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STEM Major Perceptions and Persistence to Teacher Certification

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ABSTRACT

In this qualitative research study, researchers from a rural regional university in Texas examined the perceptions of STEM teaching and persistence to STEM teacher certification in a group of STEM majors participating in a hybrid recruitment and early intense field experience. The findings from this study indicate that the hybrid recruitment and early field experience influences the desire of the STEM majors to persist to teacher certification and influences the accuracy of their perceptions regarding STEM teaching and general perceptions of teaching as a career.

Keywords: STEM teacher education; early field experience; perceptions of teaching; recruiting STEM teachers

Recruiting STEM teachers is challenging in the state of Texas and nationwide because of low salary and poor benefits, particularly in rural districts (Strauss, 2017; Viadero, 2018). In addition, students majoring in a STEM field often perceive they can make far more money upon graduation if they pursue a STEM career other than teaching, although this may not be the monetary reality (Marder, Brown & Plisch, 2018). Recruiting of STEM teachers is a focus in rural areas where teachers are often difficult to recruit and rarely stay in a STEM teaching position for more than five years (Aragon, 2016; Goodpaster et al., 2012). Texas currently has a 10.29% attrition rate (Texas Education Agency (TEA), 2018) and the majority of current STEM teachers in Texas have been teaching less than nine years (TEA, 2018). To help address the nationwide teacher shortage (Taie & Goldring, 2017; Murphy et al., 2003) in STEM, this research was designed to examine and evaluate the influence of an early field experience on potential STEM teachers' perceptions of teaching and on their persistence to teaching certification. One of the key aspects in recruiting STEM teachers is evaluating their perceptions of STEM teaching and how those perceptions impact their choice to pursue a STEM teaching career or not (Marder et al., 2018; Beltman et al., 2015). The objective of this research was to investigate the impact of an early intensive field experience on the perceptions of potential STEM teachers and their desire to pursue a career in a STEM teaching field. The research question framing this study was, "How does the Master Teacher Job Shadow (MTJS), as an early intensive field experience, influence participant perception and desire to pursue a career in a STEM teaching field?"

Literature Review

John Dewey (2007) theorized that the foundation of quality education was experience. This idea frames educator preparation, where the best education for pre-service teachers is rooted in quality field experiences. Dewey stated, "If an experience arouses curiosity, strengthens initiative, and sets up desires and purposes that are sufficiently intense to carry a person over dead places in the future…that experience is a moving force (Dewey, 2007, p. 38). Pre-service teachers' experiences before their enrollment in an EPP frame their perceptions of teaching and education (Marder et al., 2018). These perceptions are based upon the way they have experienced their own education. Research findings indicate that pre-service teacher's perceptions about a variety of educational issues can be changed by field experiences (Roth-Sitko et al., 2015; Ferguson & Sutfin, 2018, Schaffer, 2012). Dewey's theory stating the vital importance of experience in education, is highly important for the design of field experiences for pre-service teachers in order to help them form accurate perceptions of teachers, students, and schools.

The American Physical Society on Public Affairs (Marder et al., 2018) released survey data from 7,897 undergraduate and degree holding participants specifically addressing the attitudes and opinions of STEM graduates on teaching. One of the goals of the study was to develop recommendations for universities to increase the number of STEM majors considering and pursuing teaching as a career. Some of the major findings of the study included, half of the participants indicated interest in pursuing teaching as a career, 100% of those individuals said that financial incentives would increase the likelihood of achieving that career goal. The study also indicated that participants said their likelihood to pursue teaching as a career was directly influenced by faculty supporting teaching as a career and talking to them about that career, and some of the participant's perceptions of teaching did not accurately reflect the current state of teaching STEM in public schools including salary (Marder et al., 2018). These key findings indicate that more research is needed to study the complex perceptions of teaching that influence a STEM major to choose or not to choose teaching as a career. Our study, which specifically addresses the perceptions of the participants of STEM teaching in public schools, helps fill the gap in the research about how field experiences help STEM majors interested in teaching choose to persist to teaching certification.

The idea of immersing the pre-service teacher in the classroom through an early field experience is supported by theory and research. Early intensive field experience is recommended by Darling-Hammond (2006) and Denton (1982). Darling-Hammond posited that educator preparation programs need to implement field experience models that are based on, "stronger relationships with schools that press for mutual transformations of teaching and learning to teach" (p. 302). The research findings of Schaffer (2012) also indicate that early field experiences have a great deal of impact upon the pre-service teacher's perceptions of teachers and students. The Master Teacher Job Shadow (MTJS) is a unique field experience for individuals who are considering pursuing a STEM teaching career. At the time of this publication, the authors are not aware of any other similar recruitment and early intensive field experience: designed for participants who are interested in teaching STEM to experience STEM teaching with a mentor teacher for a full week before they have even enrolled in the educator preparation program and paying them a stipend upon completion. Significantly, the MTJS includes no commitment beyond the full week in the classroom and a one-evening debrief session. Since the MTJS is a unique synthesis of a recruitment/early intensive field experience, there is little research to support

specific implementation (Hubbard, Beverly, Cross, Mitchell, 2018), however components of the program design are based on current educational research. McCadden and Rose (2008) document a year-long early intensive field experiences instituted as a part of their institution with the intent of improving students' cultural responsiveness. The program not only succeeded in cultural responsiveness but also improved the efficacy of other, related educator preparatory courses. Piro et al., (2015) reported on a pilot program that instituted a five-week early field experience and found that afterward participants reported higher self-perceptions of preparedness to teacher. Other studies parallel these two (Caprano et al., 2010; Roth-Sitko et al., 2015; Eckman et al., 2016), however, each one of these programs targets students already committed to teacher certification.

Since the research site is located in a rural area, with a city population of less than 50,000; and surrounding rural public schools often express difficulty in recruiting and retaining high quality STEM teachers, we reviewed the research on the recruitment and retention of STEM teachers in rural areas.

