The continuation of a mentoring network for pre-service teachers into early in-service years

Chrissy Cross, Keith Hubbard, Lesa Beverly, Dennis Gravatt and Adrienne Aul
Stephen F. Austin State University, USA

Many educator preparation programs have formal and informal mentoring for pre-service teachers. However, few educator preparation programs continue the mentoring of mathematics teachers after graduation. This qualitative research examines the impact of a mentoring network for pre-service mathematics teachers embedded in the educator preparation program and continuing after they graduated from a rural university in Texas. The focus of the research is to evaluate the impact of the mentoring network on the choice of instructional methods used in classrooms by novice mathematics teachers.

Introduction

Initial teacher education programs depend on quality field experiences to produce effective teachers (Darling Hammond, 2012; Howe, 2017). Within those field experiences, the initial teacher education program relies upon seasoned teachers to act as mentors for pre-service teachers. However, many seasoned teachers are not formally trained in mentoring pre-service teachers and may not have the time necessary to devote to mentoring a pre-service teacher, because of the demanding time investment required by many PK-12 public school teachers (Fraser & Watson, 2014; McIntyre & Hagger, 1996).

Much of the literature and research regarding mentoring during an initial teacher education program is geared towards mentoring during clinical practice or student teaching. There is a lack of research focused on mentoring during the pre-clinical component of the traditional initial teacher education program. Darling Hammond (2012) stated that only 70% of students enrolled in teacher education persist to graduation and enter the teaching field, and of that 70%, only 75% stay longer than three years in the teaching field. Guthery and Bailes (2019) tracked 5-year persistence rates of over 175,000 Texas teachers and established a 40% 5-year retention rate along with a correlation between persistence and type of preparatory program. But this study did not seek to interrogate the causes of the disparity in preparation routes. More research needs to be done on the influence of mentoring on pre-service teachers before they enter student teaching and how it impacts retention. This study is an effort to fill that gap, specifically addressing the different and unique needs of novice mathematics teachers, who often require more intensive and directed retention interventions than other content area teachers (Fisher & Royster, 2016).

Transitioning from an undergraduate pre-service teacher to a novice teacher is often a difficult and jarring progression for many students. At many universities, there is no connection with university faculty or staff from the initial teacher education program once the pre-service teacher transitions to full-time classroom teacher. While there is plenty of research indicating the efficacy of mentoring networks in higher education (Sorcinelli &

Yun, 2007; Paula & Grinfeld, 2018; Wilhelm, Woods, del Rosal, & Wu, 2020), and for novice teachers (Ingersoll & Strong, 2011), there is little research about designing mentoring networks for undergraduate pre-service mathematics teachers before their semester of student teaching and connecting the mentoring experience through student teaching and through the first few years of teaching.

The university where this research was conducted is located in a rural area of the southern United States. As a regional comprehensive university, it has a traditional university-based initial teacher education program in which each course requires a field experience component, concluding in a capstone clinical teaching course which requires the pre-service teachers (PST) to observe and then teach in a public-school classroom for fifteen weeks, under the direct supervision of a certified teacher in their teaching field. In each of these field-based experiences, the PST has a mentor teacher in the public school. While these individuals do have some mentoring training, they may not be certified in the content area of the teacher they are observing. There is no formal faculty mentoring component within the program design of the initial teacher education program. For many PSTs who go through the initial teacher education program, the temporary mentoring of classroom teachers is the only mentoring they receive during their undergraduate pre-service teacher experience. Feedback from mathematics PSTs about the lack of direct mentoring was developmental in the design of this research.

This university conducted the *Noyce Scholarship* program, in which participating PSTs were provided with a mentoring network to assist them in their maths and education undergraduate classes, clinical experiences, student teaching, and after graduation, for up to four years in the classroom as a novice mathematics teacher. This grant scholarship and mentoring program was funded by the National Science Foundation (NSF 1136416) and sponsored through the Robert Noyce Scholarship initiative. The aim of the Noyce Scholarship program is to attract future science, technology, engineering, and maths (STEM) teachers through scholarships, allow them to experience secondary teaching through early and intense field experiences, and provide mentoring to encourage persistence and retention (Hubbard, Embry-Jenlink & Beverly, 2015).

This research examines the choice of instructional methods by two groups of novice high school mathematics teachers, one that experienced a supplemental mentoring network as a part of the Noyce scholarship program, and one that experienced the informal mentoring of the traditional initial teacher education program. The research question is:

> How does mentoring during educator preparation and beyond graduation influence the novice mathematics teacher's choice of instructional methods in the classroom?

Theoretical framework

Dewey posited that students construct their own knowledge through experiential learning (Dewey, 1938). Soon after, Piaget (1972) theorised,

> ... to understand is to discover, or reconstruct by rediscovery, and such conditions must be complied with if in the future individuals are to be formed who are capable of production and creativity and not simply repetition (p. 20).

In the cases of pre-service maths teachers transitioning from pre-service to novice teachers, they must reconstruct their mathematics content knowledge from their undergraduate maths classes in a completely different framework integrated into their choice of instructional methods used in their classroom. "Mathematics is an inherently social activity" stated Schoenfeld (p. 335, 1992). A pre-service teacher must synthesise the college maths experience (which is often an individualised focus) into a mathematics social activity as instructional methods for their students. In the case of mathematics teachers, the ability to reconstruct their mathematics knowledge from their undergraduate studies in a completely different framework for their own classroom instructional methods, is a drastic shift in their paradigm of thought, requiring social support, according to Vygotsky's theories of social learning (Kolb & Kolb, 2012).

There is great complexity in this paradigm shift, as a pre-service teacher moves from being the problem solver as a student in a mathematics classroom, to a teacher who is a creator of problems to solve for their own increasingly diverse students. This drastic shift requires social support from teachers, mentors, and advocates, as the social support system needed to help construct an environment where the pre-service teacher has an opportunity to individually struggle to adapt to the new role while learning from their social support system (Kolb & Kolb, 2012). This research is framed in the recognition of the individual cognitive transition from pre-service teacher to novice teacher, while recognising the importance of developing epistemology with a novice teachers mentoring network, such as the Noyce mentoring network (NMN).

Literature review

What is mentoring?

A mentor is a person who takes an interest in you or counsels you because they have either volunteered or been assigned that role within an organisation (Hewlett, 2013; Ambrosetti, 2012). According to Ingersoll and Smith (2004),

> The overall objective of teacher mentoring programs is to provide newcomers with a local guide, but the particulars in regard to character and content of these programs themselves widely vary (p.30).

In education research, there is great variety of types of mentoring pre-service and novice teachers receive, both during their initial teacher education program and after graduation (Cullingford, 2017; Mahlangu, 2018).

Sponsorship and mentoring

While most mentoring provided for pre-service and novice teachers follows a traditional definition of mentoring, there is a movement in higher education that includes mentoring

and sponsorship (Lewis & Olshansky, 2016). The concept of mentoring and sponsorship is important to this study because of the variety of the functions and roles of mentoring experienced by the participants in the Noyce Scholarship grant. Hargreaves and Fullan (2000) stated, "In any complex occupation, new entrants need someone who can "show them the ropes," develop their competence and understanding, and help them fit in" (p. 52). Within the Noyce program, faculty take on the role of the sponsors, while an experienced teacher takes on the role of a mentor. The roles of sponsors and mentors intertwine and overlap within the NMN. A complete design of the NMN is located in Appendix 1.

