"Lived Experience of STEM Faculty Becoming Teacher Educators"

Abstract

This study employed a qualitative research study employed an ethnographic approach to examine the experiences of Science, Technology, Engineering, or Math (STEM) faculty who participated in a supplementary mentoring network, the National Science Foundation Noyce Scholarship program, for STEM pre-service teachers. The findings highlight the ways in which mentoring programs can positively impact faculty and the preparation of STEM pre-service teachers.

Introduction

While the research studying educator preparation programs of Science, Technology, Engineering, or Math (STEM) pre-service teachers is growing, the research on professional growth, collaboration and identity of the faculty involved in STEM pre-service teacher education is limited (Rogers, Berry, Krainer, Even, 2021). This ethnographic study documents the experiences and growth of STEM faculty who were not hired to be teacher educators but became involved in the National Science Foundation Noyce Scholarship program that provides scholarship funding, mentoring, and support for pre-service STEM teachers. The research in this project was completed by two qualitative teacher educator researchers involved in the Noyce project, who observed paradigm shifts in their STEM faculty co-workers and realized this was important and needed to be documented and shared as research. The sharing of the lived experiences of STEM faculty as teacher educators, their growth, and their changing and evolving perspectives on teacher education is key to involvement, recruiting, and support for STEM

teacher education program such as the Noyce scholarship program and other STEM focused teacher education programs in institutions of higher education (IHE). This study examined the following research question:

1. "What experiences did STEM faculty report after participating in a supplementary mentoring network for STEM pre-service teachers?

Additionally, the goal of this research study is to examine the lived experiences of STEM faculty involved in the Noyce STEM teacher education program and examine how their role in becoming teacher educators, and involvement in the Noyce program impacted them as STEM faculty working with teacher candidates.

Literature Review

STEM Teacher Shortage

There has been a declining number of students declaring a major in STEM fields since the 1990's (Laws, 1999; Rask, 2010). This decline has resulted in an increased need for STEM teachers, specifically in rural and remote areas. (Dept of Education, 2021; Morton, 2021). There has been in a rise in the number of STEM educators leaving teaching to enter a non-education STEM field for two decades (Han & Hur, 2021; Ingersoll & May, 2012). Additionally, the STEM teacher shortage is becoming increasingly critical as the COVID 19 pandemic has upended the labor, real estate, and education sectors (Rural Schools Collaborative, 2021). Research findings suggest reasons for teacher attrition such as salary, lack of mentorship, and working conditions (Carver-Thomas & Darling-Hammond, 2019; Han & Hur, 2021; Ingersoll & May, 2012; Kukla-Acevedo, 2009). However, findings also indicate a connection between teacher preparation and retention (Carver-Thomas & Darling-Hammond, 2019). In fact, Henry et

al.'s (2012) studied found that less effective STEM teachers leave the teaching field early in their career, making teacher preparation a vital element in meeting the gap in the recruiting and retaining qualified STEM educators.

STEM Faculty and Teaching Experience

Due to the decreased enrollment in STEM fields, there has been an increased national push to recruit and retain STEM majors and future educators (Aulck et al.,2017, Valerio, 2014). However, many "new teachers in higher education confess that they are not very sure how to go about teaching and translating their knowledge and enthusiasm for their fields to others" so they "model their teaching after their memories of their undergraduate and graduate experiences" even if they were not particularly successful models (Austin, 2011, p. 5). Research findings indicate that underperformance in STEM classes has been connected to STEM faculty deficit perspectives on students (Canning, Muenks, Green, Murphy, 2019) and that STEM faculty are more likely to use non-research based classroom pedagogy, such as lecture, instead of active learning instructional strategies, and that the STEM faculty are often not able to accurately self-assess their teaching practices (Smith, Vinson, Smith, Lewen, Stetzer, 2014). Samaras et al. argues that STEM faculty often teach foundational courses but are afforded "little training in teaching and/or opportunities to collaborate with peers as they assess their pedagogical strategies" (2019, p. 195).

Becoming a Teacher Educator

In addition to barriers STEM faculty may face as an educator, there are challenges in becoming a teacher educator. The success of teacher education is dependent upon the skills, identity, knowledge, and growth of the teacher educators guiding the curriculum, instruction, and

experience of the teacher education programs (Rogers et al., 2021; Blomeke, Felbrich, Muller, Kaiser, and Lehmann, 2008; Tatto, Lerman, Novotna, 2010). Research on teacher educators is key to understanding the complexity of teacher education, and Rogers et al. suggest that a "double goal and role of understanding and improving teachers' learning" is key for teacher educators (p.168). Murray and Male (2005) argued that it takes three years for teacher educators to reframe, and this reframing brought on "feelings of professional unease and discomfort" (p. 139). Additionally, teacher education is "complex work involving curriculum, pedagogy and research, yet most teacher educators are provided with little professional development" (Loughran, 2015, p. 273). In many STEM departments in institutes of higher education, faculty mentoring,or involvement in pre-service teacher education programs, is not valued by the STEM department on the same level as other tenure and promotion requirements, so faculty are often not able devote their time and energy into participating in such programs (Andrews, Weaver, Hanley, Shamantha, Melton, 2005).

