INVESTIGATING HOW AN INFORMAL PROGRAM SUSTAINS TEACHERS IN THEIR PROFESSION

by

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ABSTRACT

Teacher turnover is a significant problem in the United States. Research has examined how to retain teachers through teacher induction and continuing education programs, mentoring, and building a supportive community and environment. However, despite efforts by educators, administration, and universities, turnover rates remain high. Although there is a large body of research on how traditional professional development (PD) provides support to teachers, there is a lack of research on how informal summer programs, such as summer math camps, accomplish this. This study examines the experiences of five teachers in a summer math camp that included a teaching component and an associated PD program, called JSMC. A phenomenological approach is taken to understand the experiences of the teachers, how the setting contributes to their experiences, and how these experiences help to sustain the teachers in their profession. In this study, I found that the teachers learned both about mathematics and also about teaching while participating in JSMC. They formed mentoring relationships with the professors running JSMC, collaborated with other teachers and formed lasting friendships. They adopted teaching strategies and honed their teaching during camp. Most importantly, they were inspired to stay in their profession because of the supportive environment. The various experiences had by the teachers contributed to sustaining them in the profession.

I. INTRODUCTION

There is a critical shortage of science, technology, engineering, and math (STEM) teachers in the US. Mathematics and science classrooms are the most difficult to staff fields. The production of teachers for these subjects is insufficient. These shortages are magnified by increasing student enrollment and teacher retirement. Schools with higher percentages of minority and low income students experience the most shortages, and this contributes to inequalities in education for students in these areas (Ingersoll & Perda, 2010). The U.S. Department of Education maintains a database documenting the shortage of teachers in each area organized by state and specialization, which confirms that there are shortages of teachers across all specializations and states, including math for the 2017-18 school year (Cross, 2016).

Eamonn O' Donovan, an assistant superintendent and former principal, discussed teacher shortages in California, which illustrates the national problem. In California, student enrollment in schools is expected to grow by more than 230,000 by 2018-2019, which will increase the demand for new teachers. Despite this, nearly 50% of undergraduates who obtain a teaching degree do not go into the teaching profession immediately after graduation (O'Donovan, 2011). As a specific example, in California in 2007-2008, nearly one third of the approximately 3800 algebra teachers in the state were underprepared or held a full certification in a different subject area (Guha, Shields, Tiffany-Morales, Bland, & Campbell, 2008).

Teacher Retention

Research suggests that the revolving door phenomenon of teachers leaving the profession is the main reason for the teacher shortage, with teacher retirement and the growing number of students as contributing factors. Between 40% and 50% of teachers leave the profession within the first five years of teaching (Ingersoll & Smith, 2003). Some individual schools have a teacher turnover rate up to 50 percent for teachers in their first year of teaching (Whitener, Gruber, Lynch, Tingos, & Fondelier, 1997).

Many schools experience problems staffing qualified math and science teachers, and one of the most striking source of this staffing problem is preretirement teacher turnover (Ingersoll, 2003). Teacher turnover includes teachers leaving the profession altogether or migrating to other schools, and is a significant problem in the public school system (Grissmer & Kirby, 1987; Macdonald, 1999). Gujarati (2012) described the problem of teacher retention as a national crisis. Sutcher, Darling-Hammond, & Carver-Thomas (2016) report that by 2020, approximately 300,000 new teachers will be needed each year, and this will increase to 316,000 by 2020. They predict teacher shortages as high as 112,000 nationwide by 2018.

Reasons Why Teachers Leave

There are many factors that affect teachers' willingness and desire to stay in the teaching profession. After controlling for the characteristics of teachers and schools, researchers have found that inadequate support from the school administration and discipline problems are related to the problem of teacher turnover. Although low pay is

one cause, it is not as significant of a factor for teacher turnover (Phillips, 2015). Other factors include poor-hiring practices, a lack of decision-making power among teachers, and difficult working conditions (Chapman & Green, 1986; Johnson, Kardos, Kauffman, Liu, & Donaldson, 2004).

Tickle, Chang, and Kim (2011) wanted to understand teacher working conditions, and how administrative support affects teachers job satisfaction and desire to stay in the profession. They conducted a path analysis to investigate the relationship between teachers' intent to stay in teaching, their job satisfaction, administrative support, teaching experience, student behavior, and pay scale satisfaction. Administrative support was the single most important predictor of teachers' job satisfaction, and in turn, job satisfaction was the single most important predictor of teachers' desire to stay in the profession of teaching. Moreover, administrative support mediates the effect of teaching experiences, student behavior, and pay scale satisfaction.

Liz Riggs (2013) outlines current and former teachers' perspective on the problem of teacher turnover. Lack of respect, stress levels, work-life balances, high standards, overworking, low pay, emotional exhaustion, and issues with administration were all cited among other complaints. Teachers who have even a small support structure, such as a mentor relationship or regular communication with a supportive administrator, are more likely to stay in the profession. The stress and challenges of dealing with issues that plague new teachers frequently lead teachers to leave their professions (Gold, 1996).

The Impact of Teacher Turnover

Impacts of teacher turnover on society include the quality of education that students receive, pressures on school districts, and an economic impact. This is particularly the case in STEM, where teachers are critical for student success. As Hutchison points out, low math and science ability in students can be attributed to "reduced number of initially certified STEM teachers, the inability to retain certified STEM teachers, and the lack of systematic professional development" (Hutchison, 2012). When teachers leave, students' education, professional development, and instructional programs are disrupted (Johnson, et al., 2004).

Teacher turnover creates a challenge for school districts to keep classrooms staffed with highly qualified teachers and recruit new teachers to fill vacancies (Ingersoll, 2003). Additionally, there is a loss of productivity associated with a teacher leaving (Watlington, Shockley, Guglielmino, & Felsher, 2010). Teacher turnover models have been used to predict the cost to the district-and therefore, the taxpayer -of a teacher quitting. These estimates range from at least 20 percent to up to 200 percent of the leaving teachers' salary (Texas Center for Educational Research, 2000; Norton, 1999). Other researchers report that the cost is anywhere from $11,120 to $70,000 per teacher (Afolabi, Nweke, Eads, & Stephens, 2007; Barnes, Crowe, & Schaeffer, 2008). When the cost of the 220,700 teachers leaving the profession or moving to other schools is calculated, the yearly cost is $4,867,879,421 (Kersaint, 2005). Included in these costs are sick leave, vacation, interviewing prospective teachers, and transfer or exit paperwork. (Watlington, et al., 2010).

Problem Statement

There is a significant problem of teachers quitting, especially in high stakes subjects like math, as documented by the organizations and researchers previously mentioned. This is a significant problem for our student's education and for society as a whole. However, keeping a teacher from quitting is only the tip of the iceberg. There needs to be a strong emphasis on sustaining highly qualified teachers in their profession. The term "sustaining" in this context means creating an environment where teachers are part of a collegial community of professionals, and are able to experience rich opportunities for growth in pedagogical knowledge, content knowledge, and knowledge about students' thinking. Teachers need freedom to explore new ideas, learn from colleagues, make mistakes, and become deeply invested in their profession and content area. They need to be supported and challenged by colleagues and administration. They need relevant, well-designed PD opportunities that use their limited time wisely.

There are communities of practice that create rich learning opportunities for students and teachers and in the second chapter we will review the research on these types of communities and how they impact teachers. The myriad of programs available for teachers, and the research on the impact of these programs on sustaining teachers in their professions, will be discussed in detail in the second chapter.

This study investigated a particular type of program, namely an informal summer math camp, and also studied how teachers' participation in this community created opportunities for the teachers and sustained teachers in their profession. There is a need to

better understand how this type of PD can contribute to sustaining teachers in some or all of the ways described above. This program was examined in terms of the concept of a community of practice, a concept that will be explored in detail in the next chapter. Specifically, there is a gap in the literature in understanding how informal summer programs such as math camps can influence factors that affect teachers' long-term interest in teaching and being sustained in their profession.

Purpose of the Study and Research Questions

The purpose of the study was to provide rich descriptions of the experiences of teachers who have taught in the Mathworld Junior Summer Math Camp (referred to as JSMC henceforth) for a minimum of three years. The descriptions were aimed at understanding how the experience of teaching at JSMC sustains and contributes to the teachers in their profession within the context of the community of practice created in this environment.

This study captures the experiences of the teachers over time as they taught in JSMC for many years. It provides insight into the sustained impact of JSMC as the teachers advanced in their careers and informs how summer programs can sustain teachers in their profession. Using individual teacher accounts about their camp teaching and PD from the teachers as data, this study attempts to capture what is important about the experiences in the summer camp from the teachers' perspectives.

The primary audience for the findings of this research are math teacher educators, policy makers involved in teacher education and math education research and other

education researchers.

The study addresses the following research questions:

1) What are the experiences of the teachers in camp?

2) What elements of the setting contribute to the teachers having those experiences?

3) In what ways do the teachers interpret these experiences as beneficial towards sustaining their career?

The research questions addressed in this study are examined using a phenomenological methodology as described in the third chapter. The questions are answered based on data obtained from an initial survey, interviews conducted with the teachers, and classroom observations. This study is informed by my own experiences with camp, which include teaching and attending the PD sessions in previous summers.

From collecting these descriptions of the teachers' experiences, I was able to dig deeply into understanding how JSMC provides teachers with these valuable experiences, how these experiences contribute to the teachers' long-term career trajectory, how the community of practice is created, and how the teachers are sustained in their field.

Significance of the Study

This study adds to the body of literature on how informal programs, such as summer math camps, sustain teachers in their profession. It adds to the literature on how communities of practice are created and how the dynamics of this type of environment impacts teachers. It contributes to knowledge of the development of PD programs that

support the learning of teachers. It informs knowledge on what factors motivate teachers and what drives them to remain in the teaching profession.

As Feiman-Nemser (2001) advocates, there must be an emphasis on teacher education at every career stage. School and university partnerships exist to help teachers navigate teaching in reform-minded ways, but this work needs to be extended through the induction years. This study adds to the literature by examining the ways one particular program is doing this.

This research can inform policy decisions related to supporting teacher education at all career stages. It can inform teacher educators wanting to create rich, relevant mathematical and pedagogical learning experiences for teachers and develop opportunities for collaboration between teachers. It explores the connection between university teacher education programs and the teachers themselves.

Summary

There is a strong need to retain high quality math teachers, and an equally significant problem of teacher turnover in the United States. There is a need to emphasize the importance of teacher education at every stage of a teacher's career, and provide strong support for teachers. Teachers need opportunities to study and discuss curriculum, mathematical content, and pedagogical practices. They need a community that provides collaboration with other teachers, mentoring, and social engagement. Within the body of research on the types of support provided for teachers, there is a lack of research on how informal PD opportunities, such as summer math camps, sustain teachers in their

profession. There is a need to understand what this looks like, how it occurs, and what characteristics of such a program can be of value for sustaining teachers in the teaching profession. This study provides an opportunity to examine this phenomenon from the perspective of the teachers.

II. LITERATURE REVIEW

This chapter discusses literature pertinent to three areas: teacher education research, communities of practice, and professional development (PD). Teacher education research informs understanding teachers, what teachers learn, and how they learn in PD settings. This includes who runs the settings, what content is delivered, how teachers engage with the content, and what types of collaboration occur in PD settings. The concept of a community of practice provides a framework to understand the development of the PD community at JSMC. Research on PD programs allowed JSMC to be compared to other programs.

Highly Qualified Teachers

The No Child Left Behind (NCLB) act stipulated that all students should be taught by *highly qualified* teachers (Dash, Magidin de Kramer, O'Dwyer, Masters, & Russell, 2012; Fulton, Yoon, & Lee, 2005). Smith, Desimone, & Ueno (2005) discuss how NCLB considers highly qualified to mean having full certification, a bachelor's degree, and a grasp of all content knowledge that will be taught. Highly qualified teachers are crucial to students' academic success (Darling-Hammond & Berry, 2006; Geringer, 2003; Lasley, Siedentop, & Yinger, 2006).