Mentoring networks also play significant roles in professional socialisation of novice teachers (Paula & Grinfelde, 2018), helping novice teachers to cope with challenging workplace experiences (Caspersen & Raaen, 2014), and combatting the feelings of isolation so commonly experienced by novice teachers (Buchanan, Prescott, Schuck, Aubusson, Burke & Louviere, 2013).

Mentoring for novice teachers

Research findings indicate that mentoring for novice teachers is an integral part of novice teacher's choice to stay in the teaching field. In a meta-analysis of 15 empirical studies on mentoring programs and beginning teachers, Ingersoll and Strong (2011) found that mentoring programs had a significant positive impact on beginning teachers in satisfaction, commitment and retention. In addition, Joiner and Edwards (2008) stated that a mentoring program improved the retention rate of teachers in challenging educational environments. Ingersoll and Smith (2004) posited effective induction incorporates a supporting collaborative group for planning and other activities, as well as a formal mentor from the same teaching field. National and State Teachers of the Year were surveyed and they responded that they highly valued the mentoring as part of their novice teaching experience (Behrstock-Sherratt, Basett, Olson & Jacques, 2014). Behrstock-Sherratt et al. (2014) stated, "68 percent of the 55 percent of survey respondents who had an assigned or informal mentor ranking it among their top three supports." (p.14) Research findings such as these clearly indicate that the success and retention of novice teacher is highly dependent on mentoring and has informed the design of the NMN.

Lofthouse (2018) recommended that mentoring begin within the initial teacher certification program as faculty and administrators develop mentoring policies and structures within the program, which allows faculty and students to learn together about mentoring as a collaborative professional development. She posited, "Mentors need to act in many capacities towards their student teachers" (Lofthouse, 2018, p. 15), thus indicating that mentoring needs to be flexible and fit the needs of the individual students who are becoming novice teachers.

Mentoring and retention of STEM teachers

Sithole, Chiyaka, McCarthy, Mupinga, Bucklein and Kibridge stated that "high attrition, low motivation, and low entrant numbers are big challenges for STEM education growth"

(p. 48, 2017). To ensure pre-service teachers succeed in their STEM careers, Sithole et al. (2017) recommended that STEM pre-service teachers be provided with institutional support consisting of peer mentoring experience and increased faculty connections. Fisher and Royster (2016) and Kilpatrick and Fraser (2019) stated that novice teachers of mathematics often are subjected to an increased level of stress and pressure in their novice years of teaching. They discovered that many schools had no official plan for retention of mathematics teachers. This is all the more startling when coupled with research showing in consequence of one teacher's departure schools make an average of 3.8 personnel swaps (Atteberry, Loeb & Wyckoff, 2017), extending the consequences of each departure.

In addition, Fisher and Royster (2016) stated that mathematics teachers often needed more specialised professional development and support from peers for them to choose to continue their career. These recommendations are similar to the design and implementation of the NMN provided to the pre-service mathematics teachers who were participants in this study.

Noyce Scholarship participants mentoring network

While all eight of the participants of this study went to the same University and went through the same initial teacher education program, only four of the participants were involved in the University's Noyce scholarship program. The design and implementation of this program and its mentoring network are important to this study and help the reader create context for the findings and implications of this research.

Each Noyce scholarship program participant experienced a complex and dynamic mentoring network consisting of multiple individuals responsible for specific duties/ experiences related to each participant within and beyond their undergraduate experience (Appendix 1). Within this study, there are two identified roles of individuals within the NMN that can be classified as either a mentor or a sponsor; neither of these roles is exclusive and there are often times where the roles and responsibilities overlap. Hewlett (2013) stated that mentors take time to listen, give advice, provide feedback on skills, and share their experience and wisdom with the mentee. Mentors traditionally expect very little in return for their investment. This is more aligned with the traditional definition of mentoring that takes place for pre-service and novice teachers (Ambrosetti, Knight, Dekkers, 2014). Hewlett (2013) defined sponsors as senior leaders who routinely advocate for the protégés they are sponsoring, provide opportunities for protégés, promote their visibility to higher ranking personnel, provide honest and critical feedback on skill development, and provide opportunity for protégés to expand what they can do as professionals. Sponsors see their investment of time and energy into protégés as an investment in their own professional development and expect a great deal from their protégés in return for their investment. When a PST becomes a Noyce scholar, they are surrounded by individuals who take on the roles of mentors (experienced STEM teachers) and sponsors (content area and education faculty); this creates the NMN that is implemented at the University where this research took place.

Three types of mentoring are evident in the NMN, traditional formal mentoring by an experienced STEM teacher, sponsorship by STEM and education faculty (Hewlett, 2013), and intra-cohort peer mentoring. The participants are provided with an experienced STEM teacher as a mentor (Ingersoll & Strong, 2004). This individual begins his or her relationship with the participants as undergraduates, designing bi-weekly meetings for Noyce scholars to practise researched-based mathematics instructional strategies. During the transitional student teaching semester, the Noyce mentor STEM teacher also serves as a field experience supervisor for the Noyce participants, visiting and watching them teach, at least six times during the fifteen weeks student teaching placement semester. After Noyce participants graduate, the mentor teacher then routinely visits their classrooms to provide feedback and ideas on their classroom instruction and management.

Participants in the Noyce scholarship grant are also connected with faculty sponsors. Each PST has a faculty sponsor in the STEM department and a faculty sponsor in the Education department. These faculty sponsors are also the co-PI's and project directors for the Noyce grant, so they are the recruiters, organisers and information keepers for the grant. The faculty sponsors in the STEM department advocate for that PST within the department and college. They also connect those PSTs with professors and tutors if necessary, to make sure the PST has academic support in their STEM classes. The education faculty sponsor also advocates for the Noyce participant within the department and in the college of education, specifically assisting as needed with the navigation of the complex teacher certification process. These faculty sponsors have roles distinctly different from the mentor teacher's role that is much more focused on making sure the PST succeeds in field experiences, while the faculty sponsors focus on PST success within the undergraduate coursework and initial teacher education program. The mentor teacher and faculty sponsors both make deliberate efforts to have a positive and supportive academic and socio-emotional relationship with the Noyce participants.

Finally, the Noyce participants have a relationship with their cohort of peers who entered the Noyce grant at the same time. They interact with each other consistently because they are involved in activities with each other bi-weekly, during their classes, and at the beginning and end of the semester. They often meet together outside of these formal events for study sessions. After they graduate and obtain teaching jobs, they participate in bi-annual professional development activities; they also informally and regularly communicate and support each other's teaching careers.

Methodology

The study took place in several different schools, with very different teachers, who have experienced similar and different education experiences in a common educator preparation program. Therefore qualitative research methods were chosen to best investigate the research question, because of its naturalistic setting, and the complexity of the particular experiences of the participants (Erlandson, Harris, Skipper, Allen, 1993; Lincoln & Guba, 1985). Denzin and Lincoln (1984) stated, "Qualitative research is multimethod in focus, involving an interpretive naturalistic, approach to its subject matter" and "Qualitative research involves the studied use and collection of a variety of

empirical materials — case study, personal experience, introspective, life story, interview, observation, historical, interactional and visual texts – that describe routine and problematic moments and meanings in individuals' lives." (p. 2). Qualitative research design fits the nature of our research question, and our data collection methods, and gives the appropriate respect to the individuals who are the participants within our study.

For this study, a qualitative, particularistic, multisite case study method was chosen as the research design. Merriam (2009) defined particularistic case study,

> Particularistic means that case studies focus on a particular situation, event, program, or phenomenon. The case itself is important for what is reveals about the phenomenon and for what is might represent (p.43).

