Title: The influence of a mentoring network during educator preparation and beyond

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Abstract

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 the classroom of novice mathematics teachers.
Introduction

Educator preparation programs (EPP’s) depend on quality field experiences to produce effective teachers (Darling Hammond, 2012; Howe, 2015). Within those field experiences, the EPP 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 EPP, 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 EPP. 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. 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 between university faculty or staff from the EPP 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), and for novice teachers (Ingersoll & Strong, 2011) there is little research about designing mentoring networks for undergraduate pre-service math 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 takes place is located in a rural area of the southern United States. The regional comprehensive university has a traditional university based EPP and 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 teach. There is no formal faculty mentoring component within the program design of the EPP. For many PSTs that go through the EPP, 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.

At this same university, there was a Noyce scholarship program, where PSTs who were involved in the Noyce scholarship program were provided with a mentoring network to assist them in their math 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 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 of two groups of novice high school math teachers, one that experienced a supplemental mentoring network as a part of the Noyce scholarship program and one group that experienced the traditional EPP, through the research question, “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 theorized, “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, 1972). In the case of a pre-service math teacher transitioning from pre-service to novice teacher they must reconstruct their mathematics content knowledge from their undergraduate math 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 synthesize the college math experience (which is often an individualized focus) into a mathematics social activity as instructional methods for their students. In the case of mathematics teacher, the ability to reconstruct their mathematics knowledge from their undergraduate studies in a completely different framework of their own classroom instructional methods, this drastic shift in their paradigm of thought requires 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 increasing 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 their environment 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 recognizing the importance of developing epistemology with novice teachers mentoring network, such as the Noyce mentoring network (NMN).

**Literature Review**

**What is mentoring?**

A mentor is a person who take interest in you or counsel you because they have either volunteered or been assigned that role within an organization (Hewlett, 2013; Ambrosetti, 2012). According to Ingersoll & 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 within types of mentoring pre-service and novice teachers receive both during the EPP and after graduation (Cullingford, 2016).
Sponsorship and Mentoring

While most mentoring provided for pre-service and novice teachers follows the more 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 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 & Strong (2011) found that mentoring programs had a significant positive impact on beginning teachers in satisfaction, commitment and retention. In addition, Joiner & 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) 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.

Mentoring and Retention of STEM teachers

Sithole, Chiyaka, McCarthy, Mupinga, Bucklein, & Kibridge state 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 recommend that STEM pre-service teachers be provided with institution support consisting of peer mentoring experience and increased faculty connections. Fisher and Royster (2016) 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. In addition, Fisher and Royster (2016) stated that mathematics teachers often needed more specialized 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 EPP, only four of the participants were involved in the Noyce scholarship program at the university. 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 implication of the findings 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. 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 mentors take time to listen, give advice, provide feedback on skills, shares their experience and wisdom with the mentee. A mentor traditionally expects very little in return for their investment. This is more aligned the traditional definition of mentoring that takes place for pre-service and novice teachers (Ambrosetti, Knight, Dekkers, 2014). Hewlett (2013) then defines a sponsor as a senior leader who routinely advocates for the protégé they are sponsoring, provides opportunity for protégé, promotes their visibility to higher ranking personnel, provides honest and critical feedback on skill development, provides opportunity for protégé to expand what they can do as a professional. Sponsors see their investment of time and energy into a protégé as an investment in their own professional development and expect a great deal from their protégé’s in return for their investment. When a PST becomes a Noyce scholar, they are surrounded by individuals who take on the roles of mentors (experience 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 their relationship with the participants as undergraduates. She designs bi-weekly meetings for Noyce scholars to practice 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 classroom to provide feedback and ideas on their classroom instruction and management.

The 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 they are the recruiters, the organizers, and the 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 distinctly different roles than the mentor teacher, a 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 EPP. The mentor teacher and faculty sponsors both make deliberate effort to have a positive and supportive academic and socio-emotional relationship with the Noyce participants.

Finally, the Noyce participant has a relationship with their cohort of peers that enter the Noyce grant at the same time. They form strong relationships with each other because they are involved in activities with each other biweekly, 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

Since the context of the study takes place in several different schools, and with very different teachers, who have experienced similar and different education experiences in a common educator preparation program, qualitative research methods were chosen to best investigate the research question because of the naturalistic setting of the research and 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 and interpretive naturalistic approach to it is 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 that are the participants within our study. For this study, a qualitative particularistic multisite case study methodology 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 utilized 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 methodological design to allow participants to connect choices of instruction with previous experiences within the EPP 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 in design of mentoring research yielded guidelines that state the research design must be based on context of the mentoring network (Janssen, S.; Vuuren, M.; Jong,
M.D., 2016), and 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 (in their 1st-3rd year of teaching) mathematics teachers who were currently teaching high school mathematics. Four male teachers and four female teachers participated between 21 and 27 years of age. Each participant earned a Bachelor’s degree in mathematics with a Texas secondary teaching certification through the same rural state university in Texas. All participants graduated within the last four year, with four of the participants graduated as participants in the Noyce Scholarship program at the university, and four of the participants graduated in the traditional program. Participants were given pseudonyms to protect their identity.