The math education community has made progress in documenting and describing what is meant by high quality math instruction (Munter, 2014). Math education reform efforts have focused on concepts rather than procedures, as well as the application and value of math concepts in everyday life (Smith, et al., 2005). Cohen and Ball (1990) emphasize reform that are intended to deepen the understanding of math, improve

reasoning ability, and embrace a greater appreciation of math. As a component of the interview process for this study, I considered whether the teaching environment provided by JSMC affords opportunities for teachers to engage in some of the reform-minded teaching practices described herein.

The National Commission on Teaching and America's future (1996) stresses the importance of teacher knowledge on students' education. Policies, curriculum reform, and new assessments help schools only if teachers and staff have the knowledge, support, and skills required to use them effectively. According to Feiman-Nemser, "if we want schools to produce more powerful learning on the part of students, we have to offer more powerful learning opportunities to teachers" (Feiman-Nemser, 2001, p. 1013-1014).

One way that teacher education reform is being enacted is the conceptualization of the teacher as the designer of the curriculum rather than the textbook. The curriculum materials and textbooks are an important part of the process of teaching, but the teachers themselves, as they engage in curriculum enactment, are the main source of curriculum design, not the materials (Ball & Cohen, 1996).

Feiman-Nemser (2001) proposes that teacher education should take a central role in the school system. This requires rethinking how teacher preparation, induction, and continuing PD programs are conducted. Teachers need relevant learning opportunities at every stage of their career, otherwise their teaching will not be up to current standards for student learning (Ball & Cohen, 1999). Teacher educators often cram too much material into their pre-service teacher (PST) education courses, believing this is the last

opportunity they have to impact students (Feiman-Nemser, 2001). The vast number of learning opportunities which could come from experiences such as child study, classroom inquiry, co-planning, and co-teaching are not emphasized (Feiman-Nemser, 2001). Although some school and university partnerships provide opportunities for PSTs to learn reform minded practices, there is a need to have "a continuum of serious and sustained professional learning opportunities for teachers" (Feiman-Nemser, 2001, p. 1049).

The Teacher Education and Learning to Teach Study conducted by the National Center for Research on Teacher Learning (1991), examined teacher learning in diverse teacher education programs. Seven hundred teachers and teacher candidates involved in 11 different teacher education programs participated in the study. Researchers found that the structure of teacher education programs was less important than the content, and that differences in knowledge and beliefs at the end of the program were due to beliefs they brought with them (as well as the content of the programs) rather than to differences in the program structures.

The Journal of STEM Education published an article discussing the state of affairs regarding teacher shortages and the lack of highly qualified teachers in Texas. The researchers conducted a needs assessment designed to support decision-making in the preparation of highly qualified teachers for positions in high-needs school districts in south Texas. Two sets of surveys were conducted, which revealed that many freshman and sophomore STEM students are interested in becoming teachers, and would be willing to teach in high-need school districts. Students found funding for STEM education was

insufficient, K-8 STEM Education was inadequate, and PD for STEM teachers was insufficient (Yang, 2015).

Teacher Preparation

Many teachers are thrust into the classroom with little or no discussion about teaching, and find out what classes they will teach as late as the day before school starts. Teachers report learning general information unrelated to specific teaching experiences, such as about health care benefits. Only a small number of teachers reported engaging in discussions about school expectations, issues, and curriculum (Johnson & Kardos, 2002).

Teacher preparatory programs or PST programs usually occur during the certification process, either in a traditional university or alternative setting, but may continue to support teachers into their first or second year of teaching. These programs can address content, pedagogy, and other issues related to teaching before the teacher enters the classroom.

Ball and McDiarmid (1989) intended to motivate research in the area of subject matter preparation of teachers. Prior research focused more on issues such as teachers' beliefs, teaching strategies, knowledge of students, curriculum, etc. They consider learning that can occur during teaching, spurred by a question from a student or a classroom discussion. Three dimensions of learning occur in studying subject matter, substantive knowledge, knowledge about a subject, and dispositions.

In math, substantive knowledge refers to concepts themselves, along with definitions, conventions specific to the field, and procedures, whereas knowledge about a

subject means understanding differing perspectives, disagreements in the field, how claims are justified or refuted, and the nature of discourse in the field. Dispositions refer to likes and dislikes for certain topics or activities, beliefs about mathematical ability (such as being good at math), and propensities towards certain paths of inquiry (Ball & McDiarmid, 1989).

Ball & McDiarmid (1989) were interested in the fact that the knowledge teachers rely on, especially early in their career, comes from their own high school experiences. Teachers spend a much longer time in K-12 schooling than college, and may have learned topics that they are then called on to teach in a procedural manner without conceptual clarity. They may not have encountered K-12 math content (such as slope) during their college years.

A study conducted by the National Center for Research on Teacher Education involved 252 prospective elementary and secondary math teachers (PSTs). The PSTs completed questionnaires and were interviewed. The focus of the study was on concepts such as place value, slope, multiplication and division, and perimeter and area. The researchers found that elementary and secondary teachers were unable to make conceptual sense of math, which suggests the importance of including well-designed courses focused on mathematical conceptual understanding in teacher preparatory programs. Furthermore, many PSTs believe that teaching is to pass on knowledge and learning is to memorize (Ball & McDiarmid, 1989; Calderhead & Robson, 1991; Feiman-Nemser, 2001).

PST programs can be effective if they address common issues that PSTs face, such as integrating courses and fieldwork, attention to students entering beliefs, and evolving identity in the practice and the field (Feiman-Nemser, 2001; Barnes, 1987; Howey & Zimpher, 1989; National Center for Research on Teacher Learning, 1991). However, some research suggests that the influence of PST education is limited in comparison to precollege learning. This can be explained by the powerful effects of school culture on new teachers, as well as precollege schooling (Ball & McDiarmid, 1989; Hoy & Rees, 1977; Zeichner & Tabachnik, 1981).

The Conference Board of the Mathematical Sciences (2001), an umbrella organization composed of seventeen different professional societies has aims related to diffusion of knowledge in the mathematical sciences. The Board emphasized that teachers must have more than a students' level knowledge of mathematical concepts. Comprehensive and sustained PD programs focusing on math for in-service teachers, and more in-depth study of math and math specific to PSTs should be implemented. College math majors learn about math needed for graduate school or business careers rather than teaching specific math.

Induction Programs

Induction programs are generally provided during the first few years in teaching, and may overlap or be combined with teacher preparatory programs. They are aimed at helping teachers navigate the organizational, pedagogical, and other issues that they encounter in the teaching profession. They attempt to address low morale, teacher attrition, and limited teacher expertise (Cohen, 2005). They involve components such as

meeting regularly with a mentor teacher, workshops, courses, PD, assessments of teaching, and feedback on teaching from administrators, mentors, and others. Programs may try to maintain teacher quality by linking summative assessments and state certification standards to induction programs (Villani, 2002). The purpose of reviewing literature on induction programs in this study was to better understand the experiences of novice teachers, and how these shape their experiences. This background may inform the interpretation of teachers' experiences in the JSMC PD.

These induction programs became widespread after the 1980s amidst efforts to professionalize teaching and rising concerns about the challenges new teachers face. Goals of these programs included developing and sustaining good teaching and improving teacher quality.

Teachers are attracted to the teaching profession for strong personal reasons, but often find the reality of their experiences to be misaligned with their expectations (Lortie, 1975). New teachers often hold strong beliefs about teaching and an idyllic view of teaching and induction programs can bridge the transition between these beliefs and reality. There is limited understanding of the effectiveness of these programs, as it is difficult to ascertain if the impact is due to other factors (Feiman-Nemser, Schwille, Carver, & Yusko, 1998).

Teaching requires being a performer and developing a public personality (Featherstone, 1993). Content must be considered along with delivery, including transitions and pacing. Induction programs can ease teachers into teaching by mentoring

and supporting them as they learn what is expected of them. New and prospective teachers should have opportunities to observe good teaching, form a vision of what good teaching means, and critically examine their own beliefs. Doing this requires viewing learning as an integral part of teaching, and developing habits of observation, interpretation, and analysis (Feiman-Nemser, 2001).

Beginning teachers worry about their ability to do monitor student learning within the complex classroom environment (Sadler, 2006) and induction programs can provide teachers opportunities to hone these skills.

In American schools, teachers have little opportunity to engage in deliberate practice which, as defined by Ericsson, Krampe, & Tesch-Römer (1993), involves:

a) well-defined tasks at appropriate levels of difficulty,

b) informed feedback and

c) opportunities for repetition and error.

One effective way for teachers to develop and study their own teaching practice is Japanese Lesson Study (Isoda, 2007). Teachers, with numerous pressures and a fast-paced school environment where they only reteach a lesson the following year, often do not have many opportunities to engage in deliberate practice. Teachers who do engage in deliberate practice (by frequent engagement in planning and assessment) become the best teachers (Dunn & Shriner, 1999).

Colbert and Wolff (1992) have found that in order to retain teachers, districts must

place a strong emphasis on reducing feelings of isolation new teachers experience by supporting collaboration between teachers.

The short-term mentoring and support many districts offer new teachers may be primarily emotional support, and may not address the learning needs of new teachers. If the first few years of teaching are viewed as a learning phase, then the culture can evolve to support teacher learning. New teachers face many struggles: late hiring, quick classroom preparation, deciding what to teach and how to teach it, consideration of assessments, administrative expectations, classroom management, and diverse students' needs (Feiman-Nemser, 2003). When things go wrong, teachers are blamed by parents, their administration, and society, and this adds to the challenges they face (Watkins, 2013). Retention of new teachers depends on effective mentoring and support during this critical time. (Feiman-Nemser, 2003). Therefore, the quality of induction programs can be measured by the mentoring opportunities they provide. Teachers desire and need opportunities to learn how to implement curriculum, address students' needs, and how to teach their subject from experienced colleagues (Johnson & Kardos, 2002). These colleagues have an influential role in the experience the new teacher has (Feiman-Nemser, 2003).

Many mentors view their primary role as providing emotional assistance or help understanding policies, and view their role as complete when the novice teacher expresses confidence. Continued support will allow for sustained mentoring relationships (Feiman-Nemser & Parker, 1993).

Communities of Practice

The notion of a community of practice was first introduced by Lave & Wenger (1991), and has since taken on multiple nuances and meanings. For the purpose of this study, a community of practice is defined as a collaborative environment that supports the exchange of knowledge and sharing of ideas (Hara, 2009). Members of a community interpret, respond, and react to their environment. They engage in informal learning (Johnson, 2001). Members are connected by shared experiences and a professional identity (Wenger, 1998). The sharing of knowledge and ideas within a community involves cooperation and complicated decision-making. Individuals participate in the community and contribute to the collective body of knowledge. Communities of practice emerge from the shared experiences of a profession; they are not created as such, but can be nurtured and cultivated (Lave & Wenger, 1991; Wenger, 1998; Wenger, McDermott, & Snyder, 2002).

Fullan (1991) found that school-based communities of practice develop norms supporting collegiality and active collaboration. They are resilient and maintain their ability to change and adapt over time. They encourage review and evaluation by members of the community.

Feiman-Nemser (2001) discusses the importance of communities of practice in the context of teachers' education. Teachers are often isolated in their classroom. Meaningful conversations with colleagues about pedagogy, content, and new ways of teaching can mediate this isolation and support the building of a community. Collaboration with other

teachers affords the opportunity for inquiry into teaching practices and feedback from colleagues.

Cuddapah and Clayton (2011) used a community of practice framework to study how a PD cohort can support new teachers (many with alternative certification) in difficult teaching assignments. They contributed to the conversation around focusing policy on teacher education based in practice, rather than recruitment and retention. The concept of *legitimate peripheral participation* (Lave & Wenger, 1991) refers to how new members of a community enter and learn from the community, become a part of it, and begin to contribute to the community over time. The researchers examined data from observations of a cohort involving 12 teachers (10 female and 2 male) across 16 two-hour sessions. They were interested in what Wenger's (1998) theory explains about how cohort structures support new teachers. They found that new teachers discuss practice frequently, sharing their challenges and successes. Teachers further engaged in making meaning of their experiences, expressed frustration, discussed classroom management, and discussed their identity as a teacher. The community was central to the teachers discussions of each topic, and became a safe place to engage in discourse. The interactions between practice, community, identity, and meaning provided a rich set of resources and mentoring opportunities for the teachers. The teachers experiences pushed the boundaries of legitimate peripheral participation and allowed teachers to become full participants in the PD community of practice, complementing the other induction activities in which they were involved in (Cuddapah & Clayton, 2011).

