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Identifying Why STEM Students Seek Teaching Internships

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Abstract

To increase the number of STEM majors exposed to the teaching profession and applying for undergraduate/graduate education programs, a paid teaching internship program for current STEM undergraduates was created at our institution. This program currently places students with secondary STEM teachers to observe, assist and finally teach under supervision. The high number of applicants and the competitive applicant pool (similar to demographics, GPA and background reported for Research Experiences for Undergraduates (REU) applications) led to the following research questions: (1) How do STEM students' perceptions of their present activities and future goals relate to their desire to gain teaching experience? (2) To what extent do STEM students applying for teaching internships feel that they belong in their current STEM major? (3) How do these students characterize teaching and what attributes do they possess that align with attributes of teachers? Information from program applications and electronic questionnaires were our data sources. The questionnaire asked about background, demographics, reasons for pursuing a teaching internship, attributes of professionals in teaching and in STEM, previous internship experiences, whether they felt a sense of belonging in their current department, and future goals. Results showed that most interns have various reasons for pursuing the internship opportunity, have considerable experiences working with youth, want to teach at some point in their careers, and feel a sense of belonging in their STEM departments. Most interns also highlighted different attributes needed to be a teacher and a STEM professional. When describing attributes of teachers, social skills were mentioned most often and academic skills were mentioned least often. When describing STEM professionals, academic skills were mentioned most often and social skills were mentioned least often.

Introduction

In an effort to ensure economic competitiveness, the United States has prioritized attracting and retaining students into science, technology, engineering or mathematics (STEM) degree programs. While most agree that this is a good pathway¹, how these undergraduate STEM degrees should be utilized in the job market and how to best educate STEM undergraduates are still part of the national debate. Undergraduates in STEM still look at non-traditional careers after completing their undergraduate degrees even when they are considered to be traditionally excelling (as signified by indicators such as GPA)². Pantiz highlighted that a flow of engineers (a subset of the STEM undergraduates) go into non-engineering jobs because the U.S. job market rewards their skills more highly when they cross into other fields compared to remaining in engineering positions³. Engineering undergraduate degrees have been identified as good technical grounding for subsequent careers as patent lawyers, medical practitioners and or as analysts within financial consulting firms³. Due to the high number of engineering undergraduates pursuing non-engineering careers, the 1995 National Science Foundation (NSF) report *Restructuring Engineering Education* recommended that engineering education should support two classes of career aspirations. One career pathway outlined in this report was one with “significant technical content, but focused on various non-engineering career objectives including careers in K-12 education, public policy, management, financial services, and health care.”⁴

The movement of undergraduates out of traditional STEM careers and into K-12 education has been viewed as a way to ensure a high level content knowledge of new teachers teaching K-12 STEM courses. Although many undergraduates have experience with informal K-12 teaching/mentoring experiences, these experiences are often short in duration, provide little training on teaching methods and the objectives of the program are normally focused on relaying the importance of outreach to STEM undergraduate students or to develop communication skills of these students. These opportunities often initiated as part of extracurricular activities through student organizations, required as part of an assistantship, or through large programs supported by government funding agencies such as the NSF⁵. In an effort to increase the number of STEM undergraduates transitioning into U.S. classrooms, the NSF began funding new programs. Some of these programs were designed to give STEM undergraduates an opportunity to intern within K-12 schools under the guidance of a cooperating teacher, while other programs offered recent graduates a pathway to quickly gain teaching skills needed to enter the classroom. The NSF *Robert Noyce Teacher Scholarship Program* was first authorized under the National Science Foundation Authorization Act of 2002 (P.L. 107-368) and reauthorized in 2007 under the America COMPETES Act (P.L. 110-69) to recruit talented science, technology, engineering and mathematics majors and professionals to become K-12 STEM teachers. The goal of these programs was not to discourage undergraduate STEM students from working within the STEM field as engineers, scientists or mathematicians, but instead to promote teaching as a valued career option and then to provide support for STEM majors who showed an interest in becoming K-12 educators².

The NSF Robert Noyce Teacher Scholarship site located at our institution was developed as a partnership among colleges of education, engineering and the sciences, in collaboration with partner school districts in our region of the state. This program has implemented recruitment strategies including an undergraduate internship program. Beginning in 2012, the program created an internship for full-time undergraduate students enrolled in STEM majors to intern within elementary schools. After providing two cohorts of internships at elementary schools, based on feedback from the interns, the program shifted all interns into high school settings.

