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Investigating and Reflecting on the Experiences of STEM Students in a Residential Learning Community

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Abstract

The National Science Foundation projects that the United States could see over 2 million unfilled STEM jobs in 2025 (National Science Foundation, 2018). At Redacted University for Review faculty from the STEM fields have undertaken the Science and Mathematics Attraction, Retention, and Training for Texas (SMART Texas) project, a National Science Foundation initiative funded under the Scholarship in STEM program to increase recruiting and retention. Scholars enrolled in SMART Texas were provided scholarship support, a STEM first-year success course, a STEM residential learning community (RLC), and opportunities to engage in STEM conferences and undergraduate research. These scholars and this program demonstrated great levels of success, given six years to graduate, 70% of SMART Texas scholars graduated with a STEM degree. Programs like SMART Texas can assist in the national efforts to both recruit and retain STEM majors to meet the growing and continual demand.

Keywords

Residential Learning Community, retention, STEM education

In the late 1990's a noticeable decline in the numbers of undergraduate students majoring in a Science, Technology, Engineering, or Math (STEM) fields was observed (Laws, 1999; Rask, 2010). This decline is projected to create significant future issues. In fact, the National Science Foundation (2018) projects that the United States could see over 2 million unfilled STEM jobs in 2025. Furthermore, students declaring a STEM major often do not persist to graduate. Chen & Soldner (2013) found that 48% of STEM majors did not complete a degree or changed their major to a non-STEM field. In conjunction with a recruiting problem there is clearly a retention concern as well. To meet this demand, universities across the country have undertaken various recruiting and retention efforts, including Residential Learning Communities (RLC).

At Stephen F. Austin State University faculty from the STEM fields have undertaken the Science and Mathematics Attraction, Retention, and Training for Texas (SMART Texas) project, a National Science Foundation initiative funded under the Scholarship in STEM program. The project identified 20 academically talented, financially deserving potential biology and mathematics majors who were offered a spot in the SMART Texas Program as student scholars. The project actively recruited approximately 35 students, with 20 of those students ultimately attending on scholarship. Through enrollment in this program, scholars were also provided an average of about $6000 per year in scholarship support for four years along with engagement and STEM exposure activities. The primary activities began with a STEM first-year success course, a STEM residential learning community and STEM field trips. As they progressed, scholars were also funded and encouraged to attend STEM conferences and engage in undergraduate research.

The STEM Residential Learning Community also targeted first year students. When designed SMART Texas, implementing a residential learning community appeared to be an ideal strategy. Not only do RLCs build a sense of belonging, boost the chance of academic success, and increase opportunities for students to engage with their academic disciplines, the weekly shared meal with faculty would also serve as an ideal time to identify struggling students early and begin addressing critical issues. An RLC based on majors is a concept that has not been implemented often at the rural, state university where this study took place. This RLC included a group of 20-25 first-year STEM majors encompassing both SMART Texas Scholars and non-scholars, attempting to develop a broader network of STEM connection and success than might be reached if only grant participants were included. The community centered around living on a specific floor of a particular residence hall, although exceptions were made for a few students who were unable to do so. An evening meal was shared weekly, with most meals in the campus dining hall with 6-8 special meal gatherings throughout the year at a faculty member's home or prepared by the students. Field trips were organized to local STEM workplaces. The community also went into the public schools, spoke about STEM, and provided STEM enrichment lessons. The RLC was important to the SMART Texas Scholars as research has shown that chances of retention increase when students are afforded early opportunities to connect with faculty and their peers academically and social (Mortenson, 2005; Kuh, 2005). These connections were created and facilitated through the various elements of the SMART Texas program, particularly the RLC, which facilitated relationships outside of the classroom.

Another element that facilitated those relationships was a freshman success course. The STEM first-year success course occurred the first semester of scholar's college career and consisted of 17-20 first-year STEM students (some within SMART Texas and some not), a STEM faculty member, and a STEM upperclassmen co-teacher. The course consisted focused on exposure to STEM careers, service learning related to STEM, and required attendance of STEM events of the students' choosing. It also included more broad-reaching college and life-skills

such as time management, money management, study skills, university resource awareness, suicide prevention training, a retirement planning workshop, and some topics chosen by student vote.

