

**Attracting STEM-talented undergraduates to secondary education with early
teaching experiences**

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Abstract

This study describes how a semester-long after-school teaching experience can attract undergraduate STEM majors to consider a career in secondary education. Surveys of and interviews with eight STEM undergraduates show a positive trend toward considering teaching as a career in most cases. An additional senior not originally recruited for the program was interviewed about their experience as a volunteer and how it led them to apply for and accept a teaching position at a high school after graduation. For some participants, they were too far along towards their degree to add secondary education as a second major and pursue certification before graduation, but this experience provided early enough in a student's educational career has the potential to increase the number of STEM-talented secondary educators entering the field. This after-school program therefore shows promise in recruiting future STEM educators while it also serves high school students from a high-need district.

Attracting STEM-talented undergraduates to secondary education with early teaching experiences

Retaining and recruiting highly qualified science teachers in secondary education is a concern, particularly in high-need districts. There are critical shortages in many areas of STEM (science, technology, engineering, and mathematics) with the most critical shortage areas in all subjects (after special education) being in chemistry, mathematics, and physics according to the American Association for Employment in Education's Educator supply and demand report (2017).

To combat this shortage and to increase the numbers of passionate STEM secondary educators, the National Science Foundation created the Noyce Program in 2002 with a focus on providing scholarships and stipends to prospective secondary STEM educators (Mervis, 2015). These programs often include various recruitment strategies for attracting talented STEM majors and graduates to the field of teaching at various stages of their education and careers. This program focuses on recruiting teachers to high-need school districts, that is, ones where a majority of students qualify for federally subsidized meals. After degree completion, Noyce scholars must teach in such a district for two years for every one year that they receive scholarship funding.

At Saint Anselm College, one such Noyce-funded recruitment program was launched in 2018-2019 as a "capacity building" project. Saint Anselm College (SAC) is a four-year Catholic liberal arts college located in Manchester, New Hampshire, serving approximately 2000 undergraduate students. SAC has a well-established teacher preparation path leading to licensure where students interested in teaching at the

middle or high school level pursue a double major in (a) a specific content area (of an academic discipline) and (b) secondary education, or they can choose to minor in secondary education. Yet, despite a robust growth in the number of SAC undergraduates pursuing an education degree (166 from 2012-2017), in that same time period there have been only fourteen education graduates licensed to teach mathematics, two chemistry education, one physics education graduate, and no life sciences education graduates.

This program, called “Blazing the Trail for STEM Teachers” (BT-STEM) had two major goals:

- Determine whether a semester-long after-school teaching experience will be an effective means to attract STEM majors to consider a career in education.
- Identify the root cause(s) underlying the low frequency of STEM education students at SAC in order to design future interventions.

This paper will focus mainly on the efficacy of the after-school teaching experience.

Previous Work

When we look at teacher recruitment strategies, there is ample research that indicates that the recruitment of STEM majors into secondary teaching careers may be amplified when potential teaching candidates are provided with “purposeful [teaching] experiences” (Borderding, 2015). The environment of the specific teaching experience is critical as a positive experience can lead to a student deciding to pursue secondary education, but a negative experience can cause a student to come away with worse

attitudes towards teaching. Recruitment is also amplified when the teaching opportunities allow college students to teach science content to actual secondary students (Luft et al., 2011; Worsham et al., 2014). Interestingly, Luft et al. (2011) argue against the use of financial incentives such as the Noyce scholarship as a tool for recruiting STEM teachers, noting that this may not be attracting the kind of teachers who will stay teaching in a high-need district. They argue for the efficacy of purposeful, authentic, and well-situated experiences, and not expecting an experience such as being a teaching assistant for a college class to translate into a desire to teach secondary education.

Ticknor et al. (2017) noted that authentic teaching experiences can occur in informal (peer tutoring) or formal (free teaching class) experiences; however, they are most effective when they occur early in a STEM majors college career (see also Liou et al., 2010). In addition, service-learning/community opportunities like the one used for this project have the potential of helping *all* potential teachers, regardless of academic discipline, to better understand the content of their educational courses (Hildebrand & Schultz, 2015), as they provide fledgling teachers with the opportunity to make stronger connections between educational theory and practice (Coffey, 2010).