McLaughlin (1993) conducted a study involving fieldwork and surveys in 16 public and private secondary schools. The study focused on how workplace features influence teaching practices and highlighted the importance of building a community of practice for teachers. He found that the character of a teacher's collegial environment impacted teaching practices. Beyond supportive relationships among teachers, the community established norms for learning and innovation, reflection, feedback, and problem solving. Teachers who were isolated in schools with strong norms of privacy experienced frustration, and that the nature of the professional community in which the teachers work is the most critical factor in teaching and learning for both teachers and students.

Nurturing a Community

Wenger et al. (2002, p. 51) describes seven characteristics that are involved in nurturing a community of practice:

1. Design for evolution.
2. Open a dialogue between inside and outside perspectives.
3. Invite different levels of participation.
4. Develop both public and private community spaces.
5. Focus on value.
6. Combine familiarity and excitement.
7. Create a rhythm for the community.

These are facets of a community that can be cultivated. In my examination of the characteristics of JSMC, I focused on how teachers are sustained through interacting with the community and how the experiences they have relate to the elements of the

community as described by Wenger.

Plaskoff (2005) has discussed ways that communities of practice can be fostered. Members of the community should believe in the value of the community, behave in ways that adhere to the norms of the community, and have a sense of belonging.

Professional Development

Researchers have examined the role PD plays in impacting teachers and how this impact translates to students. Mahmoudia and Özkana (2015) found that PD can provide an environment where both novice and veteran teachers benefit. Teacher benefit from activities such as engaging in dialogue with colleagues about teaching, mentoring, reading articles, and attending courses and workshops.

Opportunities in Schools

The Wenglisky Report, published in 2000, discusses the positive effects of PD on teachers, citing improvements on math assessments by students of teachers who received PD that focused on working with special populations (Dash, et al., 2012).

PD programs take on many forms. Some programs of importance include lesson study, study groups, math circles, and informal summer programs such as summer math camps. The goals of PD designers are diverse and include addressing classroom management, ways of grouping students, and employing research based practices in the classroom. Here I highlight a few professional development programs that have aspects similar to the program under study.

White, Donaldson, Hodge, and Ruff (2013) investigated how a particular PD, Math

Teachers' Circle (MTC), contributed to teachers' performance on the Mathematical Knowledge for Teaching Assessment (Ball, Thames, & Phelps, 2008). MTC is a PD model developed at the American Institute of Mathematics for middle-grade teachers. MTC is focused on thinking deeply, exploring problems in-depth, and improving problem-solving skills. The program usually begins with an intensive summer workshop, then meets once a month during subsequent years. These programs are sustained over many years and are led by mathematicians and teachers. The original program has been scaled up and there are now approximately 53 of these programs across the country. White et al. used the LMT instrument (Hill, Schilling, & Ball, 2004) to to understand how participation in the summer workshop portion of an MTC increased teachers' math knowledge for teaching. They found that during the workshop, teachers' scores on the Number Concepts and Operations portion of the LMT instrument increased significantly and hypothesized that teachers did not gain new content knowledge, but deepened their existing knowledge.

Sustained or Short Workshops

One notable summer program for teachers is the Park City Math Institute. In this program, a "cross-pollination" of minds occurs as undergraduate and graduate students, mathematicians (including fields medalists), teachers, and artists gather to discuss math. The participants come from all over the world. In this three-week program held in Park City, Utah, participants attend classes, workshops, and collaborate around a specified theme which changes yearly. There are several threads, such as the undergraduate faculty program, which is geared toward mathematicians with an interest

in undergraduate education. Teaching is a recurring thread throughout the programming; for example, in 2008, lectures on algebraic geometry were followed by discussions on how to teach this subject (Bernoff, 2008). Mary Pilgrim used the problems from Park City Math Institute to conduct a problem-based learning (PBL) course for secondary mathematics preservice teachers (PSTs). The goal of this was to give PSTs experience with PBL so that they would then be able to use PBL in their classrooms. Comments and journal reflections from students were collected, and the results revealed that as the PSTs' perceptions shifted, and they began making connections among previous content and learning from their peers. They moved away from simply wanting the answer (Pilgrim, 2014).

Study Groups

Crespo (2006) describes the types of conversations that occur in math study groups, a fairly common type of PD that teachers engage in where they work on mathematical understanding and look for ways to improve their students mathematical understanding. Crespo describes two types of conversations, one centered on teachers own mathematical work (exploratory) and one focused on the student's work (expository). In these sessions, which meet at regular intervals during the school year, teachers discuss readings, engage in problem solving, analyze student work, and observe teaching (Crespo, 2006). Although this kind of dialogue between teachers about pedagogy, content, student thinking, etc. is healthy, it is not often the norm in American schools. There is a culture of isolation that is prevalent (Crespo, 2006).

Most of the studies involving study groups relate to students and student objectives,

and less research has been done on how teachers create learn themselves. When teachers from diverse communities come together to share in the exchange of knowledge and ideas in discourse communities, rich conversations about new insights into teaching and learning can be had (Putnam & Borko, 2000).

III. METHODOLOGY

In this study, I focus on teachers' experiences in a junior summer math camp (JSMC) that included both a teaching component and a professional development (PD) component. The purpose of this study is to describe the experiences of teachers in this PD environment, how the environment affords these experiences, and how participation in this program sustains teachers in their profession. In previous sections, I have discussed the holistic conjectures and questions that guided this study.

Through the data analysis, I intend to create a depiction of the essence of the experiences of the teachers in JSMC. The problem of teacher retention frames this study which is intended to improve knowledge of how PD environments function for teachers. Discussing the data serves the purpose of documenting teacher learning experiences and how the setting contributed to these experiences.

There is significant research on how to design effective PD for teachers, but there is a lack of research on what benefits teachers gain from this particular type of PD (embedded in an informal summer program). Research is needed to understand the experiences that teachers have in these types of settings, and how these experiences can influence teaching practices and feelings and attitudes toward the profession. The community of practice environment which is created within this informal program provides an ideal setting to examine this phenomenon.

As noted in previous sections, the research questions addressed in this study are:

1) What were the experiences of the teachers in JSMC?

2) What elements of the setting contributed to the teachers having those experiences?

3) In what ways did the teachers interpret these experiences as beneficial towards sustaining their career?

Teacher educators and program coordinators may find this research useful in designing PD programs and examining factors that contribute to sustaining teachers and reducing teacher turnover. In the following sections, I discuss the setting and phenomenological approach taken in this study.

Rationale for a Phenomenological Approach

A phenomenological methodology is appropriate for understanding the experiences of the teachers, and how the shared setting affords these experiences. Here we explore some of the ways phenomenology has been used, and the particular approach I will take in this study.

Phenomenology has been described by Creswell (1998) in the following way:

> Researchers search for essentials, invariant structure (or essence) or the central underlying meaning of the experiences and emphasize the intentionality of consciousness where experiences contain both the outward appearance and inward consciousness based on memory, image, and meaning (p. 52).

Patton describes a phenomenological study as one focused on "descriptions of what people experience and how it is that they experience what they experience" (p. 71).

Interviewing is an appropriate method of data collection in a phenomenological study, and the purpose of interviewing is to understand what is on someone's mind (Patton, 1990).

Phenomenology is a method used to understand and articulate the existence of a phenomenon, exactly how it is experienced, in terms of the meaning that it gives to those who experience it (Giorgi, 1997). Giorgi uses empirical phenomenology, which allows the researcher to obtain a comprehensive description of the experience (Giorgi, 1997). Van Manen (2016) uses a version of phenomenology known as hermeneutical phenomenology, which uses texts to examine a phenomenon. Sokolowski (2008) examines the experiences associated with the phenomenon.

The common thread that ties together the different conceptualizations about phenomenology is an attempt to investigate the essence of an experience or set of experiences amongst a group of people who have collectively participated, firsthand, in the experience. The researcher collects the descriptions of the experiences of the participants, and documents their feelings, insights, and interpretations of the experience based on their reflections.

Phenomenology is an ideal approach for this study, which is based on the premise that there is an essential reality with common features among the participants in JSMC, and these can be described by interacting with the participants during interviews conducted in the context of the phenomenon, at JSMC. From this, we produce a thematic description of the essences and structure of the lived experiences. I attempt to understand

the JSMC program from the perspective of the teachers. The aim is to understand how the community of practice operates and how it sustains teachers in their profession. I investigated how this community contributed to the teachers' experiences, their decision to stay in the teaching profession, their views and satisfaction with teaching, opportunities for growth in content knowledge and pedagogy, and mentoring experiences. I also identify aspects of JSMC that are of importance and value to the teachers. This required having an in-depth understanding of JSMC, including the intention of the professors who founded the camp, the curriculum, the PD component, and the mentoring and collaborative relationships formed. To understand these, I conducted in-depth interviews with each participant, which served as my main data source. By understanding the teachers' experiences in JSMC, and the teaching practices that they adopted as a result of these experiences, the learning trajectories of the teachers became clear. This may inform the design of the program for future participants.

Setting

Mathworld is an organization at a university in central Texas that offers several types of programs for K-12 students, including a half-day junior summer math camp (JSMC), a residential junior summer math camp (RJSMC), and a summer honors math program for high school students (HSMC). The mission of Mathworld is to create programs that can serve as an educational model, to motivate students to cultivate a self-sustaining interest in doing math at a high level, and to be a center for innovation in math education.

The camp that provides the setting for this study is the Junior Summer Math Camp (JSMC). JSMC is a ten-day camp held over two weeks each summer at a high school in central Texas. JSMC accepts interested students in grades 3-8 until between 180 to 200 slots are filled, and is conducted in partnership with a local school district. JSMC requires an online application and costs $400 for students to attend, however most students receive a scholarship that covers this fee.

The daily schedule is:

8:00AM - 10:00AM Class

10:00AM - 10:30AM Break/Snack

10:30AM - 12:00PM Class

12:00PM - 12:30 PM Lunch

Each camp day includes approximately 3.5 hours of instructional time, allowing for logistics. JSMC is organized into five levels, as described in the following table.

Table 1. JSMC Levels and Topics

Level	Topics
Level One	Exploring integers on the number line
	Building number lines
	Modeling elevation, temperature, and time with number lines

	Modeling addition on the number line Modeling subtraction on the number line Adding and subtracting large numbers Modeling problems algebraically Variables and expressions The chip model Solving equations Solving equations on the number line Graphing on the coordinate plane
Level Two	Patterns, Graphs, and Tables Graphing on the Coordinate Plane Functions and Graphs Adding and Subtracting Integers (Review) Multiplication of Integers Functions Exploring Fractions Modeling Fractions Adding and Subtracting Fractions
Level Three	Area and Perimeter Relationships Comparing Measurements of Rectangles Comparing Measurements of Right Triangles Lines, Slopes, and Intercepts Relating coordinates of points Equations of lines Slopes and Intercepts Line Applications Multiplying Fractions and revisiting Slopes Patterns and Sequences Detecting and Describing Change Ratios and Proportions
Level Four	Counting Learning the basics of Set Theory Using different ways to describe a Set Finding the union, intersection, and complement of sets Drawing a Venn diagram to represent sets Finding the sample space of an experiment Rule of Product and Rule of Sum Using tree diagrams and tables to model problems Deriving the Rule of Product and Rule of Sum Permutations and Combinations Counting the number of outcomes of an experiment Defining a k-combination Comparing combinations to permutations Probability and Sampling Simple and Compound Events Mutually Exclusive Events Successive Events

Level Five	Logical Reasoning Questioning Techniques Strategies Divisibility Number Theory Primes and Numbers of Divisors Divisibility Congruence Greatest common divisor and least common multiple Algebra Sequences Summations Variable Manipulation Ratio and Rate Applications Counting Rule of Sum and Rule of Product Permutations and Combinations Probability Geometry Areas of Triangles and Quadrilaterals Right Triangles Scaling and Similarity

The teachers who are the focus of this study teach regularly in JSMC during the summers. Because JSMC offers a PD combined with teaching, this is an ideal setting to study how JSMC sustains regular classroom teachers in their profession.