SMART Texas was also structured around mentoring and engagement. A lead STEM faculty member and three supporting STEM faculty members worked together to support students, advised them, raised awareness of STEM research and opportunities, and maximize student belonging – particularly during the critical first year in STEM. Similarly, the program was designed to connect Scholars with other STEM majors who they could study with, contemplate STEM opportunities, and cultivate a shared identity as STEM scholars.

The SMART Texas Program scholars demonstrated great levels of success. When the 20 initial scholars were selected, a paired comparison group of 20 scholars was selected. Pairing was performed first on having the same major, then on having the most similar incoming SAT or ACT score. SMART Texas Scholars graduated at a higher rate in four years in STEM, 55% to 45%. But perhaps more impressive were the long-term achievements of the SMART Texas scholars. Given six years to graduate, 70% of SMART Texas scholars graduated with a STEM degree while still only 45% of non-scholars had completed a STEM degree. Considering six-year graduation in any major, SMART Texas scholars increase their lead: graduating at a rate of 75% compared to non-scholars 45% graduation rate. Finally, comparing graduated *or* pursuing a degree the disparity is most stark: 85% to 45%.

It seems that students outside the program are either successful or leave, while students within SMART Texas had more opportunity to adjust to college and succeed in a variety of avenues. We sought to examine what enabled the successes of the SMART Texas scholars through semi-structured interviews with five scholars who successfully completed the program. Through these interviews and analysis, we sought to understand:

1. What elements of the program had the greatest impact on the scholars?
2. What elements of the program were least impactful?
3. What additions or changes should be made to the program in the future?

Participants

Brandon earned a degree in Biology in December of 2019 and is currently employed with a national rental company. COVID-19 impacted his planned biology field research position.

Jackie earned a degree in Biology in December of 2019 and is currently pursuing a master's in Biology at Stephen F. Austin State University.

Laney earned a degree in Biology in August of 2020 and will begin Physical Therapy school in August 2021.

Nate earned a degree in Cell Molecular Biology in December of 2019 and is currently working as microbiologist and will begin pilot training in the United State Air Force within the next year.

Kristen earned a degree in Biology in December of 2019 and is currently pursuing a master's in Biology at Wichita State University. (All student names are pseudonyms.)

Findings

Faculty Connections Within SMART Texas

In all the interviews the constant theme of a connection with SMART Texas faculty members emerged. Kristen identified Dr. Jones, the director of the SMART Texas program as a STEM faculty member she connected with during her academic career. She explained that "he taught me SFA 101 and pre-calculus, the same semester. So, like, freshman year, he was like the person—the professor I saw the most out of everybody. And he was always super supportive, I knew—what I remember most was just knowing that I had someone to ask questions."

Jackie revealed that she remained connected to Dr. Jones for the entirety of her undergraduate education, "Dr. Jones was always reaching out and checking in on us, or at least me. Checking in on me and seeing how I was doing, and it was just nice to know, that there is someone at SFA that like, if anything ever went wrong, I knew I could text Dr. Jones and ask what do I do?" Jackie went on to say that she relied on that relationship as a support system explain that "Whether it was like school based or even like, my tire blew out, I knew I could text Dr. Jones and ask where to get my tire fixed, like that was really nice to know. Because my family lives far away so, I didn't really have anyone in that sector that I could ask for help."

These interactions are important as evidenced by Hong and Shull's 2010 study in which students revealed that the absence of "any positive relationships" with staff or faculty member contributed to them withdrawing from STEM courses and majors (p.274). Nate also found his sustained relationship with Dr. Jones to be important and memorable, recalling that "he reaches out all the time, he's really good about it, just seeing where I'm at with air force process. He knew about the microbiology job and everything like that so, he keeps up really well."