In their research report on Teacher Shortages, the Education Commission of the States documents a 35% decrease in teacher preparation program enrolments nationally between 2008 and 2014 (Aragon, 2016), but caution this is likely a cyclic trend. They identify a limited local teacher supply as a leading driver of rural teacher shortages. Goodpaster et al. (2012) observe that close community ties are a key driver both if pushing teachers away from rural teaching and in keeping them in rural districts, calling it a "double-edged sword." They recommend intentional efforts to aid in assimilation for rural STEM teachers and also the cultivating of realistic expectations for working in rural communities. Monk (2007) examined the recruitment and retention of teachers across the United States and concluded that science and mathematics tended to be in particularly short supply (along with special education teachers) and likely to have less university science and mathematics coursework than their urban or suburban peers. Teachers at particularly small schools were also one third to one fourth as likely to have earned a passing score on the Praxis core professional practice or the Praxis II content exam (Monk, 2007). Hartman (2017) performed a case study of rural mathematics coaching and argued that it was distinct from other educational environments, deserving research in its own right. There is a lack of research on STEM teaching in rural school environments, specifically how those rural schools recruit and retain quality STEM teachers.

Limited research investigates how early intensive field experience targeting STEM majors not yet committed to teaching helps those students to form accurate perceptions of a STEM teaching career and increases participant confidence in choosing their career as a STEM teacher (Cross, Hubbard, Beverly, Gravatt, Aul, 2020). However, much literature emphasizes the importance of accurate perceptions of teachers and teaching for individuals who do choose to pursue a career in teaching (Caires et al., 2012; Miller & Endo, 2005; Howes & Goodman-Delahunty, 2015). Hutchinson (2012) recommended STEM teacher recruitment pathways such as:

> advertisement at college employment fairs, college and other print and social networks, the Internet, career counseling, peer information exchange, special certification programs designed to attract students with STEM majors into teaching, and university departmental dissemination about teacher certification tracks. (p. 543)

These same strategies are also recommended by Abell, but with the addition of stipends and scholarships for attending recruitment events (Abell et al., 2006). Crisp et al. (2018) stated:

> Early field experiences with mentor teachers can facilitate the development of intrinsic and/or altruistic motivations for teaching and therefore may be an effective way to recruit community college students who are not currently considering teaching science or mathematics. (p. 200)

The advertising for the MTJS was aimed at students on both a primary university campus and also multiple community colleges. The MTJS used a variety of communication methods such as print and digital advertising, faculty in-person recruiting, social and peer network recruiting to connect with STEM majors. It also provided a stipend for the participants.

According to survey data from 7,897 undergraduate and degree holding participants compiled by the America Physical Society (Marder et al., 2018), effective methods for recruiting STEM teachers within universities include: providing accurate information about the positive experiences of teaching as a career, financial support, and streamlining and aligning content and certification coursework. The MTJS provides a setting for participants to work closely with a master STEM teacher in order to give them an accurate and positive experience in the teaching field along with a stipend to provide the participant with financial support. Marder and colleagues' (2018) research findings also indicate that the perceptions of students majoring in STEM fields interested in pursuing teaching often have perceptions of teaching that are not accurate or aligned with the same perceptions of STEM classroom teachers. The inaccuracies in STEM major's perceptions of actual STEM teaching including incorrect perceptions of salary of the STEM majors considering teaching, this reveals an opportunity for researchers to study how STEM majors' perceptions of STEM teaching can be impacted by things such as field experiences, course work, or input from peers. The MTJS was designed to immerse the participant in a field experience, where the perceptions of STEM teacher would be accurate and based on a real lived experience. Our study is an effort to address the evolution of perceptions within people who are considering STEM teaching as a career.

Methodology

A phenomenological collective case study design and method was implemented to investigate the collective experiences of the MTJS participants as they were part of the same phenomenon and our research question focuses on discovery of their perceptions of their experiences within that phenomenon (Creswell, 2007; Merriam, 2009). Data sources such as participant's surveys, daily journals, and focus group transcripts were collected prior, during, and after the intensive field experience to determine how the MTJS influenced the perceptions of the participants as a shared phenomenon. Our goal for our data collection both from individual participants and within groups of participants, was to document the lived experiences and perceptions of participants within the collective common phenomenon of the MTJS as a hybrid early field experience and recruiting event for future STEM teachers. We also sought to determine if those perceptions and experiences of the MTJS participants influenced persistence to STEM teacher certification, thus documenting success and replicability for stakeholders in the field of STEM teaching. Modified constant comparative analysis was used (Chenoweth, 2009; Glaser & Strauss, 2017) to develop categories and themes from open and axial coding. The data sources were collected and compiled into spreadsheets and analyzed by three researchers independently for categories and codes. Categories and codes were compiled into themes grounded within the data and exhibiting theoretical saturation between the data sources and researcher's independent analysis (Glaser & Strauss, 2017). Lincoln and Guba's (1985) guidelines of trustworthiness were followed throughout the

research project. In addition to the qualitative data analysis, to determine job shadow participant persistence to teacher certification, a data request was submitted to the Texas Education Agency for a data set of all teachers certified in the last seven years to determine the number of teachers who participated in the job shadow who achieved a teacher certification. These descriptive statistics are used as a method of highlighting potential patterns (Maxwell & Miller, 2008) and support the qualitative data analysis.

Research Setting and Participants

As part of the Robert Noyce Teacher Scholarship Program grant at Stephen F. Austin State University the program staff recruit potential STEM teachers through an early intensive field experience called the MTJS. During this field experience, participants spend five consecutive, full school days with a "master teacher" in a STEM field and participate in focus groups, reflective journaling, and surveys to help them process their experiences and how that experience influences their perception of and desire to pursue STEM teaching as a career. Initially, "master teachers" were selected from two companion master teacher training projects: the Talented Teachers in Training for Texas (T4) project (NSF 1136416) and the T4 Phase II project (NSF# 1556983). Each successive year, existing master teachers were encouraged to identify colleagues who would be well suited to the MTJS and a training was instituted to clarify expectations and exchange best practices among master teachers. Master teachers had over 5 years of experience teaching STEM subjects in local public schools, had been completed training with previous NSF grant projects, and were personally recommended by fellow STEM teachers who worked closely with them. Approval for ethical human research was obtained through the university IRB.