The "particular situation" referred to by Merriam is the NMN experienced by four of the eight participants. This research methodology was specifically chosen to examine the influence of that "particular situation" upon classroom teacher's choice of instructional methods. This also fits with Bromley's (1986) description of performing a case study,

> ... get as close to the subject of interest as they possibly can, partly by means of direct observation in natural settings, partly by their access to subjective factors (thoughts, feelings, and desires) (p. 23).

Within the research design and analysis, a phenomenological lens was utilised by the researchers to design data collection and complete the data analysis.

> The empirical phenomenological approach involves a return to experience in order to obtain comprehensive descriptions that provide the basis for a reflective structural analysis that portrays the essences of the experience. (Moustakas, 1994, p. 13)

Concerted effort was made within the method design to allow participants to connect choices of instruction with previous experiences within the initial teacher education program and beyond, to ensure the researchers the ability to describe the "essences of experiences" (Moustakas, 1994, p. 13) of the participants.

A review of literature on the design of mentoring research yielded guidelines that state the research design must be based on context of the mentoring network (Janssen, Vuuren & Jong, 2016), must include how the mentoring impacts the career and psychosocial development of the mentee (Kram, 1985), and should also include control/comparison groups, multiple research sites, specify key operational features of mentoring networks, and assessment of social validity through the use of participant perceptions (Gershenfeld, 2012). This study meets all of those recommendations.

Participants

The participants of this study included eight novice mathematics teachers, in their first to third years of teaching, who were currently teaching high school mathematics. Four male teachers and four female teachers aged between 21 and 27 years participated. Each

participant had earned a bachelors degree in mathematics with a Texas secondary teaching certification through the same rural state university in Texas, Stephen F. Austin State University. All participants graduated within the last four years, with four having participated in the Noyce Scholarship program at the university, and four having graduated in the traditional program.

Contacting potential participants was facilitated by faculty members and mentors of the NSF Noyce Scholarship initiative observed in this study. Participants were given the opportunity to volunteer after being contacted by email. No compensation was given for volunteering to participate in the study, institutional review board (IRB) approval was obtained through the University sponsoring the study to ensure the privacy and rights of the human subjects. Participants were given pseudonyms to protect their identity.

Setting

The setting of this study was six different rural high schools within a 70-mile radius of the graduating institution. The enrolment of the high schools ranged from very small, less than 105 students, to very large, 1060-2099 students. The variation in school sizes was considered in the data analysis, as were the rural or urban characteristics of the schools.

Educational experience during initial teacher education

Each participant experienced the same educator preparation program at the University. In addition to a full degree in mathematics, the educator preparation program comprised 24 total hours of teacher preparation courses, including a capstone clinical teaching component, where the pre-service teacher spends the entire school day for 15 weeks in a public-school classroom. Four of the participants (Daniel, Sophia, Luke and Emma) took part in in the Noyce scholarship program for preservice STEM teachers while they were undergraduates, and the other four participants (Amelia, Lucy, Owen, William) were enrolled only in the traditional initial teacher education program. The Noyce Mentoring Network (NMN) is compared to the traditional initial teacher education mentoring structure in Appendix 1.

Data sources

Data sources for each participant included a semi-structured interview, a Likert scale survey, in class observations and debriefings, and a follow up email survey. Cresswell (2007) and Merriam (2009) stated that data sources should allow the participants a voice in describing their particular experiences; the value and authenticity of each of the participant's voice was captured through these data sources. The interviews specifically questioned the participants about the influence of mentoring (both during educator preparation and after graduation) on choice and implementation of instructional methods. The interview questions addressed the participants' views and beliefs about how their teacher preparation program and/or supplementary mentoring influenced their choice and implementation of instructional methods. The Likert scale survey specifically allowed each of the participants to consider an empirical level of agreement with specific statements

related to the choices of instructional methods. According to Yin (2003), qualitative case study data can be triangulated with empirical surveys. The in-class observations allowed the researcher as a participant observer (Spradley, 1980) to observe the participant's implementation of instructional methods. After each observation, the researcher debriefed with the participant. The debriefing sessions also served as a data source. A follow up email questionnaire, also used as a data source, was sent to each of the participants to allow an opportunity to share any newly remembered ideas or experiences influencing their choice of instructional methods that they would like to voice.

Data collection

The participant teacher interview, semi-structured in nature (Merriam 2009) was conducted with the teacher before the observation. Pre-observation interview and survey questions were designed using several sources (Creswell, 2007; Merriam, 2009; Patton, 2002; Walkington & Marder, 2013) and incorporated several types of questions, such as questions about experience, opinions, beliefs, feelings, knowledge and background, to collect meaningful data. Prior to the observation portion of the research, each participant met individually with the researcher to complete the written survey and interview. Each participant was interviewed during their conference period for approximately 20 minutes then completed a written Likert scale survey designed by the researcher. Interviews with the participants were audio recorded and transcribed.

The classroom observation was based upon a modification of the *Classroom Observation Protocol for Undergraduate STEM* (COPUS) (Smith, Jones, Gilbert & Wieman, 2013) and the *UTeach Observation Protocol* (Walkington & Marder, 2013). Three classroom observations were conducted for each participant during the 2015-2016 school year throughout both semesters using the designed protocol. Teachers were able to choose their observation dates and times and each observation lasted the duration of one class period, which ranged from 35 to 90 minutes. All participants were encouraged to teach each lesson as planned and not modify or adapt the lessons for the researcher. All observations were video recorded and transcribed by the researcher. After each of the observation sessions, the researcher debriefed the class observation session with each of the participants, so that they could comment or clarify the events that occurred during the observation. After all the observations for the participants had been completed, each participant was sent an email interview asking for further comments on their use of instructional methods and the impact of their educational experience.

Data analysis

As suggested by Merriam (2009) and Creswell (2007), the researcher used open coding to organise and manage data into categories and patterns. The constant comparative method was used between each of the data sources as the researcher transcribed, coded and analysed the data to look for categories and patterns (Glaser & Strauss, 1967; Strauss & Corbin, 1998). Participants' interviews, surveys, and observation data were transcribed in a spreadsheet and the data was examined comprehensively for common categories. Field notes of each participating teacher's observations as well as debriefs of each observation,

if available, were kept and referred to constantly. The categories were triangulated between the transcripts of the interviews and observation, data from the surveys, and observation field notes to develop emergent themes (Denzin & Lincoln, 1994). After initial data analysis was completed, a peer debreifer also examined the data sources to determine any additional categories or to corroborate the categories that emerged. Specific attention was paid to the differences between the groups of PSTs who had participated in the formal mentoring program (Noyce) during their initial teacher education program.

Since the formal mentoring program was considered a particularistic phenomenon impacting only four of the eight participants, a phenomenological lens (Moustakas, 1994) was used to examine each of the artefacts to determine how the mentoring as the phenomenon influenced the choices of instructional methods as novice teachers. As the constant comparative method was used to examine and re-examine the data (Glaser & Straus, 1967), it became apparent the data became saturated with evidence that the mentoring of the Noyce program indeed influenced the responses and experiences of the participants. Descriptive empirical trends were also included in this study to help the reader create a more detailed picture of the classroom choices made by the participants.

Within the interviews, surveys, in-class observations, debriefings, and researcher's journal, a common theme emerged about the participants of the study. There were two distinct groups evident in the data from participants. The participants who took part in the Noyce Program presented a different set of data compared with the participants who did not take part in the Noyce Program. These differences lead the researcher to evaluate the data as two different groups who experienced different phenomena.