Research Participants

The participants include five regular classroom teachers who also taught in JSMC. To answer my research questions, the best candidates for my study were teachers who had been teaching in JSMC for at least four years in addition to their school teaching. This supports the goal of investigating how Mathworld sustains teachers in the profession. From this standpoint, it was advantageous to choose teachers who have the possibility of having been sustained for some length of time. The second criteria that I used to select the teachers was that they were currently teaching in JSMC at the time of the data collection. This aided in the process of data collection because the teachers were accessible during the same two-week period. The fact that the teachers were in the same

location at the same time made it more likely that there were common threads among their experiences.

The population for this study includes current and former teachers, who are currently teaching at JSMC during the summers, or who have taught for JSMC for some number of summers. All of the teachers are currently teaching or are former teachers

Within the set of teachers that were currently teaching at JSMC, I recruited five teachers. I obtained consent from these five teachers to be interviewed during the two-week camp period, and to share artifacts including their reflective journal entries and camp evaluations with me.

The teachers who are the focus of this study teach regularly in the half-day junior summer math camp, and have done so for varying numbers of years. In JSMC, each teacher is assigned to teach one of five aforementioned levels of this multi-tiered camp to teach. The lessons for the two weeks follow the curriculum written by the JSMC professors, with teachers given the freedom to include their own activities as appropriate.

Teachers attend an afternoon PD coordinated by math education professors. These professors teach content courses for PSTs at a large university in the Southern United States. The PD courses involve discussing JSMC, reflecting on teaching and math, and are sometimes organized around a theme, such as noticing student thinking. Videos are incorporated to provide prompts for discussion or illustrate examples of teaching strategies, etc.

Here I will introduce the five teachers in this study, and describe their current

teaching position at their home school, as well as their years and levels of experience with the summer camp. All information is based upon their responses to my interview questions.

Mary taught elementary school for thirteen years and then seventh grade math for seven years, for a total of twenty years of teaching. She taught second, fourth, sixth, and seventh grades, and was in the process of transitioning to fourth grade. Attending JSMC the same year that she began teaching seventh grade math was helpful. She was excited about the fact that the fourth-grade students she would soon be teaching were at the same level as the students she taught in camp. In JSMC she taught levels one and two. In school, Mary's district was using the JSMC curriculum for their Pre-AP students. One year, the teachers who taught Pre-AP, including Mary, talked via Skype and with the JSMC professors once a week to discuss the curriculum and provide support for the teachers in their implementation of the curriculum

Pilar taught seventh grade algebra one. She had been teaching algebra one for seventeen years, in seventh, eighth, and ninth grade. She had also taught one semester of calculus and one semester of physics. She had been thrown into teaching as a student teacher when two teachers at her school left while she was still doing student teaching. She was asked to take over their courses, a calculus and a physics course. She began attending JSMC PD the year she began teaching. She was involved with JSMC for seventeen years, the same number of years that she had been teaching.

Allison is an eighth-grade math teacher. She had been teaching for fourteen years.

She had taught sixth, seventh, and eighth grade algebra and high school credit geometry and algebra one. She had been teaching at JSMC for twelve years, and one year as a trainee teacher. Allison, therefore, had taught for one year in school and then participated in camp every summer thereafter.

Edgar is a middle school math teacher. He had taught seventh-grade math for three years, and then one section of seventh grade and one section of eighth grade math for his fourth year. For his upcoming fifth year teaching, he was planning to go back to seventh grade and teach one resource class. He had been teaching for a total of four years. He attended JSMC for four years, the first year as an observer, and three years as a level two teacher.

Diane is an eighth grade math teacher. She had always intended to teach high school after obtaining her teaching degree and 8-12 certification, but ended up teaching middle school instead. She had taught sixth and seventh grade at a private school her first year teaching, and then 8th grade math, sixth grade math, prealgebra, algebra one, geometry, and algebra two in public school. She had taught for a total of eleven years. She taught at JSMC for three years, and as a trainee teacher for one year. She taught level four twice, and level two once.

This study was approved by Texas State University's Institutional Review Board, and the teachers were provided with a consent form explaining the purpose of the study, the option to voluntarily participate or decline, and the confidentiality of their identifying information. The teachers did not receive any compensation for participating in the study.

More details about the day-to-day operations, design, curriculum, and goals of the programs are described during the course of the study based on conversations with the JSMC professors and observations of JSMC.

Data Collection

The sources of data for understanding how JSMC sustains teachers in their profession came from an initial survey with potential participants. This survey informed the study by providing a general sense of the impressions of the teachers teaching at JSMC. A complete list of the initial survey questions used can be found in Appendix C.

The results of the initial survey suggested that JSMC has been a source of learning, inspiration, and a place to build strong and meaningful relationships for many of the teachers. In this initial survey, teachers reported that the experiences teaching in JSMC have had direct impact on their teaching careers. These initial results increased my desire to understand how this program impacts teachers and sustains them in their teaching careers. The results of the initial survey were useful in formulating the research and interview questions for this study.

Interviews

An in-depth interview with each participant was conducted, focusing on the experiences of the teachers that were meaningful, how these experiences impacted them, and sustained them in their professions (a complete list of the interview questions used in this study can be found in Appendix B). In a phenomenological study, it is important to obtain concrete descriptions of the phenomenon under study, in sufficient detail, free

from generalizations and abstractions (Giorgi, 1997). The interview questions are designed to allow the teachers to describe their experiences in detail and explain how these experiences were meaningful to them.

The interview with each teacher was conducted during the 2016 summer camp (June 6th through June 17th, 2016). The interviews were conducted at the JSMC site, in the teacher's classroom. Conducting the interview at JSMC allowed the participant and myself to be positioned in an environment which increased the likelihood of dialogical openness, where the participant speaks freely and feels inspired to relate what comes to mind in the immediate present (Parse, 2003; Paterson & Zderad, 1976). This location was convenient because the teachers did not need to commute to a separate site in order to participate in the interview. The environment was familiar and comfortable to the teachers, and devoid of the distractions of people coming in and out of the room. The interviews varied from about 25 minutes to one and a half hours in length. The interviews were conducted in a conversational style. The conversation was guided to address the phenomenon under study, how the experience of participating in JSMC sustained them in their profession. The interviews were semi-structured, guided by the questions in the interview protocol. Some of the interviews were divided into two parts, before and after lunch, or before and after a meeting, depending on the teacher's schedule. The interviews included discussions of my observations of their classrooms, the curriculum they were currently using, and any other issues or topics relevant to their experience that the participant wished to discuss.

The issues discussed during the interviews included challenges placed on teachers by their school administration, what they valued about the JSMC PD as compared to other programs, what they valued about teaching at JSMC, how it compared to regular classroom teaching, and other issues.

During the interviews, I was careful to acknowledge the social context of the setting, and ensure that the interviewee did not feel that they were being evaluated. After each day of interviews, I read the transcripts to begin to form an initial sense of the themes that were emerging. This allowed me to adjust the interview protocol for the next interview as needed.

I used two recording devices to record the audio from the interviews, an audio recorder and recording software on an iPhone, in case one device malfunctioned. After the interviews were complete, I transcribed them and shared them with my dissertation chair.

I listened to the recording of each interview multiple times. This allowed me to correct any errors that occurred in the transcriptions and begin to reflect on the interview data. During the interview, responsive interviewing techniques were used (Rubin & Rubin, 2012). In a responsive interview process, a relationship can be built with the participant. I allowed time in the beginning of the interview for casual conversation and to develop a rapport with the participant. Throughout the interview, I kept the style informal and allowed it to veer off topic occasionally, following the natural course of the conversation. I frequently asked for clarification and elaboration on the responses to the

interview questions, in order to ensure that the teachers words, thoughts, and feelings were being captured as accurately as possible.

Daily Reflections

I collected the daily reflections that the teachers completed for the first five days of camp. These were a structured opportunity for the teachers to reflect on their teaching provided by JSMC. The professors provided prompts to get the teachers thinking about what went on in JSMC, and the teachers answered the prompts in writing. For various reasons, not every teacher completed or turned in a daily reflection each day, so I was only able to collect a sample of these reflections, as noted below.

Day 1: Mary, Pilar, Allison, Diane, Edgar.

Day 2: Mary, Allison, Edgar.

Day 3: Allison, Diane.

Day 4: Pilar, Allison, Diane.

Day 5: Mary, Pilar, Allison, Diane, Edgar.

The first prompt was the same each day:

Write about two things that caught your eye or surprised you in today's camp class. Was it an interaction, comment, activity, etc.? Explain.

Why did that instance stand out to you?

Two different prompts were used for the second prompt. The second prompt was

the same on days 1 and 2, and again on days 3, 4, and 5.

Days 1 and 2. What kinds of communication did you observe? Please elaborate on one of the communication episodes (indicate if observed or you were a participant in the interaction).

Days 3, 4, and 5. What did you notice about the classroom culture? Please elaborate on a couple of the aspects.

Data Analysis

This study is particularly interested in the structure of the phenomena of the teachers' experiences in JSMC. The goal is to specify the process of the teachers' experience and learning within the JSMC, and provide information that may inform future iterations of JSMC and PD. I wish to understand what goes on in JSMC, why it is interesting for the teachers and what makes them return each year, and how the experience influences school teaching and desire to stay in the teaching profession. The data were analyzed in order to understand the essential meanings that are derived from the teachers' experiences. Kleiman (2004) describes the process of analyzing phenomenological data as a process of reading and rereading the interview transcripts, as outlined in the following table:

Table 2. Process of Analyzing Phenomenological Data.

Steps of Data Analysis	**Purpose**
Reading and rereading the interview transcripts	To get a global picture of the phenomena, then begin to derive meaning, categorize findings, and collect parts of transcripts that have a similar meaning or theme.
Free Imaginative Variation	To decide which units decided in the first step are essential for the phenomena under study.

Revisit raw data	To ensure that the essential meanings and general structure of the phenomena are truly reflected in the data.
Critical examination of findings	To ensure that concrete and detailed descriptions have been obtained; that the phenomenological reduction has been maintained throughout the analysis, that essential meanings are present, that a structure has been articulated, and that the raw data has verified the results.

The analysis uses an emergent strategy where the method of analysis follows the nature of the data. The purpose is to understand the meaning of the description of the participant's experiences. From the interviews transcripts, observations of camp, and journal reflections, I extracted themes and attempted to distill the essence of the meaning of the experiences that were being described. I used the process known as phenomenological reduction, which is common in phenomenological research. In this process, the first step is the use of bracketing, or withholding prior knowledge of the phenomenon under consideration. In other words, I attempted to interpret the experiences of the teachers exactly as described without theorizing based on what is already known. This involved identifying personal biases that may be present, and being open to the existence of a variety of possibilities, in order to experience the phenomenon under study (Kleiman, 2004).

When analyzing the data, the literature on communities of practice was considered to understand how this environment acts as a community of practice. The analysis is informed by the concepts of representations, decompositions, and approximations of practice in order to understand how this community affords these types of opportunities to teachers (Grossman et al., 2009).

During the interview process, the teachers were asked to address issues that were relevant to their own experiences with JSMC. The purpose of these interviews was to understand the teachers' views about teaching math in school, how their experiences teaching in JSMC were the same or differed from regular school, their professional goals and goals for students, and how the experience of teaching at JSMC sustained them in their profession. The teachers were asked about their teaching and personal goals for themselves, and their learning goals for their students. They were asked in what ways they observed growth in their students, in terms of mathematical ability, growth in confidence, excitement about math, etc. They were asked to provide feedback about what they would change or do differently in JSMC. They were asked about relationships that they formed with other teachers, mentors, and students. Other questions focused on how they structured the JSMC lessons, how they implemented the curriculum and whether they brought their own curriculum into JSMC. Questions regarding their classroom organization were also addressed. These questions were helpful in understanding the teachers mathematical and instructional goals for their students, the challenges the teachers faced, and incidents in the classroom that were meaningful either because they were motivating or frustrating.