The Noyce grant provided a stipend to the participants as well as pays for their lodging on the campus of Stephen F. Austin State University (SFASU). A stipend was also provided to the cooperating Master Teachers who hosted participants in the local public schools. The MTJS was intentionally designed to allow participants to experience a week with a teacher with the goal of inspiring the participants to consider STEM teaching as a career or at least giving a realistic perception from which to make educated career choices.

The participants for this research were recruited through in-class visits, on-campus handouts and posters, and web information disseminated by researchers on the campus of SFASU and partner community colleges. A variety of math, science, and education classes were visited by the researchers, who spent about 5-10 minutes explaining the experience and giving the class handouts of information about the field experience. In addition, outreach to local community colleges through onsite visits and information sent to representatives and professors who taught basic STEM and education courses in order to increase the diversity of the applicants. Past MTJS participants were also encouraged to utilize their peer networks to promote the program.

Prospective participants filled out an online application as the first step in qualifying for the experience. The MTJS requires students be a STEM major either at a community college or university, at least 18 years-old, and successfully passed a background check. In order to receive the stipend, they must also have a 2.75 or better GPA, and be a U.S. citizen or permanent resident. Over a period of four years (2012-2015), there were a total of 63 participants, 32% male, and 68% female. Of these participants, 79% identified themselves as Anglo-American, 10% as African American, 8% as Hispanic, and 2% as Asian-Pacific Islander. Participants all signed informed consent forms to indicate their agreement to participate in the research.

Master teachers were teachers of record in a variety of sizes of local schools surrounding the university. All schools where the job shadow took place are classified as rural according to the USDA, which defines rural as "any area other than (i) a city or town that has a population of greater than 50,000 inhabitants" (7 U.S.C. § 1991), and all schools had a high population of economically disadvantaged students. An ancillary benefit of the MTJS is that it has strengthened connections between university educators and STEM teacher-leaders in local high schools. Due to the small, rural region in which the university and school districts are located, once established these relationships often are sustained for decades. Purposeful choices are made by the organizing faculty to only include highly experienced teachers that have excellent student rapport, good classroom management, and utilize research based instructional methods.

Data Sources

The data sources for this research include pre-experience surveys, mid-experience prompted journals, post-experience surveys, and post-experience focus groups. These same data sources were collected over a period of four years, with four different groups of MTJS participants. The surveys and journals were entered into a database accessible by the researchers, and the focus group conversations were transcribed and added to the database.

In addition, a data request was made to the Texas Education Agency (TEA) for a comprehensive list of all individuals in the state of Texas who had completed a STEM teacher certification in the state of Texas for the previous seven years in order to determine which of our participants had achieved teacher certification.

Data Analysis

Each researcher first did an independent data analysis on each of the qualitative artifacts and coded categories (Charmaz, 1983) and common topics in the participant's focus groups, surveys, and journals. The researchers met together and compared categories and coding to determine triangulated emergent themes. Grounded theory (Glaser & Strauss, 1967) was used to guide the group to concur on which themes met theoretical saturation.

It is important to note that one researcher had been present during all four years of the MTJS, one had been present during one of the years included in the data set, and one researcher had not been present during the MTJS. This variety of experience and perspective with the MTJS data helped ensure that a variety of viewpoints were represented within the independent data analysis (Fram, 2013), so that triangulated themes would be trustworthy (Lincoln & Guba, 1985). In addition, one of the researchers has experience as a STEM classroom teacher and as a qualitative researcher in classroom environments, this theoretical sensitivity also contributed to the trustworthiness of the identified themes (Glaser & Strauss, 1967). Dewey's (2007) theory of experience in education, framed the researcher's interpretation of the data on the descriptions of the observations and lived experiences of the participants within the school environment.

Findings

Four years of data about the annual MTJS were examined and the following results were identified. They are grouped into two different sections in order to address the two specific parts of the research question. The first section describes the findings related to the perceptions of STEM

teaching, and the second section describes the findings related to the desire to tech of the participants.

MTJS Perceptions of STEM Teaching

The students were asked within the surveys, journals, and focus groups to identify things within the MTJS that influenced their perspective of teaching. The data sources were independently analyzed by three different researchers for common ideas from the participants. Each of the researchers generated common categories of participant topics mentioned in journals, surveys, and focus groups.

Categories identified independently by the researchers from the job shadow journals were compared and three common categories were determined from the data analysis, each with an embedded emergent theme. Participants primarily focused their reflections and personal connections to the experience in the following categories: observations about students, observations about classroom management, and observations about teachers and teaching as a profession.

Observations About High School Students

The researchers determined that, "The MTJS participants were able to develop an accurate perception of the challenges and altruistic rewards of working with high school students based upon their field experience." As the data was analyzed, two categories emerged from the data that illustrated the students accurately documented experiences that reflected that of teachers in classrooms. The participant's perception of students can be broken down into two primary categories of observation: observations of a lack of student motivation, and documentation of the altruistic rewards of teaching. The category indicating that participants observed the altruistic rewards of teaching, is supported by the findings of Perryman & Calvert (2020) and Fokkens-Bruinsma & Canrinus (2012), which indicate that a key motivation to enter the teaching field for pre-service teachers is motivated by the altruistic rewards of teaching. The participant's observation that indicated of a lack of motivation in high school STEM students is also documented in the research of Nayir (2017) and Bedford (2017) due to an overemphasis on standardized testing and lack of engagement in STEM classrooms. These two categories of observations, not only are present in research, but also fit with the experiences of the researchers within high school STEM classrooms. Table 1 shows some of the participant quotes regarding these two categories.

The participant journals, quotes, and data analysis indicate that the participants were able to observe and communicate accurate perceptions of STEM classroom experiences due to the MTJS. While the participants could have similar perceptions before this experience, the findings seem to indicate that the participants were able to accurately document challenges like lack of motivation, and altruistic rewards of teaching.

