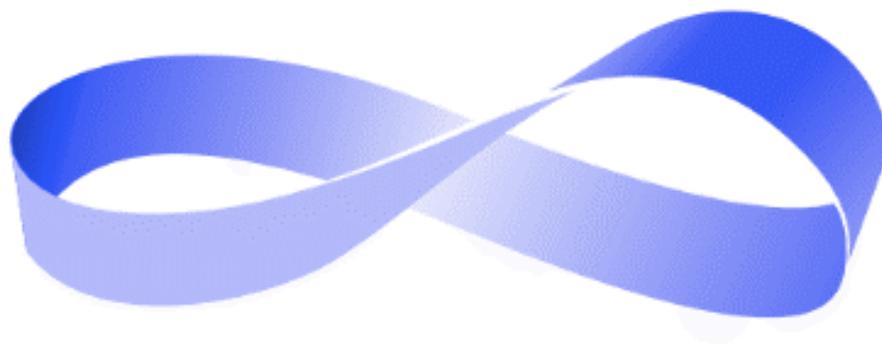




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WHERE'D THEY GO? SUSTAINING AND GROWING INTEREST IN MATHEMATICS TEACHING

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Recruiting and retaining qualified mathematics teachers are well-documented challenges. Our research objective was to examine factors that influence mathematics teaching majors to change academic direction. We utilized a sequential explanatory mixed methods protocol to identify key attrition points for mathematics teaching majors and better understand the differences in motivations between those who leave and those who persist. Particular attention is given to mentoring and support networks, barriers to persistence, and the timeline by which students matriculate and exit the program. One group within the population had a drastically higher success rate, and their motives are examined.

Related Literature

While the demand for professionals in mathematics and the sciences continues to rise, the supply of quality mathematics and science teachers has languished (National Academy, 2010; Watt, Richardson, & Pietsch, 2007). This puts significant pressure on K-12 administrators to recruit and retain mathematics and science teachers with content knowledge and efficacy to instill both expertise and interest into the next generation (National Research Council, 2011; National Academy, 2010). In 2000, the Texas Center for Educational Research released a study quantifying the costs of teacher turnover to the state at somewhere between \$300 million and \$2.1 billion. Other results corroborate the tremendous costs of teacher attrition and call for in depth study of teacher attrition and its causes (Watlington, Guglielmino, & Flesher, 2010).

A nationwide decrease in undergraduate students who earn educator certification or major in education since 1970 (Marketwatch, 2018) has occurred and mirrors the consistent annual increase in teachers who leave education (Sutcher, Darling-Hammond, & Carver-Thomas, 2016). They attribute this to financial factors, but Betancourt (2018) adds concerns about hyper-accountability and federal and state political rhetoric among other causes. Hong, Greene, Roberson, Francis, and Keenan (2018) state that pre-service teachers need opportunities to explore career choices and receive feedback from people they trust in order to be able to persist

to graduation. Research findings from Darling-Hammond (2010) identify key components of successful educator preparation programs including induction and retention. There is limited research focused specifically on how all of these factors impact pre-service STEM teacher attrition at the undergraduate level. Our research is an effort to fill that gap. This study examines the research question, what factors influence undergraduates pursuing mathematics teacher certification to change majors, not certify, or choose other certification pathways?

Context

Stephen F. Austin State University (SFA) is a rural comprehensive university with an annual enrollment of roughly 13,000, 50% reporting being the first in their family to graduate from college. Undergraduate mathematics teacher certification at SFA entails a major in mathematics taught exclusively by the Department of Mathematics and Statistics, then eight additional courses in an Education Preparation Program (EPP) taught exclusively by the College of Education. The EPP consists of six courses leading up to student teaching and a student teaching experience with a university assigned field supervisor and a secondary cooperating teacher.

The T4 program, formally Talented Teachers in Training for Texas, is a National Science Foundation program sponsored (NSF 1136416, NSF 1556983) through the Robert Noyce Scholarship initiative. Its purposes are: first, to create experiences through which university STEM majors can examine careers in high school teaching through early intensive field experience (Hubbard, Embry-Jenlink, & Beverly, 2015). Second, to target aspiring STEM teachers for authentic engagement in a community of practice with a structured mentoring network (including experienced classroom teachers, aspiring STEM teachers, STEM and education university faculty, and public school administrators) for two years before graduation and three years after entry into the teaching profession. Third, to longitudinally examine prospective STEM teachers for the purpose of identifying most effective practices in long-term STEM teacher training and retention. T4 Scholars are chosen based on GPA, professor recommendations, and essay and interview responses. They receive scholarships over the duration of the program and commit to regular participation in the mentoring network community. They participate in bi-weekly meetings with mentors and other T4 scholars to discuss a variety of STEM specific instructional, curricular, and classroom management issues. They also attend discipline specific conferences, meet regularly with education faculty and

STEM faculty mentors, and participate in other team building events with fellow T4 scholars and graduates who are current STEM teachers in public schools.