The semi-structured interviews were analyzed to reveal the experiences of the teachers. The interviews were coded twice. Initially, I went through each interview transcript and highlighted the statements made by the teachers in one of three colors, depending on whether the statement pertained to research question one, two, or three. I read the reflections that the teachers wrote during JSMC to find commonalities between

the interviews and these writings. This initial coding served the purpose of becoming familiar with the large quantity of information contained in the interviews.

For the second round of coding of the interviews, I used an open coding scheme to parse the interviews. I reread each interview transcript and developed codes from this re-reading, beginning with Mary's transcript. Each code that emerged was transferred into an Excel spreadsheet, with each line of the interview that corresponded to that code denoted in the spreadsheet. I did not code every single line of the transcript. I only coded lines that were relevant to my study. For example, Mary talked about the intercom system, which was going off during an interview. This was irrelevant to my study, so I did not code this line of speech. I then coded the remaining five interviews using the same scheme, adding codes as they came up. As I came up with codes, I began grouping the codes into themes. The broad themes that came out of this were Learning, Reflection, Motivation, Community, Teaching, and School. Within each of these themes, I had about fifteen codes for each, for a total of 116 codes. Using this open coding scheme allowed me to unpack the essence of the teacher's experiences without any preconceived notions about what their experiences should look like.

After coming up with this broad list of codes, I found that several of my codes overlapped with each other. I began to synthesize them and collapse them into slightly less specific codes. For example, using camp strategies in school and wanting to teach school in a camp way became one code, whereas originally they were two separate codes.

After this second coding process was complete, I began to construct a narrative based on the codes. Since I had already selected meaningful sentences from each

document and grouped them by code, I was able to connect the codes to the research questions. I connected statements describing camp experiences to the first research question; descriptions of what the professors, other teachers and staff did that contributed to these experiences to the second research question; and descriptions of how JSMC benefitted the teachers to the third research question.

During the coding process, the unit of analysis used was a theme rather than a specific amount of text. For instance, the code "focus on conceptual understanding" was assigned to the following two quotes:

> But even multiplication. I feel that it is important that they have what that means. When you are multiplying. And integers. I do use the number line to show them why these numbers are negative. When you are adding a positive and a negative with a greater absolute value. I do model that. Just so they know it is not just because we made up rules.

"So I think my goal in teaching these kiddos is to have them learn the material but also kind of why it works or how it works."

The two preceding quotes vary in length, but they were given the same code. By assigning codes in this way, to themes rather than specific amounts of text, I was able to focus on a particular idea, regardless of the length of the explanation.

After I had linked each sentence from my spreadsheet to a research question, I began to structure paragraphs of analysis based on my code. For example, the teachers discussed issues relating to the administration at their school at length. School Structure,

with excerpts from this transcript, became a paragraph in the analysis.

During the process of structuring paragraphs around the themes that I found, I wove appropriate quotes that provided evidence for the claims I was making into the narrative. For each quote that I used, I highlighted this quote in the interview transcript to note that it had been used.

The next thing that I did was to begin to distill the quotes. I needed to create more of my own voice and narrative rather than relaying everything in the voice of the teachers. I went through five iterations of distilling quotes and adding to the narrative. During this process, I re-read the reflections that I collected from the teachers to see which themes I was finding from the interviews were reflected in these writings. I then re-read the interview transcripts many times to deepen my understanding of the teachers' experiences.

After this process, I had a good understanding of the themes that had come out of the interviews with the teachers. I then reread the daily reflections I had collected, and applied the same codes to these reflections. This allowed me to begin to corroborate the evidence presented in the interviews with a second source of data.

Limitations

The focus of this study was five teachers who taught and participated in a two-week summer camp with an associated PD hosted by professors at a university in central Texas. The differences in length of time the teachers had taught in school and the differences in levels of JSMC they taught were taken into consideration.

The teachers were selected based on the length of time they had been teaching in JSMC and school. This left a limited pool of teachers to select from. The fact that the teachers were selected from those who returned to JSMC each year and continued teaching for at least four years creates a limitation for this study. These teachers chose to come back to JSMC each summer, and chose to remain in the profession. This study fails to address the experiences of the teachers who did not continue teaching in JSMC or regular school. It is possible that these teachers, who did not return to JSMC, because they chose not to, or were not invited back, had a different experience than the teachers in this study.

Caution should be exercised when making any generalizations from this study, as it applies to the specific experiences of a limited number of people. I do not claim that the experiences of these teachers reflect the experiences of the whole set of teachers in JSMC.

Trustworthiness

The issues of credibility, transferability, and confirmability were considered in order to determine whether the results of the analysis make sense, accurately describe the experiences of the teachers, and provide an accurate representation of the phenomena under investigation (Lincoln & Guba, 1985; Miles & Huberman, 1994). In order to enhance the credibility (or truth-value) of this study, I sought guidance and confirmation of the results of my data analysis from my advisor and the rest of my dissertation committee, who are experts in the field of math education. Regarding transferability, I

provided a rich description of the participants experiences and the meaning they derive from these experiences in the context of JSMC. Providing this rich description allows the reader to deem whether it is appropriate to transfer the results to another setting. This rich description is informed by discussions with the founder of Mathworld, observations of JSMC, interviews with the teachers, and my own experiences teaching and observing JSMC. Confirmability refers to the results extracted from the data, rather than an unsubstantiated interpretation. In order to ensure that the results are confirmable, I clearly outlined my assumptions regarding the study.

Conclusion

The aim of this study is to describe the phenomenon of a particular type of PD and its impact on teachers. The experiences of the teachers, and how the environment contributes to understanding the teachers' experiences, are explored in depth.

IV. RESULTS

The results of this analysis are presented as narrative descriptions. These descriptions demonstrate how the experiences in JSMC influenced teachers desire to stay in the profession. First, I discuss the JSMC setting, including the teaching and PD components. Then I describe the teacher's experiences as interpreted primarily from the interviews, with support from the initial survey, daily reflections, conversations with the founders, and my own observations and experience. The data are grouped by research question to allow multiple data sources to work together to create an understanding of the results for each question. I changed the name of the teachers to protect their identity.

As noted in the previous sections, the research questions addressed in this study are:

1) What are the experiences of the teachers in this professional development environment?

2) What elements of the setting contribute to the teachers having those experiences?

3) In what ways did the teachers interpret these experiences as beneficial towards sustaining their career?

I include the following table of codes used in the analysis and the frequency of occurrence of codes within each category for each participant.

Table 3. Codes

Analysis codes and frequency						
Category	Codes	Mary	Pilar	Allison	Edgar	Diane

Learning Mathematics	• *Learned mathematics relevant to teaching* • *Worked on math problems* • *Discussed math problems with other teachers or fellows*	32	24	17	59	9
Learning about Teaching	• *Learning about teaching and questioning* • *Being problem-centered* • *Thinking deeply about math* • *Discovery-style learning*	71	22	19	54	46
Learning about Student Thinking	• *Discussing or noticing student's learning* • *Strategies* • *Hard work* • *Struggle* • *Conceptual Understanding* • *Knowledge Growth* • *Willingness to answer* • *Safety of environment, goals for students*	50	17	50	26	13
Reflection	• *Reflecting on teaching* • *Reading articles and books about teaching* • *Listening to other teacher's reflections* • *Reflecting with professors* • *Reflection is beneficial*	5	3	10	2	0

Motivation	• *Saw professors exemplifying teaching strategies or questioning* • *Professors are attentive to environment* • *Modify setting in response to feedback* • *Growth in students* • *Encouragement about problem-solving or teaching abilities* • *Feeling comfortable* • *Lack of struggle* • *Feeling appreciated* • *PD is beneficial* • *Wants to keep teaching* • *Realizing math is fun* • *Feeling rejuvenated* • *Positive environment* • *Professors excited* • *Planning time* • *Student's excitement and confidence* • *Attitude changes*	101	50	101	27	22
Community	• *Communication between teachers and students* • *Teachers and professors* • *Students* • *Fellows* • *Relationships with teachers* • *Professors and staff* • *Home environment* • *Learning from other teachers* • *Mentoring* • *Discussing regular school* • *Interacting more* • *Other teacher's excitement*	53	29	43	12	2

Teaching	• *Confidence in teaching* • *Stress* • *Living up to expectations* • *Changes and improvement* • *Belief in self* • *Professional development* • *Loves teaching math* • *Observing and co-teaching* • *Feedback* • *Lack of pressure* • *Fellows assistance* • *Curriculum* • *Working hard* • *Not using formulas* • *Different knowledge levels* • *Delivery style*	88	101	107	116	12
Regular School	• *Administration* • *Feedback* • *Value of education* • *Time constraints* • *Testing pressure* • *Difficulties* • *Other teaching experiences* • *PD* • *Class Size* • *Frustration* • *Communication* • *Confidence* • *Mastery of content* • *Isolation* • *Best practices* • *Procedural Learning* • *Staying in teaching* • *Struggling students* • *Reward* • *Relevance of curriculum*	75	96	105	79	28
Transfer	• *Camp to school* • *School to camp* • *Students in both environments* • *Comparing Knowledge* • *Modifying teaching* • *Games* • *Teaching in a Discovery way* • *Shaping teaching practices*	29	26	16	33	35

Previous Experience with JSMC

I initially became interested in JSMC when I participated in a research project in the summer of 2014. During this project, I, along with several other graduate students, observed and filmed a camp classroom, and attend a PD session in the afternoon. The following summer, in 2015, I had the opportunity to teach in the summer camp. These experiences sparked my interest in this study. I got a glimpse of the environment JSMC provides, and the attitudes and behavior of students and teachers.

During my data collection, in the summer of 2016, I observed each participant teaching for approximately 30 minutes. These observations generally occurred on the day of the scheduled interview with this participant. Next, I discuss the themes that arose from my analysis in terms of each teachers' experiences. These were the result of grouping my original codes based on the experiences, themes, and benefits that I was seeing from the analysis.

Learning Mathematics

All of the teachers experienced learning math in one of two ways: either related to teaching which informed their teaching practices, or by working on interesting, challenging math problems in the PD that increased their mathematical knowledge.

Mary's math problem-solving abilities were validated. When she came to JSMC, she had not done algebra in twenty years, and the professors encouraged her about her ability to solve the problem. They made her feel comfortable.

They were so gracious. It was like just do what you know. Just check it out.

> There is no here is the formula. Do you remember this, this, and this? It wasn't that at all. It was how would you solve? And you could. And you say that even though I am an elementary teacher at the time I could sense, you know, that I can solve this using just my knowledge of what I know about things. Because I am thinking. So it was just fun.

Mary attended problem-solving sessions in the PD involving math problems which she later implemented in her seventh grade classroom. This transfer of teaching ideas and strategies between Mary's camp experience and her school teaching enhanced Mary's teaching practice.

> I would do it again in a heartbeat. It was so fun. But it was Martin and Calvin. So it was before Calvin left the first time. And we actually had math problems that were relevant to what you could do in your seventh or eighth grade. Especially your higher-level classes. I learned so much math.

Mary found that she formed lasting and meaningful connections with the professors and experienced math learning as a result of conversations with them. She particularly enjoyed talking to one professor, Tom, about math and trying to understand his explanations. She enjoyed seeing the excitement he displayed about math.

Pilar found it beneficial to discuss problem-solving strategies while working on math problems in the PD as she enjoyed problem-solving, and it helped her to gain confidence in her math knowledge. She solved both algebraic and combinatorial

problems in groups with other teachers.

Allison found herself thinking in new ways during problem-solving discussions because of open-ended problems presented which were unlike anything she had ever encountered. One example she provided was a theoretical question about whether it is possible to have two zeros on the number line, and what the implications of this would be. Allison discussed whether having two zeros on a number line was possible with Debra, and they came to the conclusion that it was not possible.

"The question was, can there be two zeros on the number line? Something like that. And them being like holy cow. I don't know. Because I think the funny thing is I was chatting with the girls and they were talking about how."

"That is, to me, that is very typical JSMC. That makes you, makes you think, or think differently or think around think through you know."