Table 1
Participant Quotes Supporting the Categories of Student Apathy and Altruism in Teaching

Lack of Student Motivation
"The only kids who don't learn much seems to be the ones who are lazy or don't care to try."
"I think the teachers are doing what they can to promote learning but it is hard when so many students don't care if they fail."
"the students have no personal drive."
Altruistic Rewards of Teaching
"I loved seeing the looks on the student's faces whenever they finally grasped a subject."
"The most rewarding part is getting to see some of the students finally understand something... [a student] walked to the front, his classmates started clapping for him. The pride on his face nearly made me cry because I was so happy and excited for him."
"Being able to help students understand some of the concepts they are working on was very rewarding."

Observations About Classroom management

Within the category of classroom management, the researchers documented how the participants communicated what they felt were positive and negative classroom management experiences, made general observations about classroom management, and also noticed the mutualistic nature of teacher and student relationships and its impact on classroom management. One student journal entry documenting a positive classroom management experience wrote, "I was blown away at how well the teacher was able to attract the attention of 95% of the class". This statement from the participant captures not only how a good teacher manages their class well, but also illuminates the types of classroom events to which participants were attuned. For comparison, participants made no mention of evidence of pedagogical content knowledge.

Participants noted both positive and negative classroom management experiences. For example, one participant wrote, "The students seem to be having side conversations, using their phones, listening to music, and anything else to avoid paying attention to learning." For this participant, seeing the students off-task was a negative experience in classroom management. Many participants made general observations about what they saw and experienced as classroom management techniques. One wrote, "The way the teacher handled certain 'troublemaker' students was intriguing. I saw the techniques that teachers use to calm one child while maintaining the control of the entire classroom." Finally, the participants also documented how the student and teacher relationships impact the dynamics of classroom management. One wrote, "not all kids will be challenging but not all will listen either. And how you interact with the student completely effects their actions back to you and that when you try and treat them as adults, they will try to behave like one."

The participant reflections and perceptions of classroom management seemed to indicate an evolving perception of the responsibilities and requirements of managing and motivating high

school students in a classroom setting. Watching teachers succeed at managing behavior and learning in classrooms of high school students is important for a future teacher to be able to develop a sense of confidence in his or her ability to also manage that same group (Marder et al., 2018). Participants were able to make that connection in their journals. Here are a few quotes illuminating that connection. One reflected, "[my experience] helped relieve some anxieties about room discipline." Another stated, "At the beginning of the week it kind of felt like I was a student. Towards the end of the week I started feeling more like a teacher." And another participant wrote, "The most rewarding part for me was observing the students as their different ones come in each class period and I would imagine how I could handle situation differently. I was able to construct ideas of teaching styles that may really grasp the students. Being in the classroom has made me more confident in my capability of this profession."

The primary theme arising from this category identified by researchers is, "The MTJS participants developed a perception of classroom management as a complex and reciprocal balance of discipline, respect, learning, and relationship based upon this field experience."

Observations about Teachers and Teaching

The final primary themes of the participant journals centered around the idea of what being a teacher truly entails and encompassed many facets of teaching as a profession such as, the physical, emotional, mental toll; the instructional and curricular choices; relationships with students, other teachers, and administrators; school scheduling and procedures; and many other parts of teaching STEM as a high school teacher. As a method of communicating our qualitative analysis, we created a chart based upon quoted words from the participant's reflections describing what one of the most important things they learned about teaching or teachers through the MTJS, Table 2.

Participant descriptors of their experience, Table 2, almost reads as if it were poetry, the participants captured the beautiful and terrible balances that are the daily demands of a teaching career. Teachers of all subjects can confirm that teaching and teachers share these qualities and descriptive keywords. This table captures some of the most powerful indicators that the MTJS indeed allowed the participants to experience an authentic early intensive field experience and were also successful in developing accurate perceptions of the characteristics of teaching and teachers.

The way that the participants wrote about their experiences with the teachers was overwhelmingly positive, yet realistic in nature, and the primary theme that arose from these categories of data was that "The MTJS participant's experiences helped them realize that STEM teachers work very hard and are very patient with their students." Some of the participant responses particularly expound on this theme, see Table 3.

Table 2
Participant Descriptors of Master Teachers and of the Teaching Profession.

Teaching Is….	A Teacher Is…
Trust	Caring and Safe
Harder than I imagined	Calm
Cohesive Relationships	Passionate
Pride	Organized
Difficult	There for her students
Demanding	Keeps students engaged
Awesome to see progress	Connecting with Students
Relatable Examples	Good at communicating
Planning	Patient
Exhausting	Orderly
Hard Work	Original
Controlled Chaos	Earns respect
Creativity	
Helping Students	
Respect	
Exciting and Rewarding	
More Difficult than I imagined	
Nowhere as Easy as I thought	

Table 3
Participant Quotes from Categories about Teachers

Teachers Work Hard
"Teaching is a lot harder than I thought."
"I've realized that the job of a high school teacher is a lot more difficult than I imagined."
"I have seen the demanding hard work the teachers do."
Teachers Show Much Patience
"As few things I admire are her respectable nature, her patience and ability to stay calm"
"Her ability to control a classroom is really admirable as well as her patience with them"
"She rarely raises her voice and is very patient."

Two identified themes from the data analysis are:

1. The MTJS participants developed an accurate perception of the challenges and altruistic rewards of working as a certified STEM teacher with high school students based upon their field experience.
2. The MTJS influenced the participant's decision making in whether or not to pursue a teacher certification.

The researchers then examined these two themes within the context of the research question guiding this study, "How does the Master Teacher Job Shadow (MTJS) as an early intensive field experience influence participant perception and desire to pursue a career in a STEM teaching field?"

The variety of categories present in the student responses and reflection about the MTJS indicate that the MTJS helped the participants form a more accurate perception of the demands of a career in STEM teaching. An accurate perception of teaching not only helps the participants be able to make more informed choices about their own career (Howes & Goodman-Delahunty, 2015), but also improves their ability as citizens to make informed decisions about education in their communities and support positive narratives about public schools and public school youth. Research by Marder et al. (2018) likewise indicates that accuracy of perceptions of STEM teaching is a driver within STEM students to choose and persist within a teaching certification in their undergraduate experiences. This is a critical aspect of the MTJS, especially within the current political climate that often presents an overwhelmingly negative critique of public schools and teachers, at times rationalizing decreasing state and federal funds provided to support those schools.