Methodology

In order to answer our research question, we chose a sequential explanatory mixed methods design. This allowed us to begin by examining the quantitative data available for the mathematics majors at SFA, and then move on to a deeper, qualitative analysis of data to “explore the participants views in more depth” (Ivankova, Creswell, & Stick, 2006, p.9).

In the initial analysis, we examined transcripts for all mathematics majors since 2007 who had at some point identified secondary education as a minor or emphasis. For these 216 students, we tracked graduation rates, secondary education courses taken, and majors and minors declared or completed. These data were analyzed to identify descriptive statistics for graduation, certification, and attrition points from mathematics teaching.

To more deeply understand why mathematics majors persist to certification or change course, we then conducted semi-structured interviews with a purposive sample of eleven mathematics majors based upon attrition and graduation categories in the quantitative data analysis. Each person was chosen to represent a group identified in the quantitative analysis. Three interviewees had continued on track toward graduation in mathematics with a certification in secondary education. Three interviewees had changed their major away from mathematics. Five interviewees had continued in mathematics while moving away from teaching. Within this group of five, one had already certified alternatively, one plans to certify alternatively, two are considering, while one has no plans to certify. Interviewees were selected in order of most recent attendance at the university, employing the assumptions that these students might be most representative of current curriculum and perspectives, and also would be most likely to respond. If a student or former student declined to be interviewed or did not reply to three attempted contacts, another student was sought using the same process.

Interviews were recorded, transcribed, and independently coded by the researchers to identify common themes through open coding and the constant comparative method of data analysis (Glaser & Strauss, 1967). Interviewers also took notes during the interview, which were digitized and compared to the open coding to improve fidelity of analysis.

Data Analysis

Since 2007, SFA has had 216 mathematics majors formally declare an intention to pursue secondary teaching certification through an undergraduate certification program. Of those, 52 were still pursuing an undergraduate degree at the university. We restricted our statistical analysis to the remaining 164 students no longer enrolled as undergraduates.

Since 2012, T4 has selected 29 mathematics students for targeted support. Of these, 12 were still enrolled in undergraduate coursework, meaning that the 164 former students may be disaggregated as 17 T4 students and 147 non-T4 math teaching majors who have graduated or left the university.

Table 1

Attrition and Graduation Categories in Quantitative Data

| | Math Grad, Certified | Math Grad, No Certification | Graduate, Not in Math | Left, No Degree | Total Students |
|------------------------|---------------------------------|--|----------------------------------|----------------------------|---------------------------|
| T4 students | 100% | 0% | 0% | 0% | 17 |
| Non-T4 students | 17% | 15% | 22% | 46% | 147 |

Of the 147 non-T4 students, 67 left without graduating (46%), 33 graduated but not in mathematics (22%), 22 graduated in mathematics but without secondary education (15%), and only 25 graduated with a mathematics major and secondary education minor (17%). Of the 17 T4 students, 100% graduated with a mathematics major and secondary education minor.

Table 2

Number of Students and EPP Courses taken Before Discontinuance

| # of Students | # of Courses |
|----------------------|---------------------|
| 6 | 7 courses |
| 2 | 6 courses |
| 0 | 5 courses |
| 4 | 4 courses |
| 6 | 3 courses |
| 43 | 2 courses |
| 30 | 1 course |
| 33 | 0 courses |

Attrition from the secondary education program might appear most readily addressable from a STEM teacher pipeline perspective. While mathematics courses make up over half of the most failed courses at our university, the education courses required for certification all have success rates above 90%. Hence, we set out to pinpoint precisely where attrition from the secondary education program occurred. The certification program requires eight courses, with the last two

courses constituting the student teaching experience. As Table 2 indicates, 85% of those who discontinue the secondary education program do so within the first two courses of the EPP program. Our quantitative analysis led us to examine the differences in experiences between students who persisted to certification, students who persisted only in mathematics, and students who left mathematics as shown in Table 1.

All three of the interviewees who had originally chosen mathematics as a major and switched to a different degree mentioned that someone in their ultimate degree field encouraged or recruited them to the program in which they are currently on track to graduate. One specifically said of the faculty and peers in her new program, “these are my people.”

The interests of mathematics majors who moved away from a teaching minor were diverse. The first changed his minor to animal science and ended up pursuing a master’s degree in pure mathematics. Although his parents (both teachers) actively discouraged him from becoming a teacher, it was actually his experience with substitute teaching that led him away from teaching. The second simply decided to graduate then certify alternatively to teach. This student indicated receiving no active encouragement or support regarding teaching from faculty or mentors and reported that her father had actively discouraged the career. The third switched her minor to Accounting. She indicated concern about the ability to procure a job in mathematics teaching. While she pointed to several faculty encouraging her in mathematics, she reported no such encouragement toward teaching. On the contrary, she had several accountants actively encouraging her into a career in accounting. Teaching was now her “backup plan.” The fourth interviewee indicated that her GPA precluded her from entrance into the EPP. The fifth interviewee mentioned timely graduation as an impediment to continuing with teacher certification. Listing no mathematics or education mentors, he indicated that he had a dance teacher who had encouraged him to pursue alternative certification if he ever decided to teach. He considers mathematics teaching “still an option.”