Analysis of the number of applicants and their qualifications showed that there was a competitive applicant pool each term, as shown in Table 1. This pool was similar to demographics, GPA and background reported for REU applications. Published reports of a program with similar objectives at a peer institution also noticed that traditionally excelling students were interested in switching out of engineering². While there has been some longitudinal research studies on the effectiveness on teaching internships⁶, there has not yet been a study identifying why STEM students choose to participate in teaching internship programs. Our study seeks to answer the following research questions: (1) How do STEM students' perceptions of their present activities and future goals relate to their desire to gain teaching experience? (2) To what extent do STEM students applying to for teaching internships feel that they belong in their current STEM major? and (3) How do these students characterize teaching and what attributes do they possess that align with attributes of teachers?

Table 1: Summary of number of applicants, age (mean and standard deviation), and grade point averages (GPA; mean and standard deviation) for the first five terms of the undergraduate education internship provided through Clemson University, supported by the NSF Robert Noyce Teacher Scholarship.

Term	Number of Complete Applications	Age of Applicants		GPA	
		Mean	STDEV	Mean	STDEV
1	21	19.7	2.04	3.34	0.46
2	23	19.7	1.93	3.28	0.47
3	18	21.0	2.57	3.35	0.43
4	45	19.9	1.67	3.32	0.46
5	55	20.9	1.96	3.39	0.45

Experimental Methods

Phase 1: Pilot Study

Open ended questions were developed for an online survey to better understand how applicants' perceptions of their future goals related to their desire be part of the internship program, the sense of belonging students had to their current STEM programs and how these applicants perceived professionals within STEM and educational fields. The questions found in Appendix A were used along with demographic questions (transfer status, major, gender, race/ethnicity, cumulative GPA, age and class standing) in the online survey.

After receiving approval from the Institutional Review Board, an email requesting participation in an online survey was sent to all applicants for a position during the sixth undergraduate internship cycle. All participants who indicated their age to be under eighteen years old were not included in the study. No incentives were offered to increase participation rates. Once data was collected and personal identifiers removed, each of the open-ended responses was coded by one research team member using conventional content analysis, or emergent coding. Conventional content analysis was chosen because it allows for themes to arise from the data to describe the phenomenon⁷.

Phase 2: Exploratory Survey

Based on the data and themes from Phase 1, initial survey questions were revised to either improve clarity or to more thoroughly prompt answers to the research questions. These revised questions can be seen in Appendix B. All applicants to the internship program during the 7th cycle were invited to complete either electronic or paper copies of the survey; the paper option was added to increase participation rates.

Once data was collected and personal identifiers removed, two members of the research team coded each of the open-ended responses again using conventional content analysis, or emergent coding. Themes were identified during the initial analysis, and key thoughts in the data were used to create codes. Code categories were identified from themes in the applicants' responses and guided by our research questions. An initial codebook with codes and code

categories was made to ensure consistency in coding between researchers. Codes and coding categories were allowed to emerge during the coding process.

Preliminary Results

Phase 1: Pilot Study

In Fall 2014, the applicant pool ($n = 51$; average age 20.9 ± 1.96 years) drew from majors in engineering (47%), mathematics (10%) and science (41%). Applicants had an average GPA of 3.39 ± 0.45 and were mostly upperclassman: 31% seniors, 31% juniors, 24% sophomores, and 2% freshman; 12% did not to report class standing.

Six applicants (11.7% response rate) completed the electronic questionnaire. Students indicated that they sought teaching experiences to gain experience for their future (either in their STEM field or in education), to help others, or for self-development (including self-reflection or increasing income). Three students did not feel that they had a sense of belonging in their current departments.

Students perceived teachers to possess strong social skills and attributes such as leadership, outgoingness, and caring. They primarily perceived professionals in STEM fields to have strong mental/academic skills and attributes such as good time management skills, problem solving skills, and work ethic. From these responses, only two of six respondents listed commonalities between teaching and STEM (leadership and intelligence). All respondents indicated that they did not have internship or coop experiences in their current STEM fields.

Phase 2: Exploratory Survey

In Spring 2015, 25 surveys were completed by applicants (4 paper and 21 electronic), which was a 46% response rate of all applicants to the program. The participant pool was 76% females and 24% males; 16% indicating that they transferred into the university. The majors were spread between engineering (Mechanical 12%, Materials 4%, Industrial 8%, Electrical 4%, Bioengineering 12%), mathematics (16%) and sciences (Wildlife biology, 4%, Physics, 4%, Food Science 4%, Biological Sciences 24%, Biochemistry 4%, Animal Science 4%). The reported GPA was 3.5 ± 0.5 , but was only calculated from 18 participants. Those not reporting indicated they were freshman and did not have a college GPA to report. The average age was 19.3 ± 1.2 . Most reported to be Caucasian/White, with only 8% reporting to be African American/black or 4% Asian/Pacific Islander.