Based upon these themes, our research findings indicate that the MTJS does indeed influence participants perceptions of STEM teaching in a variety of ways, specifically how the participants perceived high school students, classroom management, teachers, and teaching as a career. The second part of the research question, that led us to examine if the MTJS influenced the participants, "desire to pursue a career in a STEM teaching field" was examined using similar methodology but adding descriptive statistics to identify participants who actually did persist to teacher certification in the state of Texas.

MTJS Participants Desire to Pursue Teaching

Over a period of four years, only two participants out of 63 stated that the MTJS did not influence their desire to either pursue or not pursue a STEM teaching career on a secondary level. Seventy-nine percent of participants (50 out of 63 participants) communicated that the MTJS had either increased or decreased their desire to teach. Specifically, 65% participants stated the MTJS had increased their desire to teach, 14% said the experience decreased their desire to teach, 13% indicated that the experience both decreased and increased their desire to teach, and 5% did not explicitly communicate that information in their responses. The impact of the MTJS on desire to teach was communicated to the researchers in all three different data sources and was presented as a common category in all three of the researcher's data analysis documents. This data is summarized in Figure 1. Examples of the classification of student responses from the participant's journals are included in Table 4.

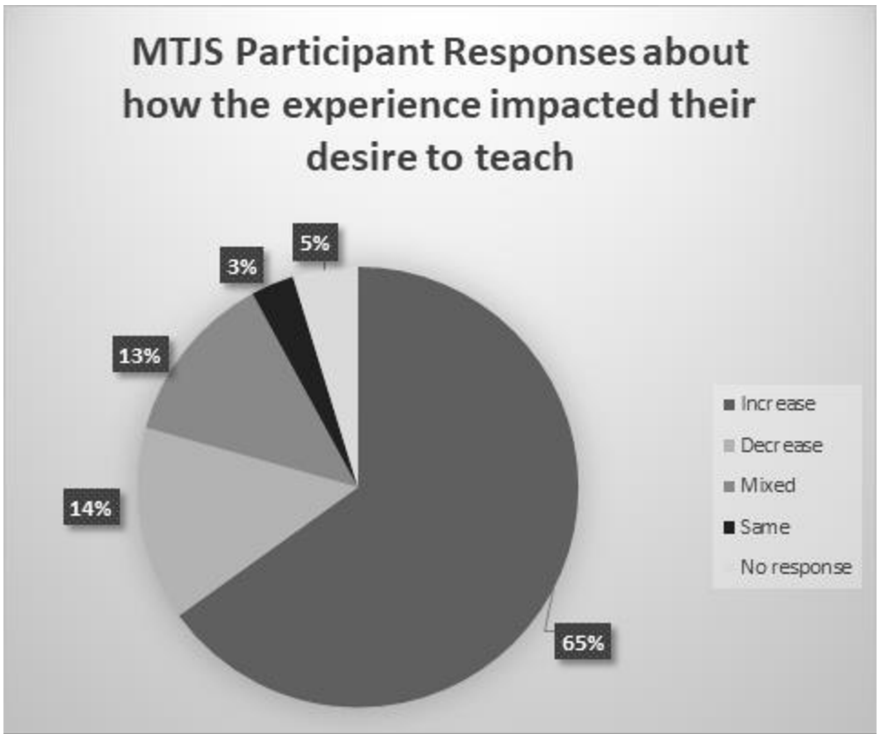

Figure 1. Participant Responses about how MTJS Impacted Desire to Teach

Table 4
Examples of Coding Participant Responses about Desire to Teach.

Coded Category	**Example participant responses**
Increased participants desire to teach	"By far this experience has increased my desire to teach. I know all the work I will have to do but I love helping all those students. This week was absolutely amazing and I now know without a doubt I will be a high school math teacher."
Decreased participants desire to teach	"This opportunity has been very helpful in clarifying what I want to do. I know that I do not want to be teaching high school."
Mixed response about the desire to teach	"This experience has and hasn't increased my desire to teach. The end of the day you feel so rewarded by helping these kids."
The MTJS had no influence on desire to teach	"I still have the same level of interest in teaching."

These four categories and descriptive statistics arising from the data led the researchers to conclude that these findings indicate that the MTJS as an early intensive field experience influenced the participants ability to make a more informed decision about their choice either to

pursue or not to pursue a STEM teaching career by allowing them to experience what it was like to teach in a public STEM classroom setting.

The researchers matched MTJS participants with the TEA database of certified teachers to determine which ones chose to pursue teacher certification after the job shadow experience. Of the 63 total participants, 29 names were matched in the TEA database. These names were also entered into the online database of the State Board for Educator Certification to ensure that indeed these individuals held a current certification in the state of Texas. This data is summarized in Figure 2.

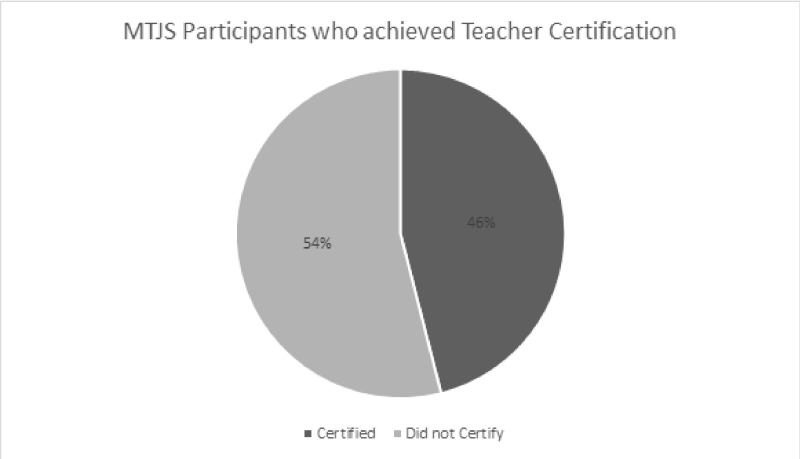

Figure 2. Participants who Earned Texas Teacher Certification

We were able to determine that 46% of the MTJS participants went on to choose to pursue teaching as a profession in the state of Texas, while 54% of participants had not pursued certification at the time of this study. For comparison, only 1% of STEM majors at the primary university feeding the MTJS choose and persist to achieving STEM teacher certification as undergraduates, with another 9% certifying at some point after graduation.