The open-ended problems presented in the PD were new for Edgar, and he found working on them beneficial. He was forced to come up with creative problem-solving strategies. An interesting, unconventional problem that caught his attention in particular involved inventing a scale to classify the degree to which a triangle was equilateral. This problem encouraged creativity because any classification system was possible. Some groups used terms such as "halfway equilateral", others used a percentage scale, and his group used the mean average deviation. Solving these types of problems gave Edgar exposure to multiple solution strategies. Edgar realized that the way another participant was approaching a problem was possibly vastly different from the way he was thinking

and he needed to be more open and accepting of his colleagues' strategies.

> We do a lot of problem solving in there, and I think that's good in a way because it makes me think about problems in different ways that I would never thought of before. For example, yesterday we had a problem where we had to come up with an expression to find the perimeter of a box and my expression was totally different from the other three that were in my group. And in that process it made me open my eyes and made me realize that their thoughts are a lot different than my thoughts. So if they can't see my way I need to open up myself and I need to understand their ways too to be better. So again it just opened me up more to accept other people's thought processes or accept other people's thinking strategies. So I think in that way it's beneficial to again open myself up to different levels of thinking.

The JSMC PD was the first one Diane had attended that was focused specifically on math and was relevant to her classroom and students. The previous PDs she attended were tailored around general teaching topics and Diane found it difficult to apply these concepts in her classroom. She developed a common bond with the JSMC PD participants over their interest in math. They "spoke the same language." It was the most valuable PD she had attended.

The teachers often worked on problems in the PD that were new to them or problems for which they did not remember relevant formulas. Although the teachers did not always use these problems in the classroom, they found working on the problems to be a valuable learning experience that improved their problem-solving skills and their

confidence in their ability to think logically about math. They began to embrace the process of logically thinking about a problem rather than trying to remember having worked on a similar problem. They took time to consider different strategies without referencing any textbook or other material. They realized that they weren't expected to immediately know the answer just because they were teachers.

Learning About Teaching

The teachers learned strategies for teaching math concepts that they could use in school, how to question students so that they could better understand student strategies and thinking, how to generate conversations between students or get a student to open up, and how to provide wait time and allow silence for thinking. They also learned how to use problems with multiple correct solutions or solution strategies to deemphasize the answer and focus on the problem-solving process.

Teaching Strategies

Mary learned to use a number line and the car model for adding and subtracting integers. Conversations with Tom led her to realize that she was not just teaching the students an algorithm for adding and subtracting, but was teaching them to understand the concept behind the algorithm.

> We have talked before about you know how the car model is so good. And at first it's like when I was first thinking of it. It's like well basically. It's because you are giving them steps that get to the right answer. But honestly that's not it at all. I

think throughout time and talking to Tom. He was talking about well, what are we trying to get them to see?

Mary learned a new visual way of proving the Pythagorean theorem in the PD. The proof involved forming a folded paper creation that was then opened up to form four triangles total, two on either side of a large square, and the viewer was able to visually verify that the area of the four triangles equaled the area of the square. She adopted this proof and used it with her students in her classroom. Mary frequently used specific strategies she learned in JSMC in her classroom and this made the JSMC experience valuable for her teaching.

Pilar learned a learned a kinesthetic activity in a PD session called "dramathics" which integrated acting and math. Students created human graphs from given mathematical functions, and acted out mathematical words and definitions. Physically acting out math allowed students to interact with math in a new way, and was very different than working out problems with a pencil and paper. Pilar also learned a "discovery-based" way of teaching in JSMC. The main focus of this method was to think deeply about a concept, and focus on the process rather than the answer or conclusion. Pilar strongly resonated with the explorative way of teaching and found her, especially the ones who didn't necessarily like math, related to this style of learning. It sometimes turned their negative attitude towards math around. These students wanted to experience this type of teaching in their school.

This whole discovery-based learning. And you know think deeply about things

and work hard not, you know, the answer sometimes doesn't matter. You know that's really not the case back home. And so all of those little, I guess, characteristics or properties or whatever you want to call them that make the camp, I guess, a success.

"I think it's a little bit of everything. It's the way the JSMC curriculum is set up. And the way that this discovery way of doing things. And I think the kids respond to stuff like that."

Some of the kids that come here already like math right, so they come here and they already have that sense of Oh I like math. I'm good at math. So they like it because it appeals to them right. And then we've got the kids that maybe didn't like math. But then they're away from their usual environment. As to maybe why they didn't like math. Cause it's like you've got to finish this by this time and that kind of environment.

"I've had kids tell me before I've hated math and now I really like it. And then I've had them come back and say, I wish my teacher would have been teaching that way."

Pilar experienced less stress and less pressure to finish topics quickly compared to regular school. The students sensed this and were less stressed out. Both Pilar and her students enjoyed JSMC more because of this. Pilar enjoyed interacting with the students

and witnessing their mathematical growth. She was inspired by their willingness to work hard in JSMC, and by the professors who created and sustained the environment.

> I think the kids also bring that sense, or they make the environment like that because of the way JSMC is run or the philosophies of JSMC. And I think they feel less restricted as well. So when everybody's feeling like not too stressed out. "It makes me like coming here. And you know, so I think it has to do with the kids also you know, their desire to work hard. Things like that. You know I think that whole environment is created by you know the JSMC curriculum. The philosophies of the JSMC creators.

In the PD, Edgar worked on problems that were chosen because they provided the opportunity for multiple correct strategies to be used and problems with multiple correct answers. In presenting these problems, the professors running the PD emphasized discussing the process used to solve the problem rather than the solution. Working on these problems allowed different groups of participants in the PD to share strategies and learn from each other. An example of the type of problem was finding an expression to represent the perimeter of an object. Edgar used this problem in his classroom. He found that his students came up with different expressions for the perimeter and saw that multiple solutions were possible. They engaged in a discussion about the multiple strategies.

> Problems with the perimeter and finding different expressions to explain where you

got your expression from. Those are cool. So even though I got one expression. But the three partners got a different expression. I still understand where they got their expression from. We are all right in the same way. So those problems like that where there is a right answer and there could be multiple right answers and but you have to explain where you got your answers from. Those are beneficial.

I definitely will take those types of problems into my classroom and I can. I got that worksheet yesterday that we did and I put that in my binder and we are going to bring it out next year throughout the school year. And I am going to have the kids try to come up with their own expressions and explain where they got their expression from and hopefully each group will have different expressions and they can see that everybody is right still.

Diane used problems that she learned in the PD in her classroom, and also to "jump start" JSMC sessions. She incorporated activities such as taping a coordinate grid to the floor in her classroom which was used to plot points and lines, and solve any problem related to the coordinate plane. She found it useful for her students who were visual learners.

The teachers thought about how to enhance their teaching in JSMC. They worked on problems in the PD in a setting that caused an exchange of ideas. They took these problems back to their classrooms. They began to emphasize the sharing of ideas and solution strategies as a focus of their regular classroom teaching. They were intrigued by problems with multiple solution strategies and multiple correct answers, as these types of problems created the opportunity to learn from each other. They witnessed working on

this type of activity helping students overcome their aversion to math.

Questioning Strategies

The teachers found the questioning strategies they learned in JSMC led to deeper understanding of concepts in students and they brought these practices back to school. For Mary, questioning strategies were the most important thing that she learned in JSMC, and using questioning became an important part of her teaching style. She observed the development of questioning being used frequently by the professors in ways she had not seen before. She found that the professors loved discussing math, and questioning facilitated this. She began to ask her students to justify and explain their reasoning, and push them to deepen their understanding.

"The biggest thing I have learned at math camp that I do not feel I would learn anywhere the way I learned it here is questioning."

Mary began to ask students things like, "Well, what do you all think about that? Does anyone else have a comment?"

Mary's students benefitted from the questioning and became more involved in conservations about math as a result. Mary also found that the questioning techniques made her more observant of her own actions in the classroom and of her students.

> Being more observant about your actions as the teacher. I think I have learned more here than anywhere else. So it involves the questioning, but also involves reacting to how kids learn because you are not going to have that class where

everyone is like Oh, you know, this is great. I love math. You just don't have it anymore you know. Even at math camp, you don't have that. But they know it is camp and I think the difference is I know it is camp.

"You are just in that fun mode. I'm always. Ah, you know, I kind of go crazy. Which means my class is always pretty loud, but in a fun way. You know they're always talking and doing stuff."

Allison learned about questioning from being an observer in a classroom taught by an instructor named Evan during her first year in JSMC. Observing Evan was particularly meaningful for Allison because her teaching style was being formed and she did not feel she was using best teaching practices yet. She found Evan was able to lead students to "some really complicated and deep understanding of the problems."

Edgar was interested in how to ask questions of students that elicited different responses from his students. He discussed different levels of questioning in the PD and how to get students to explain their thinking at varying levels of deepness.

Diane learned how to add dimension to her questioning. She began to probe the students to consider other possibilities. If they provided a solution strategy, she would ask them questions that would lead them to consider other possible ways of thinking about the problem.

I learned to ask kids questions more instead of just trying to explain them things.

So I will ask them a question as to why did you put that answer? Well why couldn't we include this or why couldn't we include that?

They learned to use questions to get students talking, probe students to think of new ways to solve problems, and to listen to other student's strategies. They grew as teachers and began to make their classrooms more discussion oriented. They recreated the engaging learning environment that they saw in JSMC in their classrooms.

Problem-Centered Thinking

A central component of the knowledge the teachers gained about teaching from JSMC was focusing on the problem-solving process rather than the answer. This was accomplished by using the questioning techniques and concept of discovery-based learning described previously. Rather than responding to questions by providing answers, the teachers started asking questions in response to questions to delve deeper into students understanding.

In the PD, Mary participated in discussions with the professors about how to respond to wrong answers by changing the focus from the answer to the thinking process behind the solution. They also discussed what to do when a student struggles with a concept.

Mary began to believe that wrong answers served as a learning opportunity after coming to JSMC. Mary observed and had discussions with Calvin, a professor involved in creating the JSMC curriculum who also sometimes taught the PD. Mary observed

Calvin demonstrating the concept of "no wrong answers" in his interactions with teachers in the way that he presented problems. Mary thought about and referred to this concept when writing her daily reflections. When a student provided a wrong answer, it created an opportunity for rich discussion.

> They're talking more about actually doing math. The observation of communication within the kids, teacher to student you know and then learning. Ok, so if this child does have trouble getting there, what can you do to help them get there without just giving them the answer so that they've shut down?
>
> "When they are talking to us as teachers they demonstrate this idea of and Calvin's, this idea of there's no wrong answers, even though there could be. The way they present it there's no wrong answers."
>
> I am always surprised how students can agree and seem to understand and then when they actually 'do' the problem or activity, they do it "wrong". I enjoy the "wrong" answers because that opens the discussion up to more whys and hows.

Mary focused on an exploration of the number line, and her students realized that subtracting a negative number from another number is equivalent to adding. She observed a particular student thinking about the connection between addition and subtraction involving negative numbers.

> This is what actually a kid told me: Well, if I am subtracting something, I want to

take away the least amount I could take. Yes. I think he said lowest amount. He said so really the further to the left on the number line is the lowest number. So that means I want a negative number, and I never thought about it because, you know, in school a lot of times you are teaching when you are subtracting the negative, you are adding the opposite. So really you are adding the positive. So you are really adding. Some of them would tell me that but his whole thought process was really, we want to go get a number that's further to the left because I'm taking away less, and I'd never thought about that.

Pilar observed a problem-centered style of teaching modeled in the PD sessions during problem-solving sessions. The professors running the PD would ask what strategies the teachers used to solve a given problem, rather than what answer they got.

"We get problems to do in the professional development class. It is modeled that way. It is not like we are expected to like the answer. Well what was your strategy? What did you use?"

Allison also became more problem-centered in her teaching. Instead of working out problems for students, she would probe them to explain their strategies. Allison reflected on student thinking in her daily reflections and paid attention to the dialogue her students engaged in about math.

"Now, you know I don't work out a lot of the problems. I say, Well I don't know

what the problem is. So let's work it out. Show me how you did it.

> I was very interested in the way kiddos came to the agreement that the hypotenuse is always the largest side. I had a kiddo using a ruler on one of the vertices and 'swing' or pivot it back and forth to show that the hypotenuse and leg will never be the same.

Diane also adopted a problem-centered approach to teaching and credited JSMC for teaching her how to implement it in her classroom.