Laney echoed this, recalling that through interactions with faculty "it made staff more approachable because when you're a freshman you're like 'oh I can't go talk to my professor, I don't feel comfortable doing that' but when you have those two people around all the time, you're like 'well, they're not as scary as you think they are.'" These connections were important for Laney on a professional level as well. She revealed that "Dr. Jones honestly helped me get into an internship that I desperately needed for PT school" and "it's all about connections, and I felt like that was very helpful, because I knew I could talk to him, or I could throw out an idea of like "hey, I need some help with getting PT shadowing" which was a difficult task for her as she was a student-athlete. Many of these relationships were created, and sustained, through the RLC because the faculty members were participating as active members of the RLC to support and encourage the students outside of the traditional academic setting (Garrison & Vaughan, 2008).

STEM Faculty Connections Outside of SMART Texas

The connection to STEM faculty members also occurred outside of the SMART Texas program. However, many of these connections were facilitated through activities sponsored by SMART Texas. Three of the participants explained that they completed research with a STEM faculty member as such research was encouraged and facilitated by SMART Texas. Kristen explained that she participated in both research and publication with a forestry professor unassociated with SMART Texas and that "because we have like publications together and are like presenting stuff at conferences, that we're co-authors on, so that kind of went from just a student-teacher to, you know, now almost like collaborators."

Like Kristen, Jackie made connections with faculty thanks to the SMART Texas program. The weekly STEM dinners included presentations from faculty and facilitated relationships and interactions. Jackie first met Dr. Brown at a STEM dinner, then enrolled in one of his courses. She revealed that this informal connection created a unique level of comfort that "it was just really cool to connect with staff in a different way, it made them more human. Not just the people I met, but like other professors that I interacted it, it was like 'okay this is a person just like I am' like, I am allowed to go to them with questions or mistakes. It made professors more approachable, I guess." Laney also recalled two staff members as they were responsible for "facilitating a lot of the shadowing opportunities" and she felt comfortable going to them for assistance.

What these SMART Texas scholars are revealing is the importance of both formal and informal interactions with faculty. Informal interactions or informal mentoring occur naturally and are not official organized or sanctioned. The strength of these relationships that they can often last longer because they began naturally, with a mutual goal or interest (Mullen, 2005). In contrast, formal mentorship and interactions are arranged within an institution and are structured from the beginning (Mullen, 2005). Both formal and informal interactions are important for students.

Furthermore, research supports "an approach to retention that encourages professors to connect to their students, offering a supportive and warm learning environment" (Christe, p.25).

This kind of environment was created within the SMART Texas program, and it fostered important connections.

Additional Educational Opportunities

The SMART Texas program also led to important outside educational experiences by facilitating and funding opportunities for the scholars including conferences, STEM fieldtrips, research connections and publications. Jackie explained that she attended a genetics conference and that "I was really into genetics at the time and I was kind of like, just wading my way through genetics and going to that conference. I remember like, I wanted to go into genetics already, like I knew that that was something I wanted to do, but I was kind of worried because I knew it was kind of like—it was hard and it was like detailed and there were all these pathways you had to know and all these sequences. And I remember going to this conference and being like 'I could do this' like, 'I'm a little lost, but I kind of understand some of this and I'm genetics right now.'"

Attendance at this conference would later become important as Jackie interviewed for PhD programs. She revealed that "when I was a senior, I had an interview for genetics PhD at A&M and one of the faculty members was like 'are you—did you go to this conference?' and I was like 'I did' and we kind of got to talk about that conference which was like a connection point."

Brandon shared a similar experience explaining that "my first research that I did I was, as a freshman, was we were monitoring or recording the number of invasive plant species at Caddo Lake" and then at a conference he "ran into a lady from Texas State, and she was doing a different invasive species on the river, so I was like 'oh, you know it's pretty cool it's you know similar interest,' and I wouldn't have met her if it wasn't for the conference."

Nate explained that he attended two conferences and that he "wouldn't have even known about" such opportunities with the SMART Texas program because when "you're going into college you don't really know what's out there at that point."