Trustworthiness

The trustworthiness of this research meets the guidelines by Lincoln and Guba (1985). Credibility, dependability, and confirmability were established through the context and theoretical sensitivity of the researcher (explained in the methodology), prolonged engagement with the participants (interviews and three observations over a period of an academic year), debriefing (member checking after the observations with participants), frequent debriefing sessions with the researcher's critical friend, triangulation of themes within the data sources, and the use of an audit trail.

Findings

Mentoring data

The participants were asked in the survey, "What resources do you have to learn about more about instructional methods?" The responses were then classified as either a formal or informal mentoring experience (Table 1).

Table 1: Formal and informal mentoring experiences

Participant	Formal mentoring	Informal mentoring	Noyce
Daniel	None.	More technology. I don't have access to much.	Yes
Sophia	Occasional conferences that I get to attend. Collaboration with fellow Noyce Program mathematics teachers is a big plus.	None.	Yes
Luke	Professional developments.	Colleagues, Google, teachers pay teachers, lead4ward materials.	Yes
Emma	Noyce Program cohort and PLC	Collaborating with other teachers, Noyce Program cohort and PLC.	Yes
Amelia	None.	lead4ward.	No
Lucy	Professional development opportunities		No
Owen	None.	Blogs (mathequalslove.com). My department head is very supportive, and colleagues. We talk about ideas a lot.	No
William	None.	The Internet, regional education service centre, principal	No

Initial teacher education program experience or perception of initial teacher education program experience data

Interview data

Asked the question, "How do you believe that your education training prepared or did not prepare you for implementing instructional methods into the classroom?", the four participants who did not participate in the Noyce Program answered that the initial teacher education program did not adequately prepare them to implement instructional methods in the classroom. One participant (Lucy) in the traditional initial teacher education program stated about the initial teacher education program,

> Because there was no SED (secondary education) math courses to take that teach how to teach math using different methods. But as for math specific, I'm not sure how to utilise the methods discussed, not prepared.

Three of the four participants that took part in the Noyce Program all answered that their initial teacher education program did an adequate job of preparing them to implement instructional methods in their classrooms, with three of the four also mentioning the importance of the Noyce program as a supplemental program to the initial teacher education program, influencing their ability to implement instructional methods within their classroom. One Noyce program participant (Daniel) stated,

> I thought along with the *Noyce* Program and the initial teacher education program, they did a great job of showing me what teaching really is.

Survey data

The survey question, "Upon completing my certification program, I felt comfortable and confident using different types of instructional methods in my classroom" using a 5-point Likert scale from strongly agree to strongly disagree gave the responses shown in Figure 1.

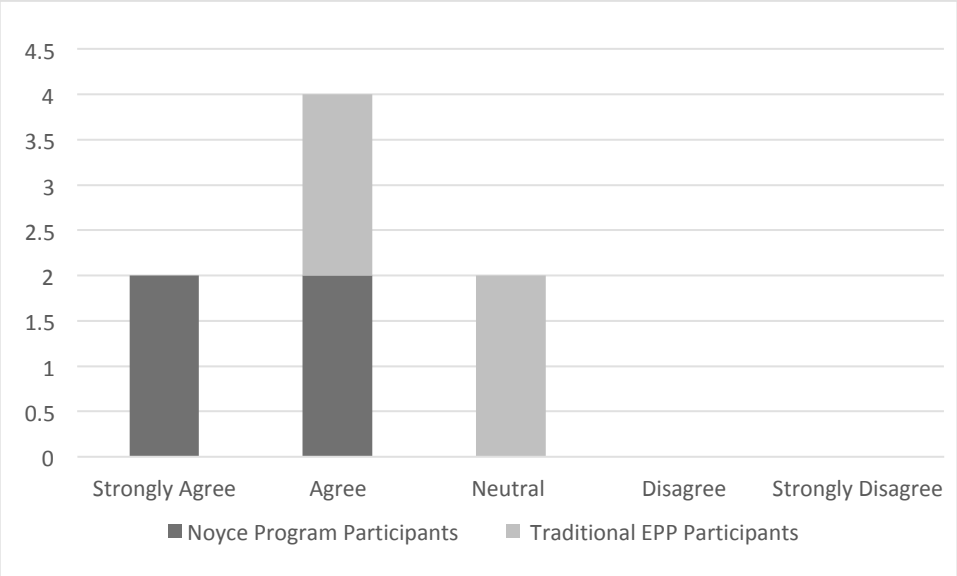

Figure 1: Confidence in instructional methods based upon experience in initial teacher education program

Data about types of instructional methods

When the participants were asked, "What types of instructional methods do you feel knowledgeable enough about to implement in your current classroom?", there was a distinct difference between the Noyce Program participants and the traditional initial teacher education program participants. The data was coded accordingly by the numbers of instructional methods listed by each participant.

Three out of the four Noyce Program participants were able to list four or more methods they were comfortable with, with one of the four indicating he felt comfortable with "most" although he stated he "struggled with implementation". Two of the four traditional initial teacher education program participants were able to list three methods, while one of the four was able to list two, and one of the traditional initial teacher education program participants was only able to identify one method he was comfortable with.

Evaluation of instructional methods for efficacy in other research findings

The research basis for the instructional methods observed in each of the participants classrooms is important to the study of the instructional methods since it contributes

directly to the ultimate academic success of the students and the evaluation of the teacher. Direct instruction does not have the support of most research findings on instructional methods in secondary mathematics teaching (Aldridge & Goldman, 2007; Freeman, Eddy, McDonogough, Smith, Okoroafor, Jordt & Wenderoth, 2014; NCTM, 2009). However, student-centred activities such as collaboration, exploration, and peer to peer activities are recommended by research findings (Aldridge & Goldman 2007; Freeman et al., 2014; Muijs & Reynolds, 2017; NCTM, 2009). Independent practice is considered an effective, researched-based instructional method for mathematics (Doabler, Fien, Nelson-Walker & Baker, 2012). Research findings indicate the efficacy of interactive notebooks in STEM fields (Jaladanki & Bhattacharya, 2015; Johnson, 2013). Non-instructional time, or "free time" is considered a non research-based method of teaching because the class can no longer be considered an instructional environment for mathematics learning.

Three of the four Noyce Program participants used research-based methods for 60% or more of their class time, while two of the Noyce Program participants used research-based instructional methods 100% of their class time. Four of the four traditional initial teacher education program participants used non research-based methods 45% or more of the total time in their classroom, with two of the traditional initial teacher education program participants using non research-based instructional methods 100% of their class time (Figure 2).