> I'm not so much for you giving me the answer. And that's awesome that I have learned from [this] math camp. That it is not so much about the answer. It is about how do you get to the answer. What did you learn by trying to get to the answer? That's more important to me. If you learn from that mistake, do you now know a better way to do it? And just hey I got the right answer. That is great. But now you have got this whole other problem. Is there something that you could have pulled from that to do the next problem?

Diane found that sometimes she needed to convince a student to talk about a problem aloud. She wrote about this in one of her daily reflections in the context of a lesson on subsets of sets.

> One student was logically thinking about how many outcomes you have if you roll

two dice. However, in his logic he was thinking that whatever you rolled the first time was eliminated for the second roll. So he was not taking into account the doubles. Having him verbally explain made him realize his thought process.

The teachers changed their philosophies about problem-solving as a result of JSMC and began to value a focus on the problem-solving process rather than the answer. This shift in philosophy influenced their teaching practice and what their classrooms looked like. The teachers saw a problem-centered classroom environment modeled in the PD they attended. From the professors, they learned that they could tackle a problem they had not seen before. They applied this to their students, and probed students to understand their own thinking. When a student provided a wrong answer, they were now equipped with strategies to divert the focus from this wrong answer and get the student to explain their thinking.

JSMC Professional Development

Allison found that the PD sessions were conducted using the Guiding Principles (see Appendix D), a document written by the professors outlining their philosophies about teaching and learning math. These philosophies were communicated to the teachers in formal and informal conversations with professors. Allison saw these principles modeled by the professors.

"Maybe it made it more meaningful, because you know that's the way that we were taught in our professional development. Then it was explicitly said one of our principles

was this."

Mary had attended many iterations of the JSMC PD over the years. The professors continually modified elements of the sessions, and rotated which professor conducted the sessions. Mary enjoyed the variety in the topics that were covered. The year of our interview was her favorite, because she was particularly motivated by the excitement and enthusiasm of Susan and Hana, who ran the sessions. Mary contrasted the JSMC PD with other PDs she had attended. She found other PDs were "tunnel-visioned," and irrelevant to her classroom as they were focused on answering questions about a curriculum, or doing activities like "foldables." She wanted PD that incorporated thinking about student learning, or included watching a video of a classroom episode and discussing what they noticed about the classroom and how the students in the class responded to the lesson. This type of activity involving discussing teaching videos was done regularly in the JSMC sessions.

"I have learned more about teaching and thinking about how kids learn in those sessions than I ever learned at any professional development."

> You know even watching a video and talking about what do you notice. What do you observe? How can that help you? What do you see that maybe you wouldn't have done? What did that child react? You know how did they react to this or that? I've never had a PD like that.

Pilar also found that the wide variety of PD sessions that she had previously attended

were too theoretical, irrelevant to her classroom and her English Language Learner (ELL) students, or involved topics she was already knowledgeable about. For example, the person conducting the session would spend an hour explaining how to solve problems which Pilar already knew how to solve and which Texas Essential Knowledge and Skills (TEKS) were involved. She would prefer if they discussed how to teach the problem to a student. These experiences left Pilar with a negative impression of PD.

In contrast, in the JSMC sessions, Pilar worked on math problems and participated in discussions about how the students would approach these problems. She also was assigned articles or parts of books to read about teaching.

> In several [sessions] we have talked about combinatorics and we do some of the problems. And we talk about maybe how kids would approach the problems. Other things have been algebraic and again do some problems. Talk about how the kids would approach them. There have been some things about challenges in the classroom that we face that we don't face here in math camp.

"Some kind of methodologies that we talked about. Also being more problem-centered as opposed to answer-centered and then maybe some cognitive things or some like I guess what is it research that's out there."

Allison had previously attended PD sessions that lacked an emphasis on content, and were focused on procedural or structural elements of the classroom, unspecific to math.

Edgar attended PD focused on ELL learners, curriculum, English, mapping content,

listing objectives, and on how to make an agenda on the board. He wanted a PD based on math or teaching strategies for math and requested his administration to send him to this type of PD. He didn't enjoy PDs that were not specific to math, as he did not find that the one-size-fits-all approach was beneficial. An example of a PD he attended that was irrelevant to his classroom involved discussing a special way of organizing materials that their district had adopted called SIM.

"I always say every year I want to go to a professional development that is math based and you know I could install it into my math classroom."

Working on math problems with other participants during the JSMC PD was beneficial for the teachers. They discussed the ways that students approach problems and the implications of these approaches for learning. They were introduced to problems with multiple possible strategies and multiple answers, and were also introduced to using questioning techniques to engage students, which they then took back to their classroom.

JSMC Environment

The JSMC learning environment was created and sustained by a mix of the professors, teachers, staff, and students. The teachers created personal goals for their teaching and learning goals for their students. These goals including wanting their students to learn math, to be exposed to new ideas, to have their conceptual understanding deepen, to leave JSMC having enjoyed math, and to have fun.

An important component of Mary's teaching was allowing time for the students to think in class. She could do this because the professors did not place any pressure on her

to finish the curriculum within two weeks. For Mary, the success of JSMC was not measured in terms of the quantity of the content covered, but by students thinking deeply about how math works. Teachers and students being able to go at their own pace while teaching or learning was one of the best aspects of JSMC.

> Here is the joy about math camp. We are not here to have all of them master all of this material in these two weeks. What we are, to me, math camp is all about introducing new stuff to them. Really getting them to think about why it works. How it works.

Mary hoped that her students would remember the essence of what they had learned in JSMC when they encountered the same concept in school and have confidence in their knowledge. She felt that if they remembered the car model, it would help students to add and subtract positive and negative integers in school. Mary once explained to a parent who wondered why there were no tests in JSMC that her goal was to introduce students to concepts and then see where the knowledge took them in the future in school. She also wanted the students to have fun, and challenged students to learn new material without pushing them too hard.

> Further in the curriculum, I want to go deeper into it but yet we start doing some of that beginning stuff and you can get so deep that they really do get it and it is kind of fun to see that. So it does kind of depend on the kids. But my goal is just really the kids got to have fun.

Mary took time to help struggling students resolve their own difficulties with the content. She provided an example of this in the context of learning algebra.

> I always have one or two that really struggle with it. But what I find is if you just don't push them. As far as like just saying like you don't want to leave them behind. But you don't want to do it so much that then they start just being like ugh you know. You kind of just let them rest a little bit. And then you keep going. And then you just keep reinforcing.

Mary found the professors were extremely attentive and vigilant to what happened in JSMC, and supported her in teaching the way she wanted. They had "a vision for what they want" and Mary saw them "orchestrate it" as they structured the JSMC environment. They expressed an excitement about math that she had not previously encountered in education leaders and "loved talking math." They paid attention to the reflections that the teachers wrote. Mary found the excitement and caring "just makes you comfortable."

Pilar was less restricted in JSMC than in school as she was not pressured to rush through the curriculum. This had a positive impact on the students, who spent time thinking about math, had fun solving problems, and discussed math in small groups.

Allison wanted her students to be excited about math after JSMC, and leave on a positive note at the end of the two weeks. She wondered what the students told their parents about JSMC; she had gained this perspective after having her own children.

> I want it to be a rich, good experience. I mean I want it to. Becoming a parent just

makes me go, if my kid were to go to a camp, I would want them to come home excited about something. Or maybe if they weren't excited, like, interested with something. You know, like I need something positive.

Like the other teachers, Allison found that JSMC professors supported her freedom to teach the way she wanted and try new innovations in teaching. As highly educated math and math education researchers, they based their teaching on best practices for math, both in JSMC and in their university teaching. They came to JSMC every day to observe classes, interact with teachers and students, run the PD, and oversee daily operations. Because of their dedication, Allison felt a responsibility to create a successful learning environment. Allison was more lenient with JSMC students than in school and struggled to engage some students. One such incident occurred with a student who would spend class time drawing with a dry erase marker on his desk. Allison didn't feel he was learning and continually asked the student to pay attention but after some time he would go back to drawing on the desk. She decided to allow him draw, provided that he worked on math. However, for the most part, she found her students remained on task in JSMC. Allison believed her classroom was successful if her students thought deeply about math even if they did not achieve mastery of the content. She realized she underestimated the amount of material students retained and absorbed in JSMC.

"Especially because there are lots of them that get more than I think. You know, like they do amazing things."

Allison wanted to teach each concept in-depth and wanted the students to remember

these concepts when they encountered them in school. She gave an example of this regarding the Pythagorean theorem.

> I know that this isn't the only time that they are going to see this stuff so I have to again be under the philosophy of do the best that I can and teach to the depth you know that I'd like to. And try to get them to think differently about stuff. But at some point if they know how, if they know that Pythagorean theorem has something to do with right triangles and squares off of each of the sides then they'll be, they'll just be way better off than anybody else that has no idea what the Pythagorean theorem is.

Edgar was used to being concerned about reaching a certain point in the curriculum in school and initially applied this to JSMC. However, Martin explained that Edgar's focus should be on student understanding rather than amount of material covered. Being able to spend more or less time on a topic in order to better address students' needs was the feature of JSMC that most appealed to Edgar.

> That is the great thing about math camp, you just got to take a break sometimes. There's no scope and sequence there's no schedule but sometimes the kids not getting it, take your time on it and let them understand it.

Diane wanted to make sure that JSMC was an enjoyable experience for her students.

> Don’t forget to play games and have fun. Yeah, because that was one big thing. We made sure that we probably played at least one game a day. I haven’t done that this year yet. But I want to make sure I try to do that. Is that you’ve got to keep them involved with something fun.

The teachers teaching philosophies evolved during the JSMC teaching experience, through conversations with professors and other teachers, and through learning about the vision the professors had for JSMC, encompassed in the guiding principles. Their ability to cultivate their own style was supported by the lack of pressure to teach a certain way or cover a certain amount of material. The professors exemplified good teaching, strategies, and questioning, which inspired the teachers. The teachers provided their students the opportunity to think deeply about the concepts they learned. This was different from regular school, where the students were bombarded with standardized tests and other sorts of assessments and all classes were paced uniformly. The teachers wanted the students to be thoroughly engaged in JSMC, enjoy the experience, and learn to love math.

Curriculum Input

The JSMC curriculum was designed by the professors with input from professor and teacher collaborators from other universities and schools. Graduate students studying math or math education were recruited to help develop the curriculum. The teachers were free to modify the curriculum, as they saw fit. They infused JSMC classes with elements

of their school teaching, such as games and other activities while still implementing the curriculum with fidelity.

Mary rearranged the curriculum to introduce the chip model for adding and subtracting positive and negative integers before introducing expressions with variables, which was opposite of the order of these topics in the text, as this made sense for her class. She also invented and used games in her class.

> I love teaching the coordinate plane. I wish I could get to the coordinate planes actually at the end. And I wish I could teach that. Although I may jump tomorrow and just talk about what it is just for something different and teach them about the x-axis and the y-axis for fun so that they are prepared for level two, because it is in our curriculum too. But I love they added the chip model this year which was really good. I just flipped [to] where they had the chip model. They had it right after introducing expressions with variables. Right after the model. The car model and stuff. And I felt that I wanted to do the chip model first and then go into the expressions and I feel that it helped.

Pilar was impressed that the young students in level one were able to tackle adding and subtracting integers with positive and negative numbers as even her seventh-grade students in school tended to struggle with this topic. She added estimation and finding square roots to the curriculum as this topic helped her students solve problems involving

the Pythagorean theorem, which involve square roots. She reasoned that the students would need to understand the square root concept anyways in school. By including topics that were part of the TEKS (Texas Essential Knowledge and Skills) JSMC could align with what the students were learning in school to some degree.

> Level one is starting with the number line and things so I do like the way that they developed the adding of integers, the subtraction of integers and it's very easy for kids to see. Because I was in shock when I taught level one. Because those kids are so small. Like they're so little age wise.
>
> "One of the things I did with the Pythagorean theorem for one was that I added things to it like finding square roots. Estimating square roots. Because that wasn't really something that we harped on."
>
> The Pythagorean theorem concepts…those were part of our TEKS that we had to know those things. Where does it fit on the number line? And things like that. And so I brought in a little bit of extra stuff just to supplement things that I think they needed.