Theoretical Framework

The theoretical framework for this research study is based upon the experiential learning and constructivist theory posited by Dewey (2007) and the ideas that mathematics is an "inherently social activity" (Schoenfeld, p. 335, 1994) and science is both "epistemic and social" (Duschl, p. 287, 2008). The idea that the social aspect of learning, in the form of mentoring, needs to be experienced by the pre-service STEM teachers in the EPP for them to be able to give that type of social support to their students is the lens through which this study was designed and guided the data analysis and organization of themes. These quality mentoring experiences framed the evolution of the paradigm shift for the STEM faculty in their dual role as teacher educators and

STEM faculty. The mentoring was the phenomenon that facilitated the paradigm shift they experienced.

Methods

This qualitative research study employed an ethnographic approach. Ethnography as defined by Brewer (p.99, 2003) is "the study of people in naturally occurring settings or 'fields' by means of methods which capture their social meanings and ordinary activities, involving the research participating directly in the setting in order to collect data in a systematic manner". Rogers, Berry, Krainer, and Even (2021) recommended that research involving teacher educators involves a balance of distance and nearness of the researchers. This study was completed in a naturalistic setting, where the researchers could observe, evaluate, and collect data in the natural setting of the Noyce project that facilitated the paradigm shift of the STEM faculty. The context for this study is a regional rural public university in Texas, where the EPP for pre-service STEM teachers was supported by two Noyce scholarship grants between 2012-2018.

Participants

The participants in this study were the four faculty members who authored the Noyce scholarship grant, and then became the grant's facilitators, mentors, and faculty advocates for the STEM pre-service teachers. Each of the faculty members were full-time, tenure track faculty at the university. Three of the participants had no experiences mentoring STEM pre-service teachers and had not participated in any EPP program activities before the grant was written. Pseudonyms were used to protect the identity of the participants.

The researchers/authors who designed the research, conducted the data collection and analysis, were involved in the university teacher preparation program, and supporting Noyce program, but were not involved from the beginning of the grant. The researchers/authors became aware of the

experiences of the STEM faculty as they interacted with the faculty and the grant participants as they conducted various research projects.

Lincoln and Guba (1985) recommend for research studies to include prolonged engagement and participant observation to ensure trustworthiness. The two researchers for this study have been involved as researchers and mentors in the Noyce program and have collaborated with the STEM and education faculty participants from 2015 to present day. Interactions included biweekly meetings, research focus groups, collaborations with faculty and Noyce scholarship recipients, and STEM teachers who completed the Noyce program. The interactions enabled the researchers to develop theoretical sensitivity (Glaser and Straus, 2017).

The definitions of faculty involvement in a traditional EPP and the Noyce supplementary program are summarized in Table 1.

Table 1- Roles of personnel in Noyce mentoring network and traditional EPP at the university where research was conducted

Role	Noyce Program	Traditional EPP
Academic Advisor	Advise when to take content/EPP courses	Advise when to take content/EPP courses
Faculty Advocate	Advocate for pre-service teacher within EPP and STEM courses, program, and certification processes. When challenges are faced, help student navigate those challenges	None present within this university EPP.
Mentor	Academic and non-academic formal and informal mentoring. Texting, calling, in person conversations to support and give advice as needed.	None present within this university EPP.
PI, Co-PI	Facilitates the logistics of the Noyce scholarship grant, performs recruitment, research, mentoring and other support for participants as needed.	Not available.
Instructor	Teaches STEM/EPP courses as needed.	Teaches courses as needed.

The Noyce mentoring network established support for the Noyce scholars during their enrollment in the EPP and after graduation. Research findings have documented the impact Noyce mentoring had on persistence to graduation and certification (Hubbard, Beverly, Cross, & Mitchell, 2018) instructional methods (Cross, Hubbard, Beverly, Gravatt & Aul, 2020) and teaching effectiveness (Wagnon, Cross, Hubbard, 2020).

The faculty participants in this study were involved with most pre-service STEM teachers as they entered the EPP, during their last two years of undergraduate courses at the university, and then after graduation for a period of 4 years, while the pre-service STEM teachers entered the teaching field and became STEM educators.