Kristen was able to attend three conferences as an undergraduate student through the SMART Texas program. She recalled that she mostly listened "just because I was an undergrad and most people there were like PhDs or master's students, so I just kind of sat back and learned" but she was excited to learn about wildlife and conservation, her fields of study. She felt that sometimes those fields are "on the backburner while everyone else is doing like, math and like chemistry and medical field but it was so interesting to see the breadth of research that was ongoing, so I could see options of like, 'wow people are doing this' and like 'this is a field that I could go into,' so that was a real benefit."

Laney was encouraged to participate in research opportunities. She describes how "Dr. Jones really wanted me to do some research with Dr. Baker, and it wasn't anything geared towards PT at all, it was actually about bugs of all things, but I did it." She went on to explain that she "submitted for the undergrad research conference at SFA, and then we got selected as one of the finalists."

Research postulates that when students participate in an early undergraduate research experiences like conferences or research there is an increased retention rates and a higher pursuit of graduate education" (Bahr et al., 2006; Hathaway et. al., 2002). It is important to note that three of the five scholars who participated in this study are pursing graduate degrees in STEM fields. Additionally, participation in undergraduate research has been shown to improve retention and persistence to graduation for STEM majors (Christe, 2013).

Social Benefits

In addition to the many academic benefits of the SMART Texas programming, it benefited students on a social level as well. The scholars recalled that the STEM dinners, the freshman success course, and other less formal activities, provided academic assistance and genuine connections.

Nate found that those interactions were very important, revealing that "I mean that's the biggest thing to me. I mean you have someone—I mean there are a lot of people, especially moving to college that may not know anybody at that point and that is where I made a lot of my friends still, to this day that I have those connections later. That was the biggest help to me."

Brandon praised the STEM dinners saying "I like those a lot just because you're not really talking about your homework or other things like that you just kind of hanging out but it's all kind of has like a science-y feel to it because everyone has the same interests, you know. We might talk about something in class that piqued their interest, and they share it and sounds like 'oh that was really cool' or you know they learn something, and all that, so it was a very fun way of learning what other people have learned." Brandon went on to add that "I feel like some people can kind of pick things up better if they're not in a classroom setting, you know and the way they explained it just kind of connects better with you and I think having a STEM dinner like that really helps because sometimes, you know, when someone else explains the same subject, a different way can really click."

Kristen revealed that living with other STEM major helped them connect both academically and socially. "We studied together, and we knew what assignments we had to work on together, and so that was really beneficial. And, like even asking other students 'hey you took this class, I'm going to take it next semester, what's it like?' And so like, having those people that you could connect with, I think, was like really nice. Especially for like— freshmen year."

Furthermore, the friendships formed have remained post-graduation. Nate explained that one of his roommates from the RLC is "one of my best friends, he works for Charles Schwab in

Dallas, and so he's a big financial guy. So he helps me on that aspect, and I'll talk to him about other stuff, so it's just good to have those connections." Both Laney and Jackie confirmed that they too had lasting friendships and that they still talk with their RLC roommates, including Kristen. Kristen reiterated Laney comments, saying that the RLC was beneficial socially "I mean because you get a friend from it, but also, we did study together and help each other with like study guides and so yeah, I think we kind of pushed each other and that helped us." Research has long asserted that RLCs have benefited students socially and the SMART Texas scholars confirm this with their experiences (Inkelas & Soldner, 2011).

SMART Texas Scholar Changes

While many praises were offered regarding the SMART Texas program, scholars were also given an opportunity to suggest changes or additions that might increase the effectiveness of future cohorts. The participants offered a few suggestions for program additions. Jackie explained that she would encourage additional speakers from multiple STEMS fields "because like sometimes like, you don't realize how knowledgeable like you are in a field and like what you can do for another field until like you've talked to someone."

Similarly, Krista proposed additional chances to connect with faculty across the university. She proposed that the program facilitate opportunities for "getting in-touch with more professors, as far as research, so I think it would be really benefit, like whoever is in charge to maybe reach out to other professors, and ask like "hey, in your department" or "do you know anyone doing research that's looking for a student?" Or "how can these students get involved?"