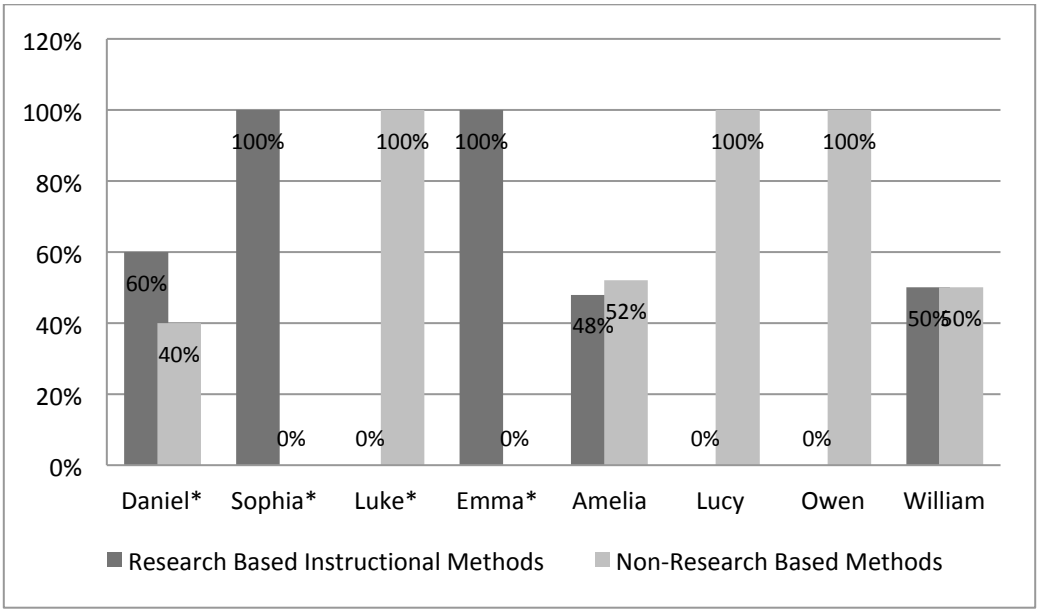

Figure 2: Percent of class time using research based or non-research based instructional methods (* denotes Noyce program participant)

Data from observations

During all three of the classroom observations, the researcher kept track of the time in minutes the participant used different instructional methods. The researcher based her

classification of minutes per each activity based upon the instructional methods the participants listed in their interviews. However, as the researcher made her observations, she added the non-instructional time category and independent practice categories, since those were two activities she was observing in the classrooms, although none of the participants mentioned using them in their choices of instructional methods (Figure 3).

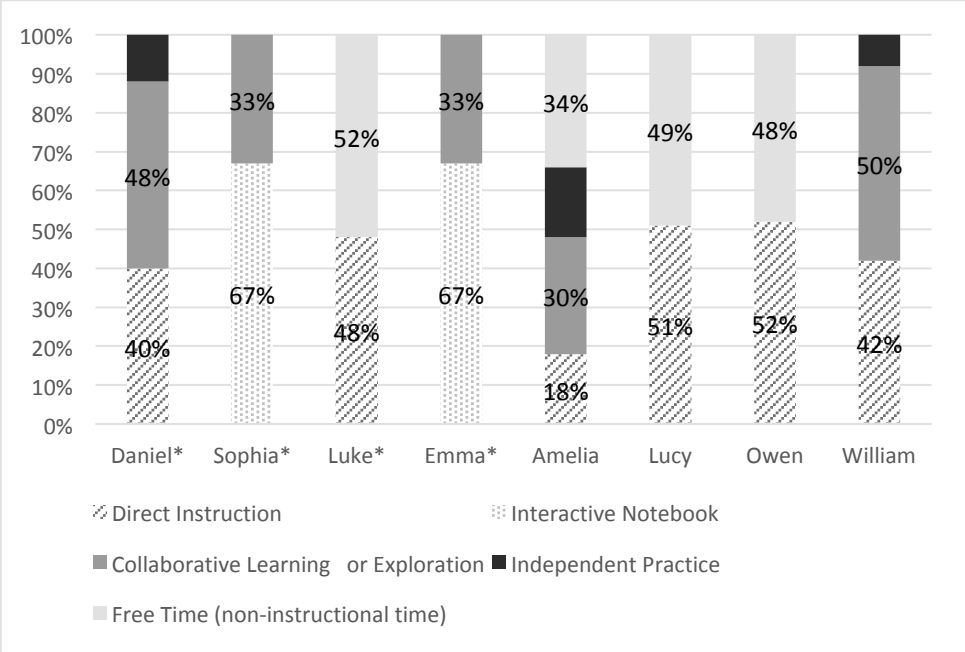

Figure 3: Percentage of class time using instructional methods
(* denotes Noyce program participant)

Data from debriefing sessions

In debriefing sessions after their observation, Sophia and Emma discussed their use of interactive notebooks as a way for students to take notes using "Foldables", three-dimensional and interactive graphic organisers. After attending a conference with their Noyce Program cohort and faculty mentors, these two participants brought this idea of notetaking back to their school districts and were observed using this instructional method in two observations.

During one of his classroom observations, Luke gave his students an in-class project to find real-world examples of parabolas and then create equations for five examples. During a debriefing session with the researcher after teaching this lesson, Luke stated that his formal mentor through the Noyce Program,

> Mrs Bradley always modelled for me how to help students make connections with the real world. So I am always reminded of her practices and modelling when constructing and implementing my lessons.

Outcomes

After using the constant comparative method to analyse the data, peer debriefing, and finding theoretical saturation, two distinct results emerged to answer our research question, "How does mentoring during educator preparation and beyond graduation influence the novice mathematics teacher's choice of instructional methods in the classroom?"

The first outcome of the data indicated, formal mentoring during the initial teacher education program positively influences experiences and perceptions during the initial teacher education program. The participants who experienced the NMN spoke positively about their experiences and perceptions of their initial teacher education program, while the ones who did not have the support of the mentoring network had fewer positive remarks about the initial teacher education program. In fact, the participants in the NMN felt more prepared for the classroom than the participants from the traditional program. The participants who experienced the NMN also scored themselves higher on a Likert scale survey to indicate their confidence using research based instructional methods, and also were able to list a larger number of research-based instructional methods than the group who in the traditional initial teacher education program. This data led us to conclude that the results from our study indicate that a formal mentoring program indeed positively influences the experiences and perceptions of pre-service teachers during their initial teacher education program experiences.

The second outcome that emerged from the findings of the data analysis was that the participants who experienced the NMN showed marked differences in the choice and quality of instructional methods in the classroom. The Noyce participants were more comfortable implementing a greater number of instructional methods than the traditional initial teacher education program participants. Our data indicates that the Noyce program participants used a greater percentage of class time for research-based instructional methods than the participants with no formal mentoring during the initial teacher education program. During the debriefing sessions, the Noyce program participants tied instruction strategies observed in their classroom to specific events related to the Noyce program, emphasising the source and the value of the instructional method, while the traditional initial teacher education program participants made no such connection between their instructional method and a person or source for their choices of instructional method.

Conclusion

The findings of this research indicate that there is a positive influence of formal mentoring during initial teacher certification and beyond graduation, on novice teacher's choice of instructional methods. Specifically, in the case of the Noyce Program participants, their confidence in choosing their instructional methods, the number and quality of their instructional methods, the in-class decisions about time management and research-based instruction, and their experiences during their initial teacher education program were all positively influenced by their participation in a formal mentoring

experienced during their initial teacher education program. The Noyce Program participants spoke highly of the network of support provided to them as teachers during their observation debriefings. Sophia stated that,

> ... the Noyce Program, has certainly challenged me to implement diverse instruction in my classroom. Being able to associate with great math counsel from my professors to my peers has given me lots of resources for games, stations, projects and fun inventive ways to present material. I am very blessed to have the [Noyce] family to keep pushing me to try new things and to encourage me to follow what I know is good for my students.

Emma told the researcher that her fellow Noyce program participants had the largest influence on how she chooses to teach and engage students. She said,

> ... two of my closest friends were in the Noyce Scholarship program with me and we bounce ideas off of each other all the time. Then, we tweak them to fit our individual teaching style. That's what collaboration is all about!