Interviewing those students who had persisted in both mathematics and EPP, the first encountered many hurdles from failing coursework to issues with being allowed to student teach. He was a T4 Scholar, however, and indicated that faculty mentorship was “huge,” The second interviewee, also a T4 Scholar, indicated that failing Calculus was a major inhibitor toward continuing. However, he indicated that although he received no direction from his parents, being a first-generation college student, his peers were very supportive; T4 professional mentors were

supportive; and “faculty had the largest effect.” The final interviewee was a successful mathematics teaching student who was not involved with T4. He reported encouragement but no academic direction from his parents, but an excellent group of peers who were also interested in mathematics teaching. He also listed former mathematics teachers and faculty with whom he has continuing relationships. He said, “I love the entire math department ... it made everything worthwhile.”

Findings

A number of themes were illuminated through the participant interviews. The most commonly identified theme from these interviews, as evident in Table 3, is that students respond to mentorship and encouragement, both positively and negatively. This is true of faculty, family, peers and professionals outside the profession. The research findings of Hong, et. al. (2018) also highlight the influence of mentorship upon persistence and choice to teach, stating that pre-service teachers “are continuously going through resynthesizing and reconfirming process” (p. 418). Thus, a mentoring network such as T4 provides a safety net for pre-service teachers within that process as they move through their undergraduate experiences.

Table 3

Summary of participant responses about reasons for leaving mathematics teaching

| Reasons for leaving mathematics teaching major | Students affected |
|---|--------------------------|
| Lack of encouragement toward mathematics teaching | 7 of 8 |
| Encouraged by someone in a different field | 5 of 8 |
| Extending time to graduation/ cost | 5 of 8 |
| Parent actively discouraging teaching | 3 of 8 |
| Early teaching exposure was negative | 2 of 8 |
| Alternative certification seemed more efficient | 2 of 8 |
| Concerns about being able to find a job in mathematics teaching | 1 of 8 |
| Not meeting GPA requirements of EPP | 1 of 8 |
| Reasons for persistence in mathematics teaching major | Students affected |
| Faculty mentorship and encouragement | 3 of 3 |
| Supportive peer network | 3 of 3 |
| Faculty support during academic or system hurdles | 2 of 3 |

A second identified theme, evident in five of the interviewees, was that additional coursework, postponed graduation, and overall cost were barriers. Several students viewed the EPP content as having limited “quantifiable value,” which they indicated discouraged them from pursuing undergraduate certification.

A third identified theme is that six of the eleven indicated that they did not start college with mathematics teaching as the primary career path - they switched to it (including two of the three

successful mathematics teaching graduates). This provides a limited “window” during which a potential mathematics teaching major would be most assisted by mentorship into mathematics teaching. This is supported by quantitative findings that 85% of those leaving the eight teacher certification courses, did so within the first two courses. It mirrors the research of Hong, et. al. (2018), whose research also indicates that pre-service teachers’ university experiences encourage or discourage persistence to certify and graduate.

Conclusion

While examining the training and retention of mathematics teaching majors is multifaceted, it is vital that programs internally examine their majors’ persistence to certification and the motivations for staying or leaving. Studies such as this allow programs to determine how their rates of attrition compare to other institutions and provide insight into how to go about supporting students most effectively.

Outside the T4 program, the traditional mathematics certification rate is 17%, while within the program it is 100%. While this program’s support is financial, experiential, and interpersonal, interviews make clear the dramatic and causal effect of mentorship in academic major and career choice. Those who left the mathematics major, to a person, indicate mentorship drew them to the new discipline. Though alternative certification was frequently mentioned among those who left secondary education, the one teacher in the study who pursued this course left teaching after having a very negative experience. This is consistent with national research on teacher attrition (Ingersoll, Merrill, & May, 2014). The costs, additional time, and perceived deficiencies in the secondary education coursework, real or imagined, form a substantial barrier to certification.

The emergent themes not only provided insight into our research question, but also aligned with the research of Darling-Hammond (2012) and Hong et al. (2018), who stated that quality EPP programs emphasize positive relationships between faculty and pre-service teachers, and that EPP programs must be identifying barriers to and improving retention for pre-service teachers. Based upon our findings, we believe that universities can create and support such an environment, as evidenced by the success of the T4 program at SFA.

It is noteworthy that successful mathematics teaching graduates indicated multiple mentoring and support sources, pointing to a mentoring network rather than a single mentor that might be most effective. More research and longer time horizons are needed to more effectively model and positively affect mathematics teacher training and retention but building mentoring

networks for students appears vital to ensuring sufficient quantities of committed teachers capable of engendering an appreciation for mathematics in the generation to come.

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