It is important to note that certifying MTJS participants did not necessarily pursue teacher certification at the same university where they were enrolled when they participated in the MTJS. Of the 63 participants under consideration, 29 (46%) participants went on to obtain certification to teach in the state of Texas, either at SFASU or at another institution or certification route. This research finding does not indicate that the MTJS directly caused 46% of participants to pursue a teaching certification in the state of Texas. However, based on our findings, we believe the MTJS was certainly an important factor in the participant's decision making to pursue a teaching career. While we cannot say that participants' choice to pursue teacher certification was due to their participation in MTJS, we can say that 46% of the participants who experienced the MTJS did persist to earning a teaching certification in the state of Texas.

In addition, we examined the interest levels of the participants and see if there was a connection between the interest level and who did go on to certify to teach. We found that 70% of the participants who communicated an increased interest in a teaching career, did actually go on to pursue a teaching career. Equally important, of those who communicated mixed responses or those communicating a decrease in their desire to teach, none of these participants chose to pursue a teacher certification in the state of Texas, Table 5.

Table 5
Relationship between participants' description of the effect of the MTJS on their interest level and participants' actual certification to teach.

Interest Level	Number	Number who Certified to Teach	Persistence to Certification
Increased Desire to Teach	41	29	70%
Decrease Desire to Teach	9	0	0%
Mixed	8	0	0%
Same Desire to Teach	2	2	100%
No response	3	1	33%
Total responses	63	32	NA

These outcomes are important not only because of the twenty-nine teachers out of our sixty-three STEM major participants who did go on to pursue a STEM teaching career, but also because of the nineteen STEM majors who did NOT choose to pursue a STEM teaching career. Undergraduate STEM majors within our research study accurately indicated their desire to pursue a STEM teaching career or not. Our research findings indicate that data collection combined with an early intense field experience such as ours can accurately predict the STEM majors who will NOT choose a career in STEM teaching. Our data collection during the MTJS was 100% accurate in indicating which STEM majors did NOT choose STEM teaching as a career. As undergraduate STEM majors attempt to establish a career path based on accurate information, the MTJS as a recruitment and early intensive field experience was 100% successful in motivating nineteen out of sixty-three participants to choose to NOT pursue a teaching career. Our results mirror the work of Schaffer (2012) who found that the pre-service teacher perceptions of teachers and students were greatly impacted by their involvement in an early intense field experience similar to ours. Further research needs to be undertaken on how early field experiences such as the MTJS could possibly impact teacher attrition, especially for novice teachers. In the state of Texas, the cost of teacher turnover for beginning teachers is estimated to be $110 million per year (Texas Center for Educational Research, 2000). How many STEM teachers who leave the field could be prevented and how many millions of dollars could be saved if they had participated in an early intensive field experience like the MTJS? If a recruitment and early field experience such as ours was implemented in teacher certification programs for STEM teacher education programs, perhaps the state of Texas and schools in our area could reduce the costs surrounding teacher turnover and more accurately recruit and predict the number of STEM teachers entering careers in STEM education.

Conclusion and Discussion

The survey results of Marder et al. (2018) indicate that "uncontrollable or uninterested students' was a concern in 41% of the 7,897 STEM undergraduate students they surveyed when those students thought about high school or middle school teaching. In our research findings, our MTJS field experience appeared to address those fears and concerns in many of our participants.

Some participants even seemed to have certainly overcome the idea that as teachers they would not be able to effectively manage apathy or misbehavior if it arises.

Marder et al. (2018) also stated that 20% of respondents indicated that altruistic motivations such as inspiring students was an appeal of choosing a teaching career. Our findings indicate that our participants were able to witness the altruistic nature of teaching and watch teachers inspire and connect with students, likely increasing the appeal of teaching for this demographic. The MTJS's function as an early intense field experience and recruiting mechanism for future STEM teachers was very successful based on our findings that 92% (58/63) participants stated explicitly that the MTJS impacted their desire or lack of desire to teach either positively or negatively or both. Providing early intense field experience and financially supporting individuals who are considering a career in teaching seems to be essential for those individuals to reflect on and make informed decision about their future career. Forty-six percent of MTJS participants achieved teacher certification, and their persistence was influenced, at least in part, by their participation in the MTJS. Finally, key to the MTJS is the idea that when participants experienced a week in the life of a public school STEM teacher, they reflected in their journals about how hard the teachers worked, how great the students could be, and how difficult the job of a teacher actually was. Hence, it is reasonable to conclude that the MTJS increased the empathy and respect among the participants for public school teachers and students, likely fostering a supportive and respectful narrative for public schools in their social circles and communities.

Similar research findings were indicated by Luft et al. (2005) who examined participant's experiences in coursework that included early intensive field experience, they posited that the field experiences were key to students choosing to continue their coursework in STEM teacher certification. "Students who enjoyed the teaching experiences felt it confirmed their decision to enter education" (Luft et al., 2005, p. 47) Schaffer (2012) stated in her research findings about early field experience's impact on perceptions of pre-service teachers, "After completing the experience, their perceptions were less influenced by the media and to a greater extent based on their own direct experience" (p. 46). Our findings also indicate that the actual experience of being in schools for a week shadowing a teacher gave the participants accurate experiential knowledge on which to base their future opinions about education and in our case, helped the participant build the confidence to make a decision to pursue or not to pursue a career in STEM teaching. These and other research findings indicate that early intensive field experiences are effective for allowing pre-service teachers to understand the requirements and demands of a teaching career (Darling-Hammond & Bransford, 2007). This corroborates the findings outlined in this study.

