had to do is to make effort and persevere long enough and I will accomplish something of significance."

Journal entries reveal a natural progression in understanding how their experience would help them in the future. Interns acknowledged that learning from their mistakes was a valuable experience as they worked their way through hands-on applications:

> If I have my mentor show me how to do something, I'm able to visually learn but if I have hands on experience, I can also learn from my mistakes and correct them. I feel great after I'm able to complete a task because I feel productive and I'm testing my knowledge.

Students recognized the importance and implications that the hands-on tasks had for improving their self-efficacy:

> I took much care to learn the procedures in filling them by learning first why we were doing it, then seeing how it was done, and now I am confident that I could do the filling on my own.… Success in the lab so far has thoroughly reinforced my plans to go into engineering.… I am still only at the community college level, I am ready to play in the big leagues.

Having time to learn the many aspects of implementing a research project was also acknowledged as a useful experience. Interns explained that trial and error helped them learn new knowledge rapidly:

> Hands-on experience is the best! It [is] easy to remember a procedure [when it is] something you actually saw how it was performed, than something you read in a book. I do look forward to more hands-on lab experience in my remaining weeks of research.

It also helped interns retain information: "Also to my amazement, I remember every single one of his techniques compared to what I have read in the book."

Further into the summer research experience, students acknowledged the powerful and unexpected results the summer experience was having—not only in terms of the knowledge they were gaining, but also with regard to their self-confidence. In fact, gaining knowledge was an important aspect of the interns' development of self-efficacy. By the end of the experience, interns acknowledged the impact of the experience on their development and, in particular, their increase in self-efficacy:

> This experience… it allows me to gain firsthand knowledge that most undergraduate students do not have access to; whether that knowledge is about my field of study as an engineer or information about my college application. This experience also allowed me to interact with people of many different backgrounds who share the same interests in sciences, which is a refreshing experience for me since I have rarely had the chance to meet and interact with such people on a regular basis.

Vicarious experience

In addition to actually completing tasks, interns explained that the opportunity to watch and work with others helped improve their self-efficacy. In terms of themes that emerged, journal entries revealed that mentors played a pivotal role in gaining this confidence. The interns explained that interactions and experiences that they had with their mentors helped put them at ease. For instance, having someone they respect tell them that they are not expected to know everything all at once provided them with reassurance that they could eventually learn the skills they needed to acquire. One student explained, "After talking to my mentor, I feel more comfortable and excited to be working in such an elite lab… "

Self-efficacy among interns was increased when they realized that their mentor was enthusiastic about the subject that they were studying, and that in many ways they were being provided with opportunities to interact with an expert in the field. One student explained how their mentor's enthusiasm was contagious:

> I am very happy about the end of this week because my mentor is awesome. I love how much you can tell how passionate he is about his field. When he speaks about it, he says things like "isn't that beautiful?," "that is amazing," or "wow, you don't see that everywhere." He makes me feel the same way about his field and it also makes me want to be more knowledgeable.

Interns also explained that situations where they were placed in the role of a mentor helped increase their self-efficacy:

> … my mentor and I went to a lunch/advising session with a high school program run by my education director.… Sometime during that lunch session, I was asked by one of the girls to tell my story and that made my day because it made me feel like a mentor/advisor. This day made me realize that when I advance in my studies, I also want to give back just like my mentor. I think that is what science is about, passing that knowledge on to other generations.

Interns explained that being physically situated on the campus gave them exposure to people that they could watch and also provided them with hands-on experience in a lab setting doing research. "So far, this experience has lived up to all of those hopes. I do in fact love it here, and I cannot wait to apply. To be surrounded by so much ambition and intellect is truly amazing."

Collaborating with their mentors was an essential part of the experience that allowed students to gain background knowledge that they were missing and at the same time feel they were a partner in knowledge discovery. This was especially true when their mentor recognized what their intern might be missing, whether it be knowledge or experience, and took time to fill in the gaps. Having the understanding that interns were part of a productive team helped provide them with the sense that they were not alone. Interns explained a collaborative environment allowed them to learn from multiple individuals that they perceived as very knowledgeable, positively impacting their self-efficacy:

> The principal investigator of the lab stated that "many people aren't thinking of this yet so it will be very useful. If everything works as according, it is going to have a huge impact in the field and they'll [be] claim[ed] as inventors." I felt really good when he mentioned that because I felt like if everything works, I could be one of the people who worked hard to develop something that didn't exist before. I could be part of the project that will help transform the field in a whole new other way.