From the responses on both the surveys ($n=25$) and applications accessed with the survey participant's permission ($n=23$), we collated themes pertaining to how students' present activities and future goals related to their desire to gain teaching experience, the applicants' sense of belonging within their current STEM major, and how these applicants characterized teachers and professionals within their own STEM field. In addition to the research questions that were changed, three different questions were used to assess students' class standing. Although students gave varying answers about their class standing (freshman, sophomore, juniors or seniors) based on years in college, credit hours, and level of courses in which they are currently enrolled, based on the latter (self-reported level based on level of courses taken), 16% of the participants were freshmen, 40% were sophomores, 28% were juniors and 16% were seniors.

Responses to Open-Ended Questions

From the responses on both the surveys ($n=25$) and released applications ($n=23$), themes were collated that related to how students' present activities and future goals related to their desire to gain teaching experience, the applicant's sense of belonging within their current STEM major, and how these applicants characterized teachers and professionals within their own STEM field.

Reasons for Participating in Teaching Experiences

Participants indicated that they applied for the teaching internship for a variety of reasons, ranging from wanting to help others to needing a backup plan to their primary plan of attending medical school. A majority of applicants described seeking out the internship to decide if they wanted to teach in the future. Students reflected on wanting the teaching internship because they thought they would enjoy teaching or they wanted to teach, and on the skill of teaching being valuable in their career path or in any career path. These students wanted the teaching internship to develop teaching skills. Some students described seeking out the internship to help better themselves in other ways, such as for resumes (i.e. the internship was a good opportunity that they did not want to pass up). A majority of students described wanting the internship because of their desire to help others, or to "pay it forward" – to help others in the same way that they were helped. Students' reflections within this theme took different forms. These included seeking out the teaching internship because of a role model who was a teacher, because they would enjoy working with the students, or to help society. These students discussed the broader impacts that come from teaching, such as "creating well-prepared engineers ready to take on any task" (Participant 1).

Students discussed their love and passion for their STEM field, their ability to motivate students and get them excited about STEM, and that passion is an important attribute of a teacher. When asked, "What are some reasons you are interested in exploring this teaching internship?" one student responded:

"I know that for me, the reason I really started to like biology and science was because I had teachers that really impacted me and excited me about the subject, and I think it would be awesome to eventually be able to excite students about these subjects just like my teachers did to me." –Participant 26

Prior Experience Teaching/Working with Youth

As in prior studies, we found that many students had prior experience in informal teaching settings such as being tutors, workshop leaders, camp counselors or as big brothers or sisters⁸. Most of the students who responded to the survey/application had a considerable amount of teaching experience or experience working with youth. This may be because people who are interested in teaching pursue teaching experiences, or these teaching experiences contributed to their desire to teach. The most common experiences students had with youth and teaching youth were tutoring, coaching, mentoring, church events, camps, and helping family and friends. Other experiences students had were through 4H, girl scouts or boy scouts, teaching music, being a referee, tour guides, and volunteering. Students also described experiences working with special needs students.

Future Careers

When describing their future, students fell into five main categories: planning on entering a STEM profession after graduation, planning on pursuing a professional field outside of STEM that necessitates an advanced degree (such as medicine or law), planned on pursuing a field outside of STEM that did not require additional degrees (such as within the FBI), undecided, and teaching. Most students described wanting to teach at some point in their career, with a few specifying wanting to teach the high school or college level. Their intentions to teach were described as either immediately after graduation or after working in a STEM field. Sorby et al⁹ also suggested that there are multiple career paths for STEM majors with an interest in education. They listed two primary options including that they could work as engineer for a few years and then switch to teaching or teach for a few years and then enter industry as an engineer. The desire of engineering graduate to return to teaching later in their careers is found in multiple reports⁸.

These data did not highlight reasons for switching from STEM to teaching reported elsewhere, like increased monetary compensation⁸ or work/life flexibility⁹ reasons. In the study cited, the location of the program to encourage engineering students to become teachers was located in New York City, where salaries for entry level engineering positions are frequently below those for teachers⁸. This salary difference will depend on the area within STEM the students are currently within and which part of the country they are considering teaching in.

Students' Sense of Belonging

In response to the question, "Do you feel like you are a part of or have a sense of belonging in your current department? Why or why not?" a majority of the students reported that they do feel a sense of belonging in their current department. The most common reason reported for the feeling of belonging is because they enjoy their current field. The second most common reason involved related to social aspects. This finding is not surprising since research on belonging has stated that frequent personal interactions with another person is an aspect of belonging¹⁰. This statement may also explain why the main reasons students described feelings of not belonging was also due to social reasons.

The sense of belonging did not relate to students' persistence from a STEM undergraduate program into a traditional STEM career. Most students view the use of STEM skills as something that depends on which career you pursue, and a few students described using STEM skills in everyday life, independent of their career.