Noyce Capacity Building Project

In order to recruit STEM majors into a teaching experience, the BT-STEM group partnered with the Meelia Center for Community Engagement at SAC. The Meelia Center runs a program called “Access Academy,” which offers after-school courses to Manchester high school students. Created in 2010, Access Academy is overseen by the

Meelia Center for Community Engagement, and it targets diverse and underrepresented high school students as a direct response to the needs identified by immigrant leaders, students and their families, and educators in the Manchester school district. Access Academy brings high school students on campus to take courses and receive guidance from trained SAC undergraduates under the oversight and mentorship of SAC faculty and professional staff. At the time we began this project, most Access courses were focused on the humanities and college readiness.

The Noyce Capacity Building Grant facilitated the creation of four new STEM courses run and taught by undergraduate student workers. Each course required three co-instructors who would create lesson plans and teach the course under the advisement of a faculty supervisor. For each course, two of the co-instructors would be STEM majors with no experience in education and the third would be a double major in a STEM field and in secondary education. Thus, this program provided a first teaching experience for eight STEM majors over the course of the project. Co-instructors were part of the larger Access Academy team which included pre-semester training events, mentorship at the Meelia Center, and weekly staff meetings in addition to individual class prep meetings. Classes were offered once a week for 10 weeks and culminated in a showcase of all the high school student projects with posters and short presentations from each course.

Research Question

In what ways did participation in a semester-long after-school teaching experience attract undergraduate STEM majors to consider a career in teaching? How did it influence their ideas about teaching in practice and as a career?

Methods

Protocols for research were approved by the Institutional Review Board at Saint Anselm College. In order to learn about the impact that a semester-long teaching experience might have had on each of the eight participant's beliefs and attitudes towards teaching in a high-need district, the following data collection methods were employed:

- Pre-/Post-surveys taken before and after a semester-long teaching experience
- One 15 minute-qualitative interview, which took place after the completion of each participant's teaching experience

The participants were asked several questions about their attitudes towards teaching in high-need districts before and after the experience through these surveys and interviews. Interviews also asked participants about the most challenging, most enjoyable, and most surprising aspects of their experience. Participants were asked to share what lessons they learned from the teaching experience.

Participants were eight STEM majors who were not already in the secondary education program. They were recruited to teach at Access Academy through faculty recommendations and invitation. Four were recruited for the fall semester: two to teach

“Q is for Quantum,” a course that introduces quantum computing at the high school level, and two for “Science in Books and Movies,” a course that explored the real science behind media portrayals in popular fiction. Four more undergraduates were recruited for the spring: two to teach “Radios for Jupiter,” a course which introduced high school students to radio astronomy as they built a simple telescope to observe radio bursts from Jupiter, and two for “Remote Sensing,” a course that taught high school students to use satellite and aerial imagery and data to explore various areas geographical sites. However, two of the fall instructors enjoyed it so much that they joined as co-instructors in the spring as well, giving each of those courses a team of four co-instructors. This was a less than ideal sample as participants ranged in experience (two freshmen, two sophomores, three juniors, onw senior) rather than all being early in their undergraduate careers. Seven of these undergraduates were interviewed after their teaching experiences (one junior was unavailable for interviews.)

We also interviewed one STEM senior who was not originally recruited for the program but who was a volunteer in the Access Academy classroom for a computer graphics course. They took a job teaching high school physics after their experience, despite having no previous teaching experience before that program.

Interviews of program participants were conducted by the project Principal Investigator (Demers) and transcribed by the co-Principal Investigator (Gugliucci). (Interview of the senior volunteer was conducted by Gugliucci.) Transcripts were made in three stages of increasing complexity. The first step focused on basic transcription, the second on corrections, and the third step on capturing pauses and filler words.

Transcription also served as a part of the initial phase of familiarization with the data. The co-PI then used the basic thematic approach to coding as defined by Braun & Clark (2012) to identify major ideas. Once such themes were established, the transcripts were analyzed again with appearances of each major theme identified in each interview. As this process has only been done with one coder, we consider these to be preliminary results subject to further analysis.

Results

Five out of the eight STEM undergraduates completed both the pre- and post-experience surveys. With such a small sample size, a direct comparison of responses before and after the experience is likely to be inconclusive. Instead, each participant's responses to the surveys were looked at in the context of their post-experience interview for the four that had interviews. The participant who was not part of the original program will be treated separately.