Similar research findings were indicated in a literature review by Ingersoll & Strong (2011) who stated,

> Likewise, for teachers' classroom practices, most of the studies reviewed showed that beginning teachers who participated in some kind of induction performed better at various aspects of teaching, such as keeping students on task, developing workable lesson plans, using effective student questioning practices, adjusting classroom activities to meet students' interests, maintaining a positive classroom atmosphere, and demonstrating successful classroom management. Finally, for student achievement, almost all of the studies reviewed showed that students of beginning teachers who participated in some kind of induction had higher scores, or gains, on academic achievement tests. (p.38)

The research by Ingersoll and Strong (2011) and our research findings indicate that due to the differences in the nature of learning maths as a social and experiential learning phenomenon (Dewey, 1938; Piaget, 1972; Schoenfeld, 1992), pre-service maths teachers need a mentoring network to assist them in the paradigm shift from student to teacher, in order for them to be able to choose research based instructional methods in their mathematics classrooms. Our research findings also parallel that of Lofthouse (2018), which indicates that mentoring within teacher education should result in, "the development required of student teachers will be based on, and result in, broad and transferable professional learning" (p.15).

Based upon the findings of this research, the Noyce research team has decided to expand the current Noyce mentoring network to include a community college partnership. Our current grant funding will end in 2020, however we submitted a new grant proposal in August of 2020 to the National Science Foundation. In our newest Noyce scholarship grant proposal, we have designed a similar network for a community college partner. Some of that mentoring structure will include support for community college recruits from faculty, staff, and peers within the Noyce network, prior to their enrolment in the Noyce scholarship program. By extending the mentoring to pre-initial teacher preparation

program, we will collect data on how adding this new layer of the Noyce mentoring network will impact recruitment and retention of these STEM teachers within the Noyce scholarship program. During the COVID pandemic, we have also explored the opportunities for online mentoring, creating *Zoom* communities, and connecting digitally through social networking.

Recommendations

The findings of this research indicate that initial teacher education programs should consider implementing a formal mentoring experience for PSTs during their teacher certification coursework. These research findings inspire a call for initial teacher education programs across the United States to re-evaluate the structure and support of formal and informal mentoring within their current program structure. Other researchers supporting this call include Gershenfeld (2014), and Hobson, Castaneheira, Doyle, Csigas and Clutterbuck (2016). The findings from this study suggest that administrators at the university and school district level should consider that formal mentoring programs often do not happen organically, and need to be mindfully built in to the program and institutional infrastructure, including financial and time management support. Ehrich, Hansford and Tennent (2004) stated "formal mentoring programs are planned, structured and coordinated interventions within an organization's human resource policies" (p.519).

As the field of education becomes more dependent upon accreditation and federal accountability, the personal relationship between a seasoned instructor and a pre-service teacher cannot be undervalued. It is this mentoring relationship that lays the groundwork for the pre-service teacher to make good decisions about instruction for their own students. While the methods of creating formal mentoring programs, as well as the costs and the nature of such programs, are beyond the scope of this research, it is recommended that future studies examine how formal mentoring programs can be sustainably incorporated into teacher education programs. In addition, we recommend that future research examine the compensation, support, and value systems built into institutions of higher learning, that either nurture or discourage professors and mentor teachers to invest in the great amount of time and effort involved in developing personal relationships with pre-service teachers.

References

Aldridge, J. & Goldman, R. L. (2007). *Current issues and trends in education* (2nd ed). Boston, MA: Pearson Education/Allyn & Bacon. https://www.pearson.com/us/higher-education/program/Aldridge-Current-Issues-and-Trends-In-Education-2nd-Edition/PGM285158.html

Ambrosetti, A. (2012). *Reconceptualising mentoring using triads in pre-service teacher education professional placements*. Unpublished doctoral thesis, Central Queensland University, Queensland. http://hdl.cqu.edu.au/10018/927846

Ambrosetti, A., Knight, B. A. & Dekkers, J. (2014). Maximizing the potential of mentoring: A framework for pre-service teacher education. *Mentoring & Tutoring: Partnership in Learning,* 22(3), 224-239. https://doi.org/10.1080/13611267.2014.926662

Atteberry, A., Loeb, S. Wyckoff, J. (2017). Teacher churning: Reassignment rates and implications for student achievement. *Educational Evaluation and Policy Analysis,* 39(1), 3-30. https://files.eric.ed.gov/fulltext/EJ1129160.pdf

Behrstock-Sherratt, E., Bassett, K., Olson, D. & Jacques, C. (2014). *From good to great: Exemplary teachers share perspectives on increasing teacher effectiveness across the career continuum.* Center on Great Teachers and Leaders. Retrieved from http://eric.ed.gov/?id=ED555657

Bromley, D. B. (1986). *The case-study method in psychology and related disciplines*. Hoboken, NJ: Wiley.

Buchanan, J., Prescott, A., Schuck, S., Aubusson, P., Burke, P. & Louviere, J. (2013). Teacher retention and attrition: Views of early career teachers. *Australian Journal of Teacher Education,* 38(3), 112-129. https://doi.org/10.14221/ajte.2013v38n3.9

Caspersen, J. & Raaen, F. D. (2014). Novice teachers and how they cope. *Teachers and Teaching*, 20(2), 189-211. https://doi.org/10.1080/13540602.2013.848570

Creswell, J. W. & Clark, V. L. P. (2007*). Designing and conducting mixed methods research.* Thousand Oaks, CA: SAGE. [3rd ed.] https://au.sagepub.com/en-gb/oce/designing-and-conducting-mixed-methods-research/book241842

Cullingford, C. (Ed.) (2017). *Mentoring in education: An international perspective*. London, UK: Routledge. https://www.routledge.com/Mentoring-in-Education-An-International-Perspective/Cullingford/p/book/9781138254916

Darling-Hammond, L. (2010). Teacher education and the American future. *Journal of Teacher Education*, 61(1-2), 35-47. https://doi.org/10.1177/0022487109348024

Darling-Hammond, L. (2012). *Powerful teacher education: Lessons from exemplary programs*. Hoboken, NJ: Wiley. https://www.wiley.com/en-us/Powerful+Teacher+Education%3A+Lessons+from+Exemplary+Programs-p-9780787972738

Denzin, N. K. & Lincoln, Y. S. (1994). *Handbook of qualitative research*. Thousand Oaks, CA: SAGE. [5th ed.] https://au.sagepub.com/en-gb/oce/the-sage-handbook-of-qualitative-research/book242504

Doabler, C. T., Fien, H., Nelson-Walker, N. J. & Baker, S. K. (2012). Evaluating three elementary mathematics programs for presence of eight research-based instructional design principles. *Learning Disability Quarterly*, 35(4), 200-211. https://doi.org/10.1177/0731948712438557

Ehrich, L. C., Hansford, B. & Tennent, L. (2004). Formal mentoring programs in education and other professions: A review of the literature. *Educational Administration Quarterly*, 40(4), 518-540. https://doi.org/10.1177/0013161X04267118

Erlandson, D. A., Harris, E. L., Skipper, B. L. & Allen, S. D. (1993). *Doing naturalistic inquiry: A guide to methods*. Thousand Oaks, CA: SAGE. https://au.sagepub.com/en-gb/oce/doing-naturalistic-inquiry/book3939

Fraser, J. W. & Watson, A. M. (2014). *Why clinical experience and mentoring are replacing student teaching on the best campuses*. A White Paper. Woodrow Wilson National Fellowship Foundation. http://eric.ed.gov/?id=ED562067

Fisher, M. H. & Royster, D. (2016). Mathematics teachers' support and retention: Using Maslow's hierarchy to understand teachers' needs. *International Journal of Mathematical Education in Science and Technology*, 47(7), 993-1008. https://doi.org/10.1080/0020739X.2016.1162333

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410-8415. https://doi.org/10.1073/pnas.1319030111

Glaser, B. G. (1978). *Theoretical sensitivity*. Mill Valley, CA: Sociology Press.