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 to the participants for volunteering to participate in the study, an IRB was obtained through the state university sponsoring the study to ensure the privacy and rights of the human subjects.

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 ranges from very small, less than 105 students to very large, 1060-2099 students. The variation in the school sizes was considered in the data analysis, as were the rural or urban characteristics some the schools.

Educational Experience during EPP of the Participants

Each participant experienced the same educator preparation program at the rural state university. In addition to a full degree in mathematics, the educator preparation program consists of 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

Data Sources

Data sources for each participant include: a semi-structured interview, a Likert scale survey, in class observations and debriefings, and a follow up email survey. Cresswell (2007) and Merriam (2009) state 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 in-
fluence of mentoring (both during educator preparation and after graduation) on choice and implementation of instructional methods. The interview questions address the participants’ views and beliefs of how their teacher preparation program and/or supplementary mentoring influence 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, 2016) to observe the participant’s implementation of instructional methods. After each observation, the researcher would debrief with the participant. The debriefing sessions also served as a data source. A follow up email questionnaire was used as a data source, it was sent to each of the participants to allow the participants 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 was semi-structured in nature (Merriam 2009). The interview 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 modified a classroom observation protocol from the Classroom Observation Protocol for Undergraduate STEM (COPUS) and the UTeach Observation Protocol (Smith, Jones, Gilbert & Wieman 2013; 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 videotaped and transcribed by the researcher. After each of the observation sessions, the researcher would debrief the class observation session with each of the participants, so that they could comment or clarify the events occurring 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 organize 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 and Strauss, 1967; Strauss and 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 EPP 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 phenomena influenced the choices of instructional methods as novice teachers. As the constant comparative method was used to examine and re-examine the data (Glaser & Strauss, 1967), it became apparent the data was saturated with evidence that the mentoring of the Noyce program indeed influenced the responses and experiences of the participants who took part in that program. 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.

**Trustworthiness**

The trustworthiness of this research meets the guidelines set forth by Lincoln and Guba (1985). Credibility, dependability, and confirmability was 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.

**Data Analysis**

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 than the participants who did not take part in the Noyce Program. These common differences in participants lead the researcher to evaluate the data as two different groups who experienced different phenomena.

**Findings**

**Data about mentoring**

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. That data is compiled into Table 1.
INFLUENCE OF A MENTORING NETWORK DURING EPP

<table>
<thead>
<tr>
<th>Name</th>
<th>Additional Support</th>
<th>Mentoring Network Support</th>
<th>EPP Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daniel</td>
<td>None.</td>
<td>More technology. I don’t have access to much.</td>
<td>Yes</td>
</tr>
<tr>
<td>Sophia</td>
<td>Occasional conferences that I get to attend. Collaboration with fellow Noyce Program math teachers is a big plus.</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Luke</td>
<td>Professional developments</td>
<td>Colleagues, google, teachers pay teachers, lead4ward materials.</td>
<td>Yes</td>
</tr>
<tr>
<td>Emma</td>
<td>Noyce Program cohort &amp; PLC</td>
<td>Collaborating with other teachers, Noyce Program cohort &amp; PLC</td>
<td>Yes</td>
</tr>
<tr>
<td>Amelia</td>
<td>None</td>
<td>lead4ward.</td>
<td>No</td>
</tr>
<tr>
<td>Lucy</td>
<td>Professional development opportunities</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Owen</td>
<td>None</td>
<td>Blogs (mathequalslove.com), My department head is very supportive, and colleagues. We talk about ideas a lot.</td>
<td>No</td>
</tr>
<tr>
<td>William</td>
<td>None</td>
<td>the internet, regional education service center, principal</td>
<td>No</td>
</tr>
</tbody>
</table>

Data about EPP experience or perception of EPP experience

**Interview data.** When asked the question, “How do you believe that your education training prepared or did not prepare you for implementing instructional methods into the classroom?” Four of the participants who did not participate in the Noyce Program answered that the EPP did not adequately prepare them to implement instructional methods in the classroom. One of the participants (Lucy) who participated in the traditional EPP stated about the EPP 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 utilize the methods discussed, not prepared.” Three of the four participants that took part in the Noyce Program all answered that their EPP 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 EPP influencing their ability to implement instructional methods within their classroom. One of the Noyce program participants (Daniel) stated, “I thought along with the Noyce Program and the EPP, they did a great job of showing me what teaching really is.”