The research findings of Worsham et al. (2017) indicate that paid internships in informal STEM settings are not effective for recruitment of future STEM teachers. In contrast, the findings of this study indicate that a stipend for a week of actual immersion in the field of STEM teaching was effective in encouraging the participants to pursue STEM teaching certification, thus suggesting that an authentic, accurate and positive portrayal of STEM teaching (Marder et al., 2018) supported by financial incentives does indeed effectively recruit future STEM teachers and help them to strengthen their desire to persist to a STEM teaching career. Our results are supported by Dewey's theoretical framework of experience being a key to education and in our case the ability of our participants to choose teaching as a career. Our results also align with the host of research findings that posit the value and success of stipend based recruitment strategies, early field experiences, and authentic connections to teachers in the field as a method of increasing accurate teacher perceptions in our case helped facilitate and high rate of persistence to

certification (Abell et al., 2006; Caires et al., 2012; Crisp et al., 2018; Darling-Hammond & Bransford, 2007; Howes & Goodman-Delahunty, 2015; Hutchinson, 2012; Miller & Endo, 2005).

Limitations

This study was designed to examine the impact of the MTJS on the perceptions of STEM teachers and their desire to pursue a career in STEM teaching. The MTJS is an early intense field experience that was used to recruit future STEM teachers. One of the key limitations in this study is that the individuals who applied to participate in the MTJS possibly would have pursued a career in STEM teaching regardless of their experiences simply because they were potentially planning a career in that field. In addition, the MTJS was funded by a grant from the NSF. For this recruitment effort to be re-created on an institutional level, some funding source must be established to replicate efforts such as this. While the stipend may not have impacted a participants ability or motivation to participate in the MTJS, we believe that the stipend for the experience and providing on campus housing for the MTJS was important to the participants because a majority of students in our region come from lower income homes and often work full time during their college experience, with 86 % of students receiving federal financial aid and 41% of student receiving Pell grants (Niche, 2020).

While our findings cannot be generalized to every university or college setting for recruitment of STEM teachers, our findings may help universities design and implement similar programs to recruit STEM teachers. As the United States continues to experience a STEM teacher shortage (Marder et al., 2018), hybrid recruitment/early intensive field experience programs such as the MTJS can be a key factor in developing institutional commitment to recruitment of STEM teachers.

Based upon our findings within this research, we recommend universities implement similar early intensive field experience for recruiting and identifying potential STEM teachers outside the confines of the typical academic semester. Our research findings indicate the MTJS allowed participants to be better informed about the demands of STEM teaching and increases their ability to be more confident in choosing whether, or not, to pursue a career in STEM teaching.

While this research is primarily focused on the participant experiences, the MTJS also facilitated comradery and a community building experience for the local school districts, master teachers, researchers, and participants. This community building has led to strengthened, sustainable relationships between the university faculty and master teachers in the local public schools. We are optimistic that as research on how early intense field experience is completed, the results will continue to strengthen and build long-term reciprocal relationships in communities between university faculty, pre-service teachers, and public-school teachers.

We recommend that universities, educator preparation programs, and STEM departments collaborate to build a partnership with local public school STEM teachers in order to provide this type of rich, rewarding recruitment and early intense field experience in order to improve the accuracy of perceptions of STEM teaching in public schools, as well as increase confidence of undergraduate's who choose to pursue a career in STEM teaching.

References

7 U.S.C. § 1991 - U.S. Code - Unannotated Title 7. Agriculture § 1991. https://codes.findlaw.com/us/title-7-agriculture/7-usc-sect-1991.html

Abell, S., Boone, W., Arbaugh, F., Lannin, J., Beilfuss, M., Volkmann, M., & White, S. (2006). Recruiting future science and mathematics teachers into alternative certification programs: Strategies tried and lessons learned. *Journal of Science Teacher Education*, *17*(3), 165–183. https://doi.org/10.1007/s10972-005-9001-4

Aragon, S. (2016). *Teacher Shortages: What we know. Teacher Shortage Series*. Education Commission of the States. https://eric.ed.gov/?id=ED565893

Bedford, S. (2017). Growth mindset and motivation: a study into secondary school science learning. *Research Papers in Education*, *32*(4), 424-443.

Beltman, S., Glass, C., Dinham, J., Chalk, B., & Nguyen, B. (2015). Drawing identity: Beginning pre-service teachers' professional identities. *Issues in Educational Research*, *25*(3), 225–245.

Caires, S., Almeida, L., & Vieira, D. (2012). Becoming a teacher: Student teachers' experiences and perceptions about teaching practice. *European Journal of Teacher Education*, *35*(2), 163–178.

Caprano, R.M., Capraro, M.M., Capraro, R.M., & Helfeldt, J. (2010). Do Differing Types of Field Experiences Make a Difference in Teacher Candidates' Perceived Level of Competence? *Teacher Education Quarterly, 37*(1), 131–154.

Charmaz, K. (1983). The grounded theory method: An explication and interpretation. In Robert M. Emerson (Ed.), *Contemporary Field Research: A Collection of Readings* (pp. 109–126). Little, Brown and Company.

Chenoweth, E. (2009). *Becoming ambassadors of informal learning: Docents' development within a museum community of practice.* Article 3378811. [Doctoral Dissertation, Capella University]. ProQuest Dissertations Publishing.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Sage.

Crisp, G., Carales, V., Walls, C., & Cassill, A. (2018). A phenomenological study of community college students' experiences with mentor teachers. *Mentoring & Tutoring: Partnership in Learning, 26*(2), 183–206. https://doi.org/10.1080/13611267.2018.1471369

Cross, C., 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.

Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of teacher education*, *57*(3), 300-314.

Darling-Hammond, L., & Bransford, J. (Eds.). (2007). *Preparing teachers for a changing world: What teachers should learn and be able to do*. John Wiley & Sons.

Denton, J. J. (1982). Early Field Experience Influence on Performance in Subsequent Coursework. *Journal of Teacher Education*, *33*(2), 19–23.

Dewey, J. (2007). *Experience and Education*. Simon and Schuster.