Laney echoed this recommendation explaining that she thought some improvement could come from expanding the pool of guest speakers. She suggested that program might consider "focusing a little more on having more speakers coming in just like you know, people on their lunch break take an hour, hour and a half, fifteen, and come and talk with us and get different people involved, because a lot of it was math professors." Brandon reiterated the desire to have additional speakers. He explained that due to his athletic schedule he missed a field trip where the students learned about hydroponic farming, explaining that "I wasn't able to talk to the guy or anything like that, but if he was at the dinner instead of going to you know a field trip then maybe I would have been able to talk to him."

These proposed additions are important as a research brief from the University of Wisconsin-Madison argued that one of the three main reasons that STEM fields have low retention are barriers like lack of mentoring (Schneider et al., 2015). The RLC played an important role in facilitating effective mentoring as research demonstrates when faculty and students interact both inside and outside of the academic setting persistence to graduation rises (Purdie & Rosser, 2011). By facilitating additional opportunities to connect with STEM professionals at the university and within the community, programs like SMART Texas can work to lower STEM attrition rates.

Discussion

Meeting the demand of STEM professionals is a daunting task. However, programs like the SMART Texas have demonstrated successful outcomes. While funding to offer scholarships may not be readily available for many institutions, elements of the SMART Texas can be re-created with little cost but great benefit. The scholars clearly sought a variety of speakers and connections. Many of those contacts can be found already in existence at institutions, or within

reach of their respective communities. Establishing a setting for such interactions would be beneficial for both recruiting and retention of STEM scholars, by creating an opportunity for informal mentoring to occur.

Limited funding may create some obstacles for conference opportunities. However, many of the scholars indicated that in addition to needing funding, they would have been unaware of the research collaborations or conferences without SMART Texas. Creating a network of research opportunities and making students aware of research prospects and conferences would help disseminate this important information.

Additionally, an established RLC would bring many benefits for students. They would connect with scholars engaging in the same field of studies, with similar research interest and careers goals. These interactions will create a system which supports and propels students to academic and career success. It is important to recall that the most marked overall difference between SMART Texas Scholars and the comparison group was not simply in their STEM major success, but in their overall college persistence and success. Programs that cultivate belonging do foster STEM success, but also allow students a sense of belonging at a university even if their interested end up not being in STEM.

Again, the funding provided by the National Science Foundation initiative funded under the Scholarship in STEM program enable the institution to create a nucleus of highly committed STEM students who were guaranteed to remain in the program even as others were allowed to participate in the first-year success course or the STEM RLC as they chose. We recognize that this funding support may not be accessible to a large number of institutions, but the basic structure of the program – connections with existing STEM faculty, shared meals, etc. would be re-created manageably. SMART Texas demonstrates that the vital endeavor to recruit and retain STEM scholars is one that should center around STEM based community building and intentional mentorship.

Recommendations

The goal of the SMART Texas program was to increase STEM major persistence to graduation. The RLC was instrumental in creating connections and opportunities outside of the traditional academic realm and increasing STEM graduation rates. Despite many successes, the program coordinators would recommend some alterations and additions. A single program leader facilitated most of the SMART Texas elements. However, delegating elements of the RLC's activities, such as communicating with non-attendees and shared responsibilities for designing events, could expand the community and lessen the stress of supporting faculty and staff.

Additionally, holding activities and meals at faculty or staff homes added a degree of genuineness to the RLC, establishing a community that reached beyond the campus. Another important recommendation is to ensure that multiple faculty members are provided with opportunities to engage with the RLC members. Again, these additional interactions can help create impactful relationships and will strengthen what research has long lauded as one of the primary benefits of RLCs. Furthermore, faculty observed that it can be difficult to quantify the learning gains of RLC students in conference attendance and undergraduate research, because records tracking those metrics in non-RLC students are nonexistent. RLC coordinators might be wise to ensure tracking of non-RLC students to better communicate the value of they're programs. As institutions of higher education continue to face challenges, old and new, it is imperative that they identify and implement programs, like RLCs, that lead to student success and persistence to graduation.

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