Major Themes

Several major themes emerged from the interview data with the seven participants recruited to teach at Access Academy. (At this time, we will simply refer to them as Participant 1, Participant 2, etc.) Results are summarized in Table 1.

Table 1: Preliminary coding of major themes in participant interviews

Theme	Instances mentioned by Participant1	P2	P3	P4	P5	P6	P7
Prep/Lesson planning as difficult, a lot	X	X	X			X	
Thinking on the fly		X		X		X	X
Engaging students, learning to teach	X	X	X		X	X	
Relationships/connections w/ students and co-teachers	X			X	X	X	X
Observing student efficacy	X	X	X		XX	X	X
Importance of collaboration co-teachers, esp the ed majors	XX	X	X				X
Specific positive experience	X		X	XXX			X

When participants were asked about challenges or surprises in their experiences with the program, four of the seven listed the difficulty and time that goes into lesson planning as a major challenging factor and something they had not appreciated until this experience. Many of these participants, however, indicated that their success was largely due to collaboration with their co-instructors, specifically those that were already double majors in secondary education. Participant 7 remarked of their co-instructor with the education background:

I had never made a lesson plan in my life, so having her there to say like “this is how you do it, this is how this should look, not this is what we have but this is what we should get to” was extremely helpful especially in the beginning.

One factor that was both a challenge and enjoyable was learning the process of how to teach difficult concepts and how to engage students, as mentioned by five of the 7 participants. Participant 1 described it in discussing their own challenges of nervousness and introversion:

It took a little bit of a learning curve for me to figure out the best way for me to teach and to express what I needed to the students I think.

Participant 5 explained their feeling of accomplishment with this factor when asked what they learned from this experience:

I can actually teach a subject that I'm learning... that I could communicate to others, um, in a way that they would be able to understand.

A related challenge expressed by four of the seven participants was being able to “think on the fly” and adapt their lessons in real time in response to student needs. Participant 6 elaborated on this challenge:

...our uh class was a with a computer program there's like a lot of glitches with it sometimes it was like a lot of guess and check, so, there's a lot of thinking on the fly and being able to think on my feet so I think that was the most difficult part.

All of the participants reported a positive experience, and four of the seven participants listed their enjoyment as an important takeaway from their experience. Perhaps the most positive reaction came from Participant 4, a freshman at the time of their experience:

I, think that the STEM grant itself was SO beneficial to me as a person who, really again I really had not considered teaching and I have grown in so many ways both professionally and personally from the experience of working for Meelia, and what got me into that was that STEM grant. It has been, like probably one of the greatest things to ever happen to me. I feel so blessed by it and I truly will say that, if this is something that could come up again I, would be the LOUDEST voice in that it is so amazing it has brought in so many incredible people into our program that never would have thought about, pursuing our program before.

Two of the most important classes of positive experiences for participants came in the form of observing their students' efficacy over the course of the program (six of seven participants) and building connections and relationships with the high school students, with their co-instructors, and with other Access Academy instructors (five of seven). Participants were especially impressed by student efficacy in learning computational and technical tasks. For example, Participant 7 spoke of the "Radios for Jupiter" course, saying:

I think the most fun... I focused on the receiver, so my, like, perfect um thing was when we were at the observatory, and, the students were able

to set it up all by themselves and they were able to teach their classmates exactly what I had helped them learn out of everything, it was just a really proud moment for me, to see it all come together.

More generally, Participant 3 remarked:

...really why I wanted to go in was sharing MY love of science with the students, and I think I managed to rub some off on them a love for science.

Participant 2 elaborated on the most enjoyable aspect for them:

I enjoyed... probably the biggest thing I enjoyed was, uh the moment where they understood what I was talking about where they went “ooooh” and then they were able to you know ask further questions and kind of have like, an actual discussion about the material. That was definitely the most rewarding part of it.

Participant 4 spoke more of the connections to and relationships with the high school students in the program:

...when you break Access down that's what it is, it's giving these students a place to come where they feel safe and loved and comfortable and that is the most amazing thing to be able to provide.

Participant 5 explicitly related their positive experience in building relationships with the students outside the classroom:

I like the dinners, um that I was able to have with the kids cuz, like this one time we played Uno, during and we were able to become more

comfortable with them I think that's like was the real icebreaker of the whole year, and it just made us all more comfortable with each other...