Eckman, E.W., Williams, M.A., & Silver-Thorn, M.B. (2016). An integrated model for STEM teacher preparation: The value of a teaching cooperative education experience. *Journal of STEM Teacher Education, 51*(1), 71-82.

Ferguson, S., & Sutphin, L. (2019). Pre-service STEM teachers' views of teaching before and after their

first lesson. *International Journal for the Scholarship of Teaching and Learning*, *13*(2), Article 14.

Fokkens-Bruinsma, M., & Canrinus, E. T. (2012). The factors influencing teaching (FIT)-choice scale in a Dutch teacher education program. *Asia-Pacific Journal of Teacher Education*, *40*(3), 249-269.

Fram, S. M. (2013). The constant comparative analysis method outside of grounded theory. *Qualitative Report*, *18*, Article 1.

Glaser, B. G., & Strauss, A. L. (1967). *Discovery of grounded theory: Strategies for qualitative research*. Aldine.

Goodpaster, K. P. S., Adedokun, O. A., & Weaver, G. C. (2012). Teachers' perceptions of rural STEM teaching: Implications for rural teacher retention. *The Rural Educator, 33*(2), 9-22.

Hartman, S. L. (2017). Academic coach and classroom teacher: A look inside a rural school collaborative partnership. *The Rural Educator, 38*(1), 16-29.

Howes, L. M. & Goodman-Delahunty, J. (2015). Teachers' career decisions: Perspectives on choosing teaching careers, and on staying or leaving. *Issues in Educational Research, 25*(1), 18–35.

Hubbard, K. E., Beverly, L. L., Cross, C. J., & Mitchell, J. L. (2018, February). Where'd they go? Sustaining and growing interest in mathematics teaching. In *Proceedings for the 46th Annual Meeting of the Research Council on Mathematics Learning* (p. 132).

Hutchison, L. F. (2012). Addressing the STEM teacher shortage in American schools: Ways to recruit and retain effective STEM teachers. *Action in Teacher Education*, *34*(5-6), 541-550.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.

Luft, J., Fletcher, S. & Fortney, B. (2005). Early recruitment of science teachers: Promising or problematic strategy. *Science Educator*, *14*(1), 41–48.

Marder, M., Brown, R. C., & Plisch, M. (2018). Recruiting teachers in high-needs STEM fields. American Physical Society Panel on Public Affairs. https://www.aps.org/policy/reports/popa-reports/upload/POPASTEMReport.pdf

Maxwell, J. A., & Miller, B. A. (2008). Categorizing and connecting strategies in qualitative data analysis. In P. Leavy, & S. Hesse-Biber (Eds.), Handbook of emergent methods (1st ed., pp. 461–477). Guilford Press.

McCadden, B. & Rose, M. (2008). A system-wide approach to culturally responsive teacher preparation: The value of intensive early program field experiences. *Journal of the Association of Independent Liberal Arts Colleges of Teacher Education, 5*, 13–28.

Merriam, S. B. (2009). *Qualitative research: A guide to design and interpretation*. Jossey-Bass.

Miller, P. C., & Endo, H. (2005). Journey to becoming a teacher: The experiences of students of color. *Multicultural Education*, *13*(1), Article 2.

Monk, D. H. (2007). Recruiting and Retaining High-Quality Teachers in Rural Areas. *The Future of Children, 17*(1), 155–174.

Murphy, P., DeArmond, M., & Guin, K. (2003). A national crisis or localized problems? Getting perspective on the scope and scale of the teacher shortage. *Education Policy Analysis Archives, 11*(23). https://doi.org/10.14507/epaa.v11n23.2003

Nayir, F. (2017). The relationship between student motivation and class engagement levels. *Eurasian Journal of Educational Research*, *17*(71), 59-78.

Niche. (2020, February 7). Stephen F. Austin State University. Niche.com.

https://www.niche.com/colleges/stephen-f-austin-state-university/

Perryman, J., & Calvert, G. (2020). What motivates people to teach, and why do they leave? Accountability, performativity and teacher retention. *British Journal of Educational Studies*, *68*(1), 3-23.

Piro, J. S., Anderson, G., & Fredrickson, R. (2015). Quality and early field experiences: Partnering with junior achievement. *The Teacher Educator*, *50*(1), 31–46.

Roth-Sitko, T. L., Everett, I. T., Mernella, M. H., & D'Angelo, F. D. (2015). Preservice teachers' changing perceptions of diversity following an intensive urban teaching practicum. *Teacher Education and Practice, 28*(4), 581–582.

Schaffer, C. L. (2012). Urban immersion: Working to dispel the myths of urban schools and preparing teachers to work with diverse and economically disadvantaged students. *The Delta Kappa Gamma Bulletin, 78*(2), 42–49.

Strauss, V. (2017, August 28). Teacher shortages affecting every state as 2017-2018 school year begins. The Washington Post. https://www.washingtonpost.com/news/answer-sheet/wp/2017/08/28/teacher-shortages-affecting-every-state-as-2017-18-school-year-begins/?utm_term=.2a4cd2374de7

Taie, S., & Goldring, R. (2017). *Characteristics of public elementary and secondary school teachers in the United States: Results from the 2015-16 national teacher and principal survey. First Look*. National Center for Education Statistics & U.S. Department of Education. https://nces.ed.gov/pubs2017/2017070.pdf

Texas Center for Educational Research [TCER]. (2000). *The Cost of Teacher Turnover*. Austin, TX: Texas State Board for Educator Certification.

Texas Education Agency. (2018). Employed teacher attrition and new hires 2010-2017. https://tea.texas.gov/sites/default/files/Employed%20Teacher%20Attrition%20and%20New%20Hires%202010-2017_corrected%20accessible.pdf

Viadero, D. (2018, January 24). Teacher recruitment and retention: It's complicated. Education Week. https://www.edweek.org/ew/articles/2018/01/24/teaching-shortages-many-answers-for-a-complex.html

Worsham, H. M., Friedrichsen, P., Soucie, M., Barnett, E. & Akiba, M. (2017). Recruiting science majors into secondary science teaching: Paid internships in informal science settings. *Journal of Science Teacher Education, 25*(1), 53–77.

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