The collaborative environment of the labs also influenced the way the community college interns viewed research. Many noted that prior to this experience they viewed research as a solitary effort rather than as a "community, collaborative effort."

Social persuasion

Given their initial lack of self-efficacy, receiving verbal, as well as nonverbal, positive feedback about the tasks they would need to perform in the future to be successful in science and engineering was important. In many cases, this positive feedback came from their assigned mentors. One student explained how verbal feedback was important to them and helped improve self-efficacy:

> He read the paper and told me it looked good. Just the sheer fact that he didn't crumble it in disgust would have been rewarding to me, but the fact that he praised it made me feel welcomed and adequately prepared to be in that lab. The experience definitely gave me a new found sense of confidence in my abilities to be thrown into new daunting intellectually challenging situations. I think the experience made me feel like I am someone who deserves to be here as well as have something to offer the world of science and engineering.

Positive feedback came in multiple forms, but the most powerful seemed to be the verbal feedback from mentors and others in the lab. Interns explained that the positive feedback was rewarding because it was directly related to the hard work they were putting in during the experience: "It is definitely a good feeling to have some postdocs, graduate students, and undergrads telling you are doing a great job. It just means that you are not passing unnoticed and that is the best feeling to have." Interns explained that this type of feedback made them want to work harder.

For some students receiving constructive feedback was part of the learning process:

> As far as shared qualities, there are two which come to mind: being able to let go of your ego and wanting to figure stuff out. The first one is important because you have to be able to give and take criticism based purely on an idea's merit—NOT the individual suggesting the idea. If someone points out a flaw in my idea, I need to remember they are not pointing out a flaw in me, merely my suggestion.

Physiological reactions

Finally, experiences that allowed students to identify the anxiety that they might be feeling about tasks they felt they needed to perform to be successful in science and engineering was important. Journal entries also identified new social skills— in addition to content knowledge— that they needed to learn to be successful in a lab setting and how that created anxiety for some of them. Interns also wrote that it was important that the experiences allowed them in some way to work through the anxiety and gain new perspective and confidence—either by themselves or with the help of their mentor. Having someone to talk to about their anxiety was very important, as explained by one intern:

> Right now, I don't really see myself as being a success in this career. I told my concern to one of the postdocs. She said that most students would not get research position in their freshman year and they don't usually get their own research. After I heard what she said, I felt much better… there is still a long way for me to go. This summer won't be the end, but just the beginning of my research career.

Interns explained that in some instances their anxiety was attributed to new social skills that they had to learn:

> One of the biggest hurdles for me to overcome was trying to be social and asking questions. On the first day coming to [University of California] Berkeley, I was very shy and wouldn't be the type of person who would ask questions. Thanks to the new friends I have made along with an encouraging, positive staff, I opened up and now I can talk to most people and ask questions. Not only am I learning about academics, I am also learning about life.

Students struggled with the trust that lab supervisors and mentors put into them initially, thinking that they were inadequate for this experience. However, as students gained confidence, the independence they were given was exciting:

> My mentor at the time could not be there to supervise me… This was my moment to take charge. I was independently doing measurements and analyzing… I was able to differentiate between what would be a "good" device and a "bad" device. Also I was trouble shooting… The fact of being responsible and able to understand, analyze, and spot differences in measurements made me feel responsible. Not only do I feel great, I also feel greatly honored that I was chosen to take up this task that would make a significant impact in the world as we know it.