Participant 1 listed one surprise as being the relationships formed with colleagues:

I think just sort of the, the cooperation and the ability of everyone to relate to each other even though we were all teaching different classes, and I think that goes for both you know all the other Access coordinators but especially my co[teacher]s cuz there's one physics major, one engineering major and he's a year younger than me so he's on a slightly different path, and there is biology and education and we all found something to relate over that and I think that was really cool.

Effects on Career Consideration

The primary goal of this program was to attract STEM majors to teaching as a career. Participants were explicitly asked about this at the beginning of their experience through a survey and at the end of their experience in the interview and in a survey. All but one participant showed a positive trend, though they vary in effect size. All but one participant indicated a desire or plan to continue teaching thought Access Academy where possible. See a summary of responses in Table 2.

Table 2: Changes in opinions on teaching as a career choice

Participant	Thought of teaching before experience?	Thoughts of teaching after experience?
Participant 1	no; closest was camp counselor training	would consider it, but not sure about it - not in "top 10"
Participant 2	no	"not really on, like part of the plan but I wouldn't say it's out of the question?"
Participant 3	No; mentioned life-guarding experience	no; mentions paycut vs engineering, "as a career, it's not for me"
Participant 4	no; "Teaching was never something that I had, fully considered"	would "love to consider" in future, but currently on med school path
Participant 5	no, "I just never like uh thought of myself as a teacher before"	maybe, "I have, like, thought about it more because of access because it does seem like something that I would want to do in the future." - knows nothing about the steps
Participant 6	"I was thinking about becoming a teacher over break actually... then I had the opportunity from Professor [name], she mentioned it and so I was like I'll try teaching, see how that goes..."	"... and I enjoyed it and, I think actually might pursue it after"
Participant 7	"I've never considered being a teacher before"	"This experience has forced me to, consider it as an option. I think I would have to do more of it before I could say distinctly"

Participant 3, a sophomore, indicated that, though they had a positive experience, they had not considered teaching before Access Academy and still considers the career “not for me” after the experience. They specifically cited the pay

differences between secondary teaching and their chosen field of engineering as one major factor. They would not continue to work at Access Academy due to a focus on grades needed for their engineering program.

Five of the seven participants indicated in their interviews that they had not considered teaching before their experience and that they were now open to the possibility after the experience. Their responses ranged from “not out of the question” to “something I would want to do in the future” (see Table 2). These indicate that exposure to teaching in a positive environment such as this led these participants to consider it, though not to sign up for an education major. Two of these five participants were already in their junior year, and thus unlikely able to fit in a second major in education at that point. One was a sophomore and two others were freshmen. Interestingly, all five of these participants indicated that they were planning to continue their work as a teacher or manager with Access Academy in the next academic year.

Only one of the seven participants, a senior, indicated that they had considered teaching before the experience with Access Academy. In their interview, they explained that they had been considering it over the winter break, and so the opportunity to teach the spring course in Remote Sensing was well timed for them to try it out. As they were preparing to graduate at the time of their interview, they were seriously considering pursuing certification after graduation as a result of the experience.

The eighth undergraduate student interviewed was also a second semester senior at the time of their experience. This person was not recruited through the initial program, nor were they a co-teacher of their course or involved in lesson planning.

Rather, they were a volunteer in the course, taking direction from the co-teachers and interacting with the high school students taking a computer graphics course in Access Academy. This participant also spoke of their positive experiences witnessing the growth of student efficacy, learning the process of teaching, and building connections with the students. About halfway through the semester, this participant spoke to a recruiter for a high school at a campus job fair due to their positive experiences. They then applied for and took a job teaching high school physics as a result. This participant went so far as to encourage further participation in teaching experiences such as Access Academy for future science majors:

"I feel like the physics program should like put that into like for the freshman... I feel like that should be something the whole school should do."

Discussion

The overall positive experiences of participants as teachers in the Access Academy program led to a small increase in interest in teaching in all but one participant. Notably, participants who had never considered teaching before were not considering it as a possibility, and participants who had been considering teaching were further motivated to pursue the profession after the experience. Most importantly, this experience gave STEM majors an awareness of teaching as a possible career choice for them, even if they had never before considered it.