**Survey data.** When asked in a survey question, “Upon completing my certification program, I felt comfortable and confident using different types of instructional methods in my classroom” with the possible responses on a Likert scale ranging from Strongly Agree to Strongly Disagree. That data is summarized in Chart 1.
INFLUENCE OF A MENTORING NETWORK DURING EPP

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 EPP participants and 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 instructional 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 EPP participants were able to list three instructional methods, while one of the four was able to list two, and one of the traditional EPP participants was only able to identify one instructional 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; National Council of Teachers of Mathematics, 2009). However, student-centred activities such as collaboration, exploration, and peer to peer activities are recommended by research findings (Aldridge & Goldman 2007; Freeman, Eddy, McDonogough, Smith, Okoroafor, Jordt, & Wenderoth, 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-researched 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 researched 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 EPP participants used non-researched based methods 45% or more of the total time in their classroom, with two of the traditional EPP participants using non-researched based instructional methods 100% of their class time. That data is summarized in Chart 2.

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 things she was observing in the classrooms, although none of the participants mentioned using them in their choices of instructional methods. That data is summarized in Chart 3.
Data from debriefing sessions. Sophia and Emma each discussed in a debriefing session after their observation, their use of interactive notebooks as a way for students to take notes using “Foldables”, three-dimensional and interactive graphic organizers. 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. After teaching this lesson during a debriefing session with the researcher, 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.”

Results

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?”

Result 1- Formal mentoring during the EPP positively influences experiences and perceptions during the EPP. The participants who experienced the NMN spoke positively about their experiences and perceptions of their EPP, while the ones who did not have the support of the mentoring network had fewer positive remarks about the EPP. 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 an increased number of research-based instructional methods than the group who went through the traditional EPP. 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 EPP experiences.

The second result 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 EPP 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 EPP. During the debriefing sessions, the Noyce program participants tied instruction strategies observed in their classroom to specific events related to the Noyce program, emphasizing the source and the value of the instructional method, while the traditional EPP 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 educator preparation 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 EPP were all positively influenced by their participation in a formal mentoring experienced during their EPP. 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 council 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 have 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), they 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 of Ingersoll & Strong and our research findings indicate that due to the differences in the nature of learning math as a social and experiential
learning phenomenon (Dewey, 1938; Piaget, 1972; Schoenfeld, 1992) pre-service math 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 math classrooms.

Recommendations

It is recommended based upon the findings of this research that EPP’s should consider implementing a formal mentoring experience for PST’s during their teacher certification coursework. These research findings inspire a call for EPP’s 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); Hobson, Castaneheira, Doyle, Csigas, and Clutterbuck (2016). Administrators on the university and school district level must realize that formal mentoring programs often do not happen organically, and need to be mindfully built in to the program and institution infrastructure, this includes financial/time management support. Ehrich, Hansford, & 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 instructional 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 also recommended that future studies research how formally mentoring programs can be sustainably incorporated into educator preparation programs. In addition, it is recommended 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


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## Appendix 1 - The Noyce Mentoring Network

<table>
<thead>
<tr>
<th>Person</th>
<th>Roles and Responsibilities During EPP</th>
<th>Roles and Responsibilities after graduation</th>
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| Mentor: Experiencing Teacher in the Field | 1. Conducts biweekly informational and response meetings  
2. Create supplementary curriculum to fill in gaps in EPP 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 organizes 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. Serves as academic advisor for PSTs  
5. Provides content resources for PSTs to aid them in passing state certification test  
6. Periodically checks in with PSTs to ensure they are succeeding both personally and academically | 1. Organizes 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 organizes Noyce Scholarship grant which provides significant financial benefit to PSTs  
2. Designs and organizes team building activities for PSTs and mentors  
3. Advocates for PSTs within EPP, 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 | 1. Organizes 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 |
| Peer Mentoring: Noyce Scholarship Cohort | PSTs to aid them in passing state certification test  
6. Periodically checks in with PSTs to ensure they are succeeding both personally and academically | 1. Provides peer to peer support during common courses both in content area and EPP  
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 make sure peers are succeeding professionally and personally |
Author Bios

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