Overall, the summer experience positively impacted the community college students' self-efficacy as it pertains to research. From the data gathered through the journal entries the interns explained how the experience gave them new confidence and led to self-discovery of what a career in research might be like as well as what would be necessary in terms of the educational path to attain that career. The experience also helped other students clarify whether this was the type of career they actually wanted. One student explained like this:

> The research career is not what I have expected and as of now, I am not considering doing a PhD. The research I have conducted was very interesting, but quite stressful and I do not think at the moment that I want to do this for the rest of my life. There were many times where I felt lost and not knowing what to do, I feel this is too much for me. I see myself working in industry instead of in academia…

For others, the experience solidified their intent to pursue a career in engineering and increased their desire of transferring to a four-year institution and to go on to graduate school:

> Being able to accomplish things on my own is a very special event. It gets me even more excited about an engineering career and pursuing research. I know that I have the ability and skills to make it as an engineer. I just have to keep my nose to the grindstone and develop the necessary knowledge base to be successful in engineering… This experience made me believe that I can handle science courses after transferring and I feel better about pursuing a career in that field.

For other interns, the experience reinforced the fact that they wanted to pursue a career that would allow them to continue in research:

> My first priority at this moment is transferring to [University of California] Berkeley or to another top school. However, I am already thinking about graduate school. I have to look for more research opportunities and I have to try to be involved with the scientific community.

DISCUSSION

Interns reported measurable gains in engineering self-efficacy. Findings from this study provide detailed information about what types of experiences can lead to the improvement of self-efficacy among community college students, specifically as it pertains to conducting research. In addition, results show that while all domains were important for improving self-efficacy, vicarious experience and social persuasion were equally as important as mastery experience.

Across domain areas, mentoring and a collaborative environment were factors that emerged as critical to positively influencing student self-efficacy. Upon entering the experience, community college students identified themselves as lacking self-efficacy to conduct research and participate in a meaningful way in the research process, either indicating they were "not ready" or were in some way inferior to the individuals that they would be working with at the University of California at Berkeley. Having an assigned mentor that met with them regularly to guide them through the next steps and challenges that they faced allowed the students to see how to perform different tasks that they would need to perform, ask questions to clarify what they did not understand, and served to reduce anxiety that they were experiencing. Results from this study document how self-efficacy of community college students majoring in STEM fields can be improved over time with consistent guidance and opportunities to demonstrate skills and knowledge they have gained in a supportive environment. While specific challenges were identified, many of which are inherent in a research setting, the students felt they gained the skills necessary to address those challenges in the future through this experience.

It should be noted that the student interns self-selected to participate in this research program, and they may already have been predisposed to developing self-efficacy in relation to conducting research. There may have been different results if students were required to engage in research as part of their course work. The sample used in this study was community college students that met a minimum GPA and were enrolled in specific majors. While the results indicate that this research experience helped this groups of students enhance their self-efficacy as it relates to working in a research setting and encouraged them to transfer to a four-year institution, if the requirements for program participation were altered so that students with a lower GPA or different majors participated, it could impact the results.

Despite these limitations, this study produced some important results related to the self-efficacy of community college students. Findings identified how a hands-on, immersive research experience can positively impact self-efficacy and impact long-term career goals including desire to transfer to four-year institutions. Our findings show that a hands-on research experience coupled with mentoring from respected individuals in the discipline and student programming can improve the self-efficacy of community college students in STEM fields. As their self-efficacy improves, students' long-term interest in STEM disciplines also grows and furthers their interest in transferring to a four-year institution so that they can pursue their desired career. Following the hands-on research experience in the labs over the course of eight weeks, students explained that they participated in developing and finding solutions as part of a research team. Administrators in community colleges and four-year institutions can use these findings as they work together to design similar programs that are built specifically for community college students and offered on baccalaureate- and graduate-degree granting campuses.

Through the vicarious experiences—such as being exposed to and watching their mentors and other graduate students perform tasks that they anticipated they would need to perform in the future—community college students could begin to build the knowledge and skills they would need as they progressed to earning a four-year degree, going on to graduate school, and leading research projects of their own. The experience for these community college students was designed so that there would be adequate support in an effort to reduce anxiety or apprehension. From the journals and survey data that were collected, this experience reached that goal as students reported that while they were initially apprehensive, they were able to overcome that and continue to build their self-efficacy. In many cases this was due to the verbal and nonverbal feedback of their mentors and program staff that allowed students to feel they played an important role and were making valuable contributions.

Overall, this study provides a valuable contribution to the knowledge base and provides a better understanding of what experiences can positively impact the self-efficacy of community college students in STEM fields. Results also indicate that improved self-efficacy as it relates to research in an academic environment is related to the long-term career goals and academic aspirations of these students.

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