Table 2 Illustrates the Details of the Participants in the Study

Table 2- Participant information

Pseudonym	Field of Expertise	Public School Teaching Experience	College Teaching Experience	Role in Noyce Scholarship Grant	Role in Traditional EPP
Bertha	Math	no	yes	PI, mentor, academic advisor, advocate	Academic Advisor
George	Biology	no	yes	Co-PI, mentor, advisor, advocate	Academic advisor
Hal	Math	no	yes	Co-PI, mentor, advisor, advocate	Academic Advisor
Jennifer	Ed Leadership	yes	yes	Co-PI, mentor, advocate	none

Two participants were male, two were female, and all participants were white. The race of the participants is representative of the institutionalized whiteness that pervades higher education (Joseph-Salisbury, 2019). The authors recognize this limitation of this study and encourage all IHE's to consider ways to support diverse NSF grant PI teams and ensure equal opportunities for scholars of color.

Data and Data Analysis

Data for this research study included observations of faculty interactions, observations of faculty with pre-service teacher candidates, questionaries, focus groups, and interviews with each of the four participants. Data was grouped by question and response in an excel chart for the interview, questionnaire, and focus group responses. Each data source was coded independently by two different research for common ideas. Grounded theory and the constant comparative method were used to determine emergent themes (Glaser & Strauss, 2017). The researchers then compared and shared their codes and potential themes to determine theoretical saturation.

Findings

The findings of this research indicated that STEM faculty participation in the Noyce mentoring program directly impacted the way the STEM faculty interacted with students inside and outside the classroom through three primary paradigms shifts: (1) increased empathy and closer connections to students (2) increased ability to help students navigate challenges in their persistence to certification and (3) increased awareness of the need for a mentoring program

Paradigm Shifts in Student Interactions

All the STEM faculty who participated in the Noyce grant stated that their participation in the Noyce STEM pre-service mentoring program impacted the way they interacted with students inside and outside of the classroom, resulting in a closer connection with students and an increased amount of empathy. Bertha stated, “Because I have been more intricately involved in student pathways, I advise differently – more intrusively. I create very thorough semester plans so that students are aware of what their responsibilities are. I predict the pitfalls and try to help students develop plans for how to prepare for them.” Hal echoed this explaining that his work within the Noyce grant, “opened my eyes to persistence and mindset.” Bertha said, “I think it just

helped me see ways in which students need us to be there for them" Jennifer stated the Noyce mentoring experience allowed her the opportunity to "draw on extra levels of empathy" and Hal said he found this increased empathy enabled, "students respond better to encouragement than chastising."

Those closer connections and higher levels of empathy also assisted faculty in supporting teacher candidates to persist through difficult coursework, personal challenges, and achieve certification. An example of one of these stories came from Hal (edited for clarity and confidentiality),

> "I remember another student, who because his 400-level math professor knew that I was invested in him, he said 'This student is not getting to class.' Well, I had a sit-down with the student, and he said, 'oh well I have to take my brother and sister to school.' I asked him, 'Is that a surprise? Okay, if it's not a surprise, then what time do you have to leave?', this wasn't a surprise., it had happened repeatedly. I asked him, 'what time do you have to leave the house so that you can make it to your eight o'clock class?' And because nobody else in his family has graduated college so they don't quite understand even though you don't get fired, in the work world there is a consequence. Here you don't get fired, but it's just as bad in a way sort of. So yeah, those are the things are incredibly individualized." After Hal's conversation with the student, he was able to figure out a way to get his siblings to school and make it to his class on time, the student persisted to graduation and certification, and currently is a highly successful math teacher and soccer coach in a local high school.

George revealed a shift in himself as an educator, explaining "I'm thinking about pre-(Noyce) my approach to students was kind of reserved, it was not as confident about making connections and that since (Noyce) I have a lot more confidence when I'm going into conversations or working with students.

The ability to interact and connect with students outside of traditional classrooms is important, especially in STEM fields as we know that often "class settings [in STEM] are less conducive to teaching strategies that encourage student interaction; desks and chairs that cannot move, for example, make organizing small group work more challenging" (Austin, 2011, p.10). Research

has cited challenges such as class size and physical locations as barriers to both effective teaching practices and faculty and student engagement. (Henderson & Dancy, 2007). These findings further highlight the importance of a mentor program.

Increased Ability to Help Students Navigate Challenges

Each of the participants revealed that through their participation in the Noyce mentoring program they were able to increase their ability to assist students facing a variety of barriers, both academic and personal. Hal proclaimed that "I think that the biggest thing is feeling like I was drastically more engaged and understood far more acutely how unique the problems that students have were. And I also sort of changed my perspective as far as now believing that most of the hurdles to graduation, and particularly timely graduations, aren't actually coursework related." Bertha echoed similar revelations explaining that the Noyce grant was "my first venture into really examining the needs of undergraduate math majors and STEM majors who wanted to pursue teacher preparation as a career or teaching as a career which is kind of weird because that was my pathway so I would have thought that I would have been already in tune with, but I hadn't really spent a lot of time thinking about what additional needs they had." Jennifer found that the mentoring program was important because she was afforded the opportunity to "attend to [student] struggles with the content increased sensitivity [needed] for preparing diverse candidates." George noted that he gained a new perspective, "I think it [Noyce program] gave me a fresh look at, from a student perspective. Rather than my colleagues, we don't often talk to students and get feedback from students on how to behave. You know?"