Glaser, B. & Strauss, A. (1967). *Grounded theory: The discovery of grounded theory*. New York, NY: Aldine.

Guthery, S. & Bailes, L. P. (2019). Patterns of teacher attrition by preparation pathway and initial school type. *Educational Policy*. https://doi.org/10.1177/0895904819874754

Hargreaves, A. & Fullan, M. (2000). Mentoring in the new millennium. *Theory into Practice*, 39(1), 50-56. https://doi.org/10.1207/s15430421tip3901_8

Hewlett, S. A. (2013). *Forget a mentor, find a sponsor: The new way to fast-track your career*. Brighton, MA: Harvard Business Review Press. https://store.hbr.org/product/forget-a-mentor-find-a-sponsor-the-new-way-to-fast-track-your-career/11163

Hines, S. M., Murphy, M., Pezone, M., Singer, A. & Stacki, S. L. (2003). New teachers' network: A university-based support system for educators in urban and suburban "ethnic minority" school districts. *Equity & Excellence in Education*, 36(4), 300-307. https://doi.org/10.1080/714044338

Hobson, A. J., Castanheira, P., Doyle, K., Csigás, Z. & Clutterbuck, D. (2016). *The mentoring across professions (MaP) project. What can teacher mentoring learn from international good practice in employee mentoring and coaching?* Education Research Center, University of Brighton European Mentoring and Coaching Council. https://www.gatsby.org.uk/uploads/education/reports/pdf/mentoring-across-the-professions-final300816.pdf

Howe, E. R. (2017). *Exemplary teacher induction: An international review*. In M. A. Peters & M. Tesar (Eds.), *In search of subjectivities: An educational philosophy and theory teacher education reader, Volume II* (pp. 33-44). London, UK: Routledge. https://www.routledge.com/In-Search-of-Subjectivities-An-Educational-Philosophy-and-Theory-Teacher/Peters-Tesar/p/book/9780815359012 [reprinted from https://doi.org/10.1111/j.1469-5812.2006.00195.x]

Hubbard, K., Embry-Jenlink, K. & Beverly, L. (2015). A university approach to improving STEM teacher recruitment and retention. *Kappa Delta Pi Record*, 51(2), 69-74. https://doi.org/10.1080/00228958.2015.1023139

Ingersoll, R. M., & Smith, T. M. (2004). Do teacher induction and mentoring matter? *NASSP Bulletin*, 88(638), 28 40. https://doi.org/10.1177%2F019263650408863803

Ingersoll, R. M. & Strong, M. (2011). The impact of induction and mentoring programs for beginning teachers: A critical review of the research. *Review of Educational Research*, 81(2), 201-233. https://doi.org/10.3102/0034654311403323

Jaladanki, V. S., & Bhattacharya, K. (2015). Interactive notebook: Arts-based approach to physics instruction. *Creative Approaches to Research*, 8(2), 32. https://www.researchgate.net/publication/301627604_Interactive_Notebook_Arts-based_Approach_to_Physics_Instruction

Janssen, S., van Vuuren, M. & de Jong, M. D. T. (2016). Informal mentoring at work: A review and suggestions for future research. *International Journal of Management Reviews*, 18(4), 498-517. https://doi.org/10.1111/ijmr.12069

Johnson, S. M., (2013). *What is the impact of interactive science notebooks on student success in science?* Unpublished doctoral dissertation, Montana State University, Bozeman, MT, USA. http://scholarworks.montana.edu/xmlui/handle/1/2815

Joiner, S. & Edwards, J. (2008). Novice teachers: Where are they going and why don't they stay. *Journal of Cross-Disciplinary Perspectives in Education*, 1(1), 36-43. https://people.wm.edu/~mxtsch/Teaching/JCPE/Volume1/JCPE_2008-01-07.pdf

Kilpatrick, S. & Fraser, S. (2019) Using the STEM framework collegially for mentoring, peer learning and planning. *Professional Development in Education*, 45(4), 614-626. https://doi.org/10.1080/19415257.2018.1463925

Kim, K.-A. & Roth, G. L. (2011). Novice teachers and their acquisition of work-related information. *Current Issues in Education*, 14(1). https://cie.asu.edu/ojs/index.php/cieatasu/article/download/268/152/

Kolb, A. Y. & Kolb, D. A. (2012). *Experiential learning theory*. In N. M. Seel (Ed.), *Encyclopedia of the sciences of learning* (pp. 1215-1219). New York: Springer US. https://www.springer.com/gp/book/9781441914279

Kram, K. E. (1985). *Mentoring at work: Developmental relationships in organizational life*. Glenview, IL: Scott Foresman.

Lewis, C. & Olshansky, E. (2016). Relational-cultural theory as a framework for mentoring in academia: Toward diversity and growth-fostering collaborative scholarly relationships. *Mentoring & Tutoring: Partnership in Learning*, 24(5), 383-398. https://doi.org/10.1080/13611267.2016.1275390

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Thousand Oaks, CA: SAGE. https://au.sagepub.com/en-gb/oce/naturalistic-inquiry/book842

Lofthouse, R. M. (2018). Re-imagining mentoring as a dynamic hub in the transformation of initial teacher education: The role of mentors and teacher educators. *International Journal of Mentoring and Coaching in Education*, 7(3), 248-260. https://doi.org/10.1108/IJMCE-04-2017-0033

McIntyre, D. & Hagger, H. (1996*). Mentors in schools: Developing the profession of teaching*. London: David Fulton Publishers.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. Hoboken, NJ: Wiley. [4th ed.] https://www.wiley.com/en-au/Qualitative+Research%3A+A+Guide+to+Design+and+Implementation%2C+4th+Edition-p-9781119003618

Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks, CA: SAGE. https://au.sagepub.com/en-gb/oce/phenomenological-research-methods/book4689

Muijs, D. & Reynolds, D. (2017). *Effective teaching: Evidence and practice*. Thousand Oaks, CA: SAGE. https://au.sagepub.com/en-gb/oce/effective-teaching/book246706

NCTM (National Council of Teachers of Mathematics) (Ed.) (2009). *Focus in high school mathematics: Reasoning and sense making*. Reston, VA: National Council of Teachers of Mathematics. https://www.nctm.org/Standards-and-Positions/Focus-in-High-School-Mathematics/

Patton, M. Q. (2002). Qualitative interviewing. In M. Q. Patton (Ed), *Qualitative research & evaluation methods* (pp.344-347). SAGE. https://au.sagepub.com/en-gb/oce/qualitative-research-evaluation-methods/book232962#contents

Paula, L. & Grinfelde, A. (2018). The role of mentoring in professional socialization of novice teachers. *Problems of Education in the 21st Century,* 76(3), 364-379. http://oaji.net/articles/2017/457-1529089806.pdf

Rossman, G. B., & Rallis, S. F. (2016). *An introduction to qualitative research: Learning in the field*. Thousand Oaks, CA: SAGE. https://au.sagepub.com/en-gb/oce/an-introduction-to-qualitative-research/book246120