Perceptions of the General Attributes of STEM Professionals and K-12 Teachers

Participants in the surveys highlighted the attributes they associated with teachers and STEM professionals. Many of the attributes were listed for professionals in both fields such as good problem solving skills, patience, passion, hardworking, organized, and professional. However, there were also many attributes that participants only aligned with only teachers or STEM professionals. For teachers, attributes included general or specific teaching skills, leadership, ability to be a good role model, creativity, intelligence, outgoing personality, ability to motivate others, and persistence. Attributes that were only mentioned for STEM professionals were being able to learn quickly, ability to focus, desire for perfection, and honesty. Interestingly, all attributes could be categorized in four ways: academic skills, social skills, professional skills, and teaching skills. When describing attributes of teachers, social skills (such as a good leader or role model, approachable, and good communication skills) were mentioned

most often and academic skills were mentioned the least often. When describing STEM professionals, academic skills (such as good problem solving skills, being good at the STEM discipline, and the desire to pursue new knowledge) were mentioned the most often and social skills were mentioned the least. Beneson et al also reported that their engineering students wanted to pursue teaching to combine their technical interests with interpersonal skills and social concerns⁸.

Communication Skills

Students describe teachers as having communication skills in general, while communication skills of STEM professionals are described as the ability to convey technical information. While STEM programs highlight communication as a programmatic outcome, such as the field of engineering where the ABET Engineering Accreditation Commission student outcomes lists “(g) the ability to communicate effectively”¹¹, the focus on technical communication is noted by students. Other articles have noted that while traditional academic preparation of STEM graduate students imparts a deep understanding of their disciplinary focus, formal efforts rarely have been devised to enhance their professional skills¹².

Conclusions and Future Work

A majority of the students would like to teach at some point in their career, and are using this teaching experience to decide if teaching is a career path they want to pursue both immediately and far in the future. Also, most students applying for the internship do feel as if they belong within their STEM programs or departments. Students seeking these internships also believe that teachers have strong social skills while STEM professionals have strong academic skills. Considering students’ motivations for applying to the teaching internship such as wanting to help others, work with people, and help society, it is possible that these students don’t believe that there are enough opportunities to fulfill these desires in STEM disciplines.

The authors will continue to further develop the survey items to help understand the career paths of STEM majors at Clemson University and identify mechanisms to help STEM students transition into K-12 education. For example, when asking about students’ perceptions of the usefulness of the STEM skills they are learning in their majors, many students may have described how these skills are dependent on their career because of the wording of the prompt. The current question was, “In what ways and for how long after graduation do you plan on using what you are learning in your current STEM major as part of you day-to-day work?” In the future, this question will be reworded to, “Do you predict that you will use some of the material learned during your STEM undergraduate program in your future career. If so, how, and until what time point?”

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Appendix A: Open ended questions developed for Phase 1.

- *How did you find out about this opportunity?*
- *Why do you want to have a teaching experience?*
- *What attributes of a professional teacher do you think you have?*
- *What attributes of professionals in your current science, technology, engineering or mathematics (STEM field) do you think you have? You may even choose more than one if appropriate.*
- *Do you feel like you are a part of or have a sense of belonging in your current department? Why or why not?*
- *What disciplines, if any, do you identify with? For example, would you identify yourself as: a science student, engineering student, mathematics students, education student or undecided?*
- *Have you had an internship or coop experience in your current field? If so, describe this experience. (For example, highlight when this experience occurred in your academic career, what you did and how you felt about your overall internship and coop experience).*
- *How long after graduation do you plan on using what you are learning in your current STEM major as part of your day-to-day work?*

Appendix B: Revised survey questions for Phase 2. Bolded questions are those that were updated after analyzing the pilot survey responses.

- *How did you find out about this opportunity?*
- ***What are your current plans for the future and how might the field of education fit into your plans?***
- *Why do you want to have a teaching experience?*
- ***Describe any experiences you have had in working with youth. (Ex. camp counselor, coaching little league, etc.)***
- *What attributes of a professional teacher do you think you have?*
- *What attributes of professionals in your current science, technology, engineering or mathematics (STEM field) do you think you have?*
- *Do you feel like you are a part of or have a sense of belonging in your current department? Why or why not?*
- ***How would you identify yourself? For example, would you identify yourself as: a scientist, engineer, mathematician, teacher or undecided? You may even choose more than one if appropriate.***
- ***In what field are you most likely to choose a career in?: Science, mathematics, engineering, teaching or undecided? You may even choose more than one if appropriate.***
- ***Have you had an internship or coop experience in your current field? Why or why not?***
- ***In what ways and for how long after graduation do you plan on using what you are learning in your current STEM major as part of you day-to-day work?***