Research results have shown that when faculty participate in professional development programs with their peers they gain "approaches to analyzing teaching problems, skills to encourage student learning, and appreciation of communities that support their commitment to effective

teaching as an important part of into their careers" (Austin et al., 2008). It seems that these skills were cultivated for the faculty who worked together to create and institute the Noyce mentoring program.

Need for Teacher Candidate Mentoring

All the participants also stated that they believed other STEM faculty should have the opportunity to participate in a pre-service STEM teacher mentoring program because it builds important skills for faculty in STEM fields. Bertha pointed out that

> "oftentimes we see STEM research faculty that are solely focused on getting students to graduate school or into lab research and those kinds of things. They don't really have the same understanding of the value [that] I think those of us that work with teacher preparation, especially in STEM, who see the drastic need all over the nation for highly skilled STEM professionals. [We] recognize that it's not really about the one student that's standing in front of you, it's about all of the students that are in the public schools that are never going to make it to us because they don't have someone to prepare them well enough to get them to us."

Hal explained that prior to beginning his work with the Noyce grant he believed that "essentially what students needed to be successful was connection to the coursework" but that working through the grant he came to find that "it was rather overwhelming how many skills we didn't yet have that we had to cultivate." Hal believed that such an experience would benefit many other faculty "if they had a deep desire to work with pre-service STEM teachers." George reiterated these feelings, calling for other STEM faculty to be added "very selectively because we have academics, intellectuals, but they are not empathetic, that they would not make good mentors."

The participants noted that participation in this mentorship involved personal investments such as time, money, emotional energy into their Noyce mentoring relationships, but all reaffirmed that the experience was worth the investment. Bertha said, "It was so worth it and continues to be so, the program experiences is without a doubt the greatest accomplishment of my career because of the impact it has had to so many." Hal said he enjoyed "relationships and seeing them succeed."

Despite these perceived benefits, it is important to note that institutions of higher education often value research more than teaching and mentoring of students that is unrelated to research (Austin, 2011; Fairweather, 2002). Braxton et al. (2002), noted that publishing research was determined to be the most important criteria for faculty tenure, promotions, and salary. This demonstrates the institutional challenges faced in creating mentoring programs.

Discussion

Based upon these themes, the reported experiences of the STEM faculty overwhelmingly point to the Noyce mentoring experience as a source of increased empathy for students, better understanding of the student success, and the realization that personal investment was often required as they participated in the mentoring network. Within the Noyce mentoring program during the same period, 100% of students who entered the program graduated with a STEM teaching certification in Texas. And 100% entered the teaching field for at least one year of teaching. This can be compared with 2% of other STEM majors not enrolled in the Noyce program who persisted to graduation and certification. This information is summarized in Table 3.

Table 3- STEM Majors persistence with Noyce and without Noyce

STEM majors enrolled in EPP programs	**Percentage who persisted to graduation and certification**
Traditional EPP at same University	2%
Supplementary Noyce Program at same University	100%

Not only did the STEM faculty who participated in the program report experiences that helped them grow to be more empathetic and better advocates and mentors for their students, but also the resulting student success was opposite of the student success in the traditional EPP that did not have a structured scholarship/mentoring program.

Significance and Recommendations

Awareness, advocacy, and research is needed to determine how STEM faculty benefit from their involvement in a structured mentoring program for STEM teacher education. Since faculty time is critical to the success and experiences involved in a mentoring program, course releases or stipends should be provided to support and enable STEM faculty time to devote to such programs. Tenure and promotion requirements could be adjusted to include involvement in mentoring as an integral part of teaching and facilitating student success.

Furthermore, the significance of a structured mentoring program within STEM EPP's is key to improving rates of certification and graduation for STEM pre-service teachers. The importance of undergraduate mentoring in the STEM EPP and beyond has also been advocated for by Cross, Hubbard, Beverly, Gravatt, and Aul (2020), Sithole, Chiyaka, McCarthy, Mupinga, Bucklein, and Kibrige (2017), Ingersoll & Strong (2011); Gershenfeld (2014); Hobson, Castaneheira, Doyle, Csigas and Clutterbuck (2016). However, it is difficult for faculty to initiate such

mentoring initiatives while simultaneously meeting their additional workload demands without administrative and institutional support. The Noyce scholarship grant provides the funding and structure necessary for STEM EPP mentoring program success, however, institutions of higher education should be providing the same supports for all STEM faculty to be involved in the STEM teacher education program.

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