Sithole, A., Chiyaka, E. T., McCarthy, P., Mupinga, D. M., Bucklein, B. K. & Kibirige, J. (2017). Student attraction, persistence and retention in STEM Programs: Successes and continuing challenges. *Higher Education Studies*, 7(1), 46-59. https://doi.org/10.5539/hes.v7n1p46

Sorcinelli, M. D. & Yun, J. (2007). From mentor to mentoring networks: Mentoring in the new academy. *Change: The Magazine of Higher Learning*, 39(6), 58-61. https://doi.org/10.3200/CHNG.39.6.58-C4

Spradley, J. P. (1980). *Participant observation*. Longgrove, IL: Waveland Press. https://www.waveland.com/browse.php?t=689

Smith, M. K., Jones, F. H. M., Gilbert, S. L. & Wieman, C. E. (2013). The Classroom Observation Protocol for Undergraduate STEM (COPUS): A new instrument to characterize university STEM classroom practices. *CBE-Life Sciences Education*, 12(4), 618-627. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.783.7577&rep=rep1&type=pdf

Strauss, A. & Corbin, J. (1994). Grounded theory methodology. In N. K. Denzin & Y. S. Lincoln (Eds.)*, Handbook of qualitative research*, 273-285. Thousand Oaks, CA: SAGE. [5th ed.] https://au.sagepub.com/en-gb/oce/the-sage-handbook-of-qualitative-research/book242504

Strong, M. (2006). Does new teacher support affect student achievement? Some early research findings *Research Brief*, 6(1) 1-4. New Teacher Center at The University of California, Santa Cruz, USA. http://dcntp.org/wp-content/uploads/2012/12/making-the-case-teach_supt_student_achieve.pdf

Walkington, C. & Marder, M. (2013). Classroom observation and value added models give complementary information about quality of mathematics teaching. In T. J. Kane, K. A. Kerr & R. C. Pianta (Eds), *Designing teacher evaluation systems: New guidance from the Measures of Effective Teaching Project.* (pp. 234-277). San Francisco: Jossey-Bass. https://uteach.utexas.edu/sites/default/files/WalkingtonMarderMET2013.pdf

Wilhelm, A. G., Woods, D., del Rosal, K. & Wu, S. (2020). Refining a professional network: Understanding first-year teachers' advice seeking. *Teacher Education Quarterly*, 47(3), 96-119.

Yin, R. K. (2003). *Case study research: Design and methods*. Thousand Oaks, CA: SAGE. [6th ed.] https://au.sagepub.com/en-gb/oce/case-study-research-and-applications/book250150

Appendix 1: The Noyce Mentoring networks - Noyce and traditional

Type of network	Person	Roles and responsibilities during initial teacher education program	Roles and responsibilities after graduation
Noyce Scholarship Recipient Mentoring Network	Mentor: Experienced teacher in the field	1. Conducts biweekly informational and response meetings; 2. Create supplementary curriculum to fill in gaps in initial teacher education program and content courses; 3. Provides in class observations and feedback during field experiences including PST teaching.	1. Provides PST with in-class observations and feedback; 2. Provides instructional resources as needed; 3. Provides professional development; 4. Periodically checks in with PSTs to ensure they are succeeding both personally and academically.
	Sponsor: Faculty member in STEM department	1. Writes and organises Noyce Scholarship grant which provides significant financial benefit to PSTs; 2. Provides instructional resources as needed; 3. Advocates for PSTs within STEM department, on the college and university level; 4. Advocates for PSTs within STEM department, on the college and university level; 5. Serves as academic advisor for PSTs; 6. Provides content resources for PSTs to aid them in passing state certification test; 7. Periodically checks in with PSTs to ensure they are succeeding both personally and academically.	1. Organises and hosts reunion activities; 2. Purchases resources for classroom instruction as needed; 3. Periodically checks in with PSTs to ensure they are succeeding both personally and academically.
	Sponsor: Faculty member in Educator Preparation Program	1. Writes and organises Noyce Scholarship grant which provides significant financial benefit to PSTs; 2. Designs and organises team building activities for PSTs and mentors; 3. Advocates for PSTs within initial teacher education program, and on the college and university level; 4. Serves as unofficial advisor for PSTs navigating the complex process of teacher certification within the College of Education; 5. Provides content resources for PSTs to aid them in passing state certification test;	1. Organises and hosts reunion activities; 2. Purchases resources for classroom instruction as needed; 3. Periodically checks in with PSTs to ensure they are succeeding both personally and academically.

Type of network	Person	Roles and responsibilities during initial teacher education program	Roles and responsibilities after graduation
		6. Periodically checks in with PSTs to ensure they are succeeding both personally and academically	
	Peer mentoring: Noyce Scholarship Cohort	1. Provides peer to peer support during common courses both in content area and initial teacher education program; 2. Participate in team building activities, thus creating an atmosphere of support and relationship; 3. Attend conferences together, creating a common novel experience and memory.	1. Provides support for each other in the areas of content curriculum, challenges in classroom management, and professional responsibilities as teachers; 2. Personal friendship check-ins to makes sure peers are succeeding professionally and personally.
	Mentor: Experienced teacher in the field	1. Mentors student in field observations required by initial teacher certification. 2. May or may not provide additional mentoring experiences depending on the requests or training provided by initial teacher certification.	None
Traditional initial teacher certification informal mentoring	Sponsor: Faculty member in STEM department	Not available in traditional initial teacher certification mentoring.	None
	Sponsor: Faculty member in Educator Preparation Program	Some mentoring or observation as needed in individual initial teacher certification classes.	None
	Peer mentoring	No established structure or events for mentoring or community building within initial teacher certification, however, this may occur organically within the initial teacher certification courses and experiences	None, unless students continue contact after graduation

Dr Chrissy J. Cross is an Associate Professor of Secondary Education at Stephen F. Austin State University in Nacogdoches, Texas. She obtained her PhD in curriculum and instruction with an emphasis in science and mathematics from Texas Tech University in 2014. Her research interests include qualitative research methods and STEM education.
Email: crossc1@sfasu.edu

Dr Keith Hubbard is a Professor of Mathematics at Stephen F. Austin State University. He obtained his PhD from the University of Notre Dame in 2005, and currently serves as principal investigator or project director on three STEM-student-serving NSF projects. His research interests include STEM student success and STEM teacher education.
Email: hubbardke@sfasu.edu

Dr Lesa Beverly is the Chair of the Department of Mathematics and Statistics at Stephen F. Austin State University. She earned a PhD in mathematics from Virginia Tech in 2000. She has served as a principal investigator on two Noyce Scholarship grants and her research interests include mathematical crystallography and mathematics education.
Email: beverlyll@sfasu.edu

Dr Dennis Gravatt is an Associate Professor at Stephen F. Austin State University. He earned a PhD in forest biology from Louisiana State University in 1994. He is a co-principal investigator on the Noyce Scholarship program, and his research expertise is in plant physiology, plant ecophysiology, wetland ecology and medical botany.
Email: dgravatt@sfasu.edu

Adrienne Aul is an EdD candidate at the University of Houston studying mathematics education. As the STEM Programs Coordinator at Stephen F. Austin State University, her research focuses on STEM teacher preparation programs and students' interest in STEM and STEM careers.
Email: aaul@sfasu.edu

Please cite as: Cross, C. J., Hubbard, K., Beverly, L., Gravatt, D. & Aul, A. (2020). The continuation of a mentoring network for pre-service teachers into early in-service years. *Issues in Educational Research,* 30(4), 1286-1309. http://www.iier.org.au/iier30/cross.pdf