We discovered that there is a small population of undergraduate STEM students who decide to pursue teaching in their senior year, many of whom teach in private

schools or with emergency or alternative certification. This is especially prevalent in fields such as physics that are so poorly underserved. Though they have the passion, these new teachers are going into classrooms with little pedagogical training, and these routes to certification are a risk factor for low teacher retention rates (Zhang & Zeller, 2016). This program has the potential to reach such undergraduates long before their senior year, allowing them time to include pedagogical training in their undergraduate experience.

Conclusions

Conclusions from this research are preliminary at the time of this writing. The Access Academy project provided an early teaching experience for STEM majors that was both authentic, involving lesson planning and interactions with high school students, and well-supported by the staff and faculty at the Meelia Center and at SAC. These two factors have been identified in prior research as being important in providing a positive introduction of teaching to STEM majors. Although the overall effects in changing student career paths were small, they indicate the potential to introduce interested students to the practice of teaching early in their college experience, thus allowing them time to include secondary education in their course planning. We see that a small population of STEM majors who decide to go into secondary education late in their college career already exists, and it would be beneficial to reach them earlier with such an opportunity. These results need to be revisited in light of the campus climate at Saint Anselm College around STEM teaching, as will be revealed through an analysis of surveys taken of STEM freshmen and STEM faculty at the college. Additional benefits

of the program can be explored, such as early introduction to pedagogical thinking for all STEM students who are likely to incorporate training or education at some point in their careers (e.g. as technical trainers, graduate teaching assistants, or higher education faculty).

References

- American Association for Employment in Education. (2017). Educator supply and demand report 2016–17. Slippery Rock, PA: American Association for Employment in Education.
- https://www.aaee.org/resources/Documents/AAEE%20Supply%20_%20Demand%20Report%202017%20Ex%20Summary_fnl.pdf
- Borgerding, L. A. (2015). Recruitment of early stem majors into possible secondary science teaching careers: The role of science education summer internships. *International Journal of Environmental and Science Education*, 10(2), 236–246.
- <https://doi.org/10.12973/ijese.2015.244a>
- Braun, V., & Clarke, V. (2012). Thematic analysis. In *APA handbook of research methods in psychology*, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological. (pp. 57–71).
- <https://doi.org/10.1037/13620-004>
- Coffey, H. (2010). “They taught me”: The benefits of early community-based field experiences in teacher education. *Teaching and Teacher Education*, 26(2), 335–342. <https://doi.org/10.1016/j.tate.2009.09.014>
- Hildenbrand, S. M., & Schultz, S. M. (2015). Implementing Service Learning in Pre-Service Teacher Coursework. *Journal of Experiential Education*, 38(3), 262–279. <https://doi.org/10.1177/1053825915571748>

- Liou, P.-Y., Desjardins, C. D., & Lawrenz, F. (2010). Influence of Scholarships on STEM Teachers: Cluster Analysis and Characteristics. *School Science and Mathematics*, 110(3), 128–143. <https://doi.org/10.1111/j.1949-8594.2010.00016.x>
- Luft, J. A., Wong, S. S., & Semken, S. (2011). Rethinking Recruitment: The Comprehensive and Strategic Recruitment of Secondary Science Teachers. *Journal of Science Teacher Education*, 22(5), 459–474. <https://doi.org/10.1007/s10972-011-9243-2>
- Mervis, J. (2015). A classroom experiment. *Science* (New York, N.Y.), Vol. 347, pp. 602–605. <https://doi.org/10.1126/science.347.6222.602>
- Ticknor, C. S., Gober, D., Howard, T., Shaw, K., & Mathis, L. (2017). The Influence of the CSU Robert Noyce Teacher Scholarship Program on Undergraduates' Teaching Plans. *Georgia Educational Researcher*, 14(1). <https://doi.org/10.20429/ger.2017.140103>
- Worsham, H. M., Friedrichsen, P., Soucie, M., Barnett, E., & Akiba, M. (2014). Recruiting Science Majors into Secondary Science Teaching: Paid Internships in Informal Science Settings. *Journal of Science Teacher Education*, 25(1), 53–77. <https://doi.org/10.1007/s10972-013-9360-1>
- Zhang, G., & Zeller, N. (2016). A Longitudinal Investigation of the Relationship between Teacher Preparation and Teacher Retention. *Teacher Education Quarterly*, 43(2), 73-92. Retrieved April 8, 2021, from <http://www.jstor.org/stable/teaceducquar.43.2.73>