Allison found that although the curriculum had recently been rewritten, the essence was the same. She tried to align her implementation of the curriculum with the professor's vision. She incorporated kinesthetic activities in her class by giving her students breaks in the four-hour day to move around, and varying the type of activities she conducted in

class from individual work to group work to working out of the workbook.

The teachers enjoyed using the JSMC curriculum and were comfortable modifying and adding to the curriculum to fit their students needs while still implementing the curriculum with fidelity, staying true to the intention of the professors. The professors trusted the teacher's judgment.

Knowledge Levels

The staff and faculty assigned students to one of the five JSMC level based on their math knowledge, age, and grade in school. Despite this, teachers noticed varying levels of knowledge displayed by JSMC students. For example, some students knew the Pythagorean theorem and the distance formula, while others did not. The teachers adapted teaching strategies to accommodate all students. Pilar purposefully created situations where students could make a leap from a concept they understood to a new, related concept and build confidence. She often revisited knowledge from prior JSMC levels or school to help students understand a familiar concept in more depth.

> When I'm teaching something that maybe kids don't know, I feel that first of all they have to have the tools, previous knowledge, in order to do something that they've never seen, right? So we go through series of exercises or little questions. Things like that to where for example lets say they're trying to find what the area of a triangle is and all we've done is the area of a rectangle. And so when we do the area of a triangle we can do a model of like tape something on the floor."

> "When I get the kids they usually already know it because they've done it in previous years. But I do sometimes go back to some of that previous knowledge just to make sure that they understand it, and that they have a deeper meaning of what that means. And not just, Oh, my teacher gave me a formula. Yeah so I do that a lot with the skills that I feel are important for my area that I'm teaching.

Allison found JSMC students were a mix of mostly advanced and a few struggling students. Some students struggled to plot points on a coordinate plane and others derived the distance formula on their own. This difference in mathematical proficiency created a challenging dynamic for Allison as she was used to teaching students who were falling behind in school. The longer instructional time in JSMC gave her time to explore concepts in depth.

Edgar was surprised and intrigued by the knowledge displayed by JSMC students, and their willingness and ability to tackle difficult math and at the same time was troubled that many of his regular school students were the same age as JSMC students, and from the same district, but were behind in knowledge. He wanted to talk to the JSMC students more, observe their home environment, and meet their parents and teachers to understand the reasons for this so that he could make his school students more proficient in math.

> Every year I always get some kids and their vocabulary for their age is just so high. And just their thought process is just so high compared to other students. It

> makes me think sometimes and it just leaves me stunned and amazed. I always think why is it that these kids are so much higher, or where are they learning it from? Is it their home background? Is it that they're already gifted with this?"
>
> "And if they're in the same district and they have the same classes as the kids that I will see one day in seventh grade, why is it that you are falling behind and these kids are up here?

The teachers were interested in what factors might be creating differences in JSMC and school students, and they wanted to recreate the JSMC environment in their school. They wanted to learn what contributed to JSMC students' interest in math and willingness to work hard.

Conceptual Understanding

The teachers focused on students gaining conceptual understanding about each topic more than procedures, algorithms, or routine practice problems. For Pilar, it was important that students understood the meaning of concepts beyond an algorithm, and to know that math was not about arbitrary rules. She applied this to multiplication, and when explaining why adding a positive number and a negative number with a larger absolute value produced a negative number. She used a number line to explain this and wanted students to remember this from JSMC when they re-visited it in school.

Pilar's first year teaching in school, she showed students how to apply the theorem to find side lengths of right triangles, and gave the students the formula as this was how

she herself was taught this theorem in school. Later she saw that the JSMC curriculum justified the formula with a proof, and students made the connection that the areas of squares formed from the side lengths of the two legs of the right triangle summed to the same area as the square formed from the side length of the hypotenuse. She adopted this way of teaching the Pythagorean Theorem. Similarly, Pilar modified how she taught fractions after JSMC. In school she was taught that fractions were a portion of a whole, but for adding and subtracting fractions, was taught an algorithm and assigned drill-based problems on this. While observing level two in JSMC she realized that fraction addition and subtraction should be taught in context, with a a reference to a whole. She began to create problems involving chocolate bars for her students to give fractions meaning.

Allison also wanted her students to understand why algorithms worked while simultaneously developing fluency in problem-solving. She had difficulty maintaining students' attention for four hours in JSMC, but despite this, she was able to engage her students in rich, quality discussions about why math worked. She provided time for questions and would either answer the questions herself or have students respond.

The teachers focused on conceptual understanding. They developed new teaching strategies and ways to increase conceptual understanding in JSMC.

Suggestions for Change

The professors wanted the PD to be useful, and they adapted the content to meet the teachers' needs. They knew that not all of the fellows who attended JSMC were PSTs, and they planned sessions to have a wider appeal in terms of math, rather than solely

focusing on teaching. The teachers made suggestions for changes to JSMC for themselves or students, including more planning time, adjusting class sizes, and changes to the structured reflections.

Mary had between twenty and twenty-two students at the time of our interview, depending on attendance, and wanted a smaller class size. In previous years she had thirteen or fourteen students, which was ideal number for her JSMC class. In school, she taught up to twenty-two with ease as the teaching and instructional time were different. The helpful fellows and another teacher who visited her JSMC class made the larger class size manageable. She had up to six helpers in her class, who walked around and assisted individual students.

Allison planned at home at night because she had no time during the camp day and wanted thirty to forty minutes of structured planning time. Teaching, reflecting, and attending the PD took up the whole day. Allison also had her largest class ever of twenty-three students the year of our interview and wanted a smaller class. She enjoyed having students gather around her at the board and work on a problem while she taught which was difficult with so many students. Allison also was concerned that the fellows might develop unrealistic expectations about school after observing JSMC as this was the first classroom experience for many of them and Allison was much more lenient in JSMC than in school. Time passed more quickly or slowly in JSMC depending on the day and topic for Allison.

“It’s just funny what you’re doing that day and the moods they’re in because this

morning, two hours felt like twenty-five minutes but then another day two hours felt like fourteen hours."

Edgar found that problems such as developing a with a scale to determine how equilateral a specific triangle was were interesting to him personally but not useful for his teaching. He suggested including more problems that he could use in his classroom.

> I like kind of being creative and being like all right well let's start from scratch. We need to create a rubric. What do we want to do here? Those are cool and I like those. But I can't with problems like that. I can't really install them into my classroom. I think it's cool for me as a teacher.
>
> I don't know how I can take problems like that and take them into my classroom. Like another question was like, can you have two zeros on a number line and I think if I were to do it in my classroom sometimes it is cool for me as a teacher. I like discussing in discussions like that. But I don't think my kids in the school year would benefit from a question like that.

Edgar also suggested administering a pre-test to students containing questions about the coordinate plane, functions, patterns, sequences, and fractions, followed by a post-test of the same content. This would allow him to quantify the growth he observed students achieving in JSMC.

Diane suggested videoing an instance of the professors teaching a lesson and

showing it to the teachers.

"What would their magic look like in the classroom? Because I haven't ever seen one of them in action so that would be interesting."

The teachers made suggestions for improvement to JSMC. They were comfortable sharing their feedback with the professors, and their voices were heard. The nature of these suggestions were mostly minor.

Noticing Progress

The teachers noticed growth in their students in JSMC, both in their mathematical abilities and confidence level.

Mary observed "huge" growth in her students. Many of her JSMC students knew nothing about negative numbers or only knew that they were on the left side of the number line. She witnessed their knowledge about negative numbers grow in class discussions, and students solving problems much more quickly as JSMC progressed. She noticed growth in their confidence. They left JSMC feeling they had learned something. She discussed an example of this in her reflection session with the fellows, in the context of a lesson involving equations that demonstrated operations with positive and negative numbers. Some students immediately demonstrated familiarity with this topic, using appropriate vocabulary and solving problems quickly, while others were lost when equations were introduced. As the lesson progressed, the students who were initially lost began to demonstrate understanding and confidence.

> You will even ask, who has heard of negative numbers? Oh me me me. What does that mean? And they are kind of like well, we know they are on the number line. I think they are like on this side. They can even get that. But when you start talking to them anything about the gist of it. What does it actually mean? Then they don't really know so you have to go through but by the end they really understand.
>
> A few of the kids who were kind of struggling at the beginning, are really, their confidence is building, and they are getting it, and getting it quicker now. And they are kind of like Oh, we can do this. You know. And so that is fun to see. But I think they all leave feeling like they have learned something.

Pilar noticed students who were initially weak in math begin to express their thinking and develop math skills in JSMC. But more than math skills, Pilar found that the students' confidence grew in JSMC. The students were excited about telling their regular teachers what they learned in JSMC.

> Especially the ones that come in like really less confident than others, where math might not be one of their strong suits. And yeah it is really great to see them grow in terms of their math skills, and you know, their thinking.
>
> But more importantly for me I feel like that a lot of them gain so much more confidence when they leave. And you know they are like I am going to show my teacher you know this and this and this, that I learned this.

Allison found that students who learn the Pythagorean theorem in her class went back to

school and recalled this knowledge, and this made her feel JSMC was a success.

"So I think it is. You do feel like you are reaching kids and teaching them something."

Allison noticed that JSMC students who attended both levels one and two did well in level three and found it easier to observe these student's growth than students who came to level three without attending the first two levels. Allison found the sheer length of the four-hour class allowed her to see that the students knew more at the end of JSMC than they had in the beginning. She was particularly impressed with one student, who derived the formula for the distance between two points. Allison was excited to witness students learning, and she shared that this was why she had become a teacher in the first place. This excitement persisted whether she had a good or bad year.

> He figured it out. Given two points and looking at them. And knowing you subtract this and a little bit of this. Like the Pythagorean theorem. And giving him the point (*a,b*) and the point (*c,d*), [he] was able to say well it's really the distance between a and c and you square that. And it's really the difference between here. And you square that. Oh and then you add those together and you take the square root of…I mean he was able to tell me all these things and it was amazing.

Edgar found when he asked students what they thought about a concept or math problem, sometimes there would be silence, and he learned to see this as a learning opportunity. He would ask them to discuss the problems amongst themselves and offer suggestions or

provide an example problem. Then later in the class he would go back and ask the same problem again, and witness the students responding and demonstrating understanding. He enjoyed witnessing this growth in his students and believed JSMC allowed students to get ahead, as this had been his experience attending summer camps when he was in school.

"I think the summer camps are great. I know when I was in school I did the summer camps. And I think it benefitted me in a way to get ahead."

Edgar found would learn something in JSMC and then learn this topic again in school. Then when the students would take the state assessment test, they would remember what they had done in JSMC, and this would help them on the test. He believed the JSMC students were advanced because of a combination of their home environment and the influence of JSMC.

"I remember doing this in summer. So they already have that step ahead."

"With the kids, I've got to really get to know them. And I think a lot of it does maybe have to do with home life. And I think a lot of it does have to do with these summer camps."

One of the appeals of JSMC for Edgar was that students learned material in fifth or sixth grade that they would normally learn in seventh grade in school. This put them in a position to be better prepared when they encountered this material in school.

"And I think the camp in general is beneficial for anybody that wants to get here to get ahead. By the time you are in seventh grade and taking the state assessment they learn

this, hey, when they're in fifth or sixth grade."

To Edgar, the success of JSMC and the learning that he witnessed the students going through was not a one-time thing. It happened every year. He thought of his own son and wanted to encourage him to attend JSMC and gain from the experience.

> Every year, it's like, man that's awesome. So it makes me think of my kid.
>
> Because I hope I am going to push him in. And hope to make it enjoyable for him.
>
> And hopefully he'll be a math camper one day when he gets older because I think it's beneficial. I think it's awesome that these kids are performing at this level."

Diane's JSMC students were different than her school students.

"They were much more advanced in the class compared to most of my students. They would get things a lot quicker. They also thought of things in a different way."

When I asked Diane if the JSMC students liked math, she responded:

> Even if they don't, sometimes by the end, they are like, Wow, I really did learn a lot. It became easier. And then so when you see them in school later on, they remember that and they come back. And then it makes that connection when if you have them in class it is that much better. It's something to build on.

The teachers noticed students progress in JSMC, even though the camp was only two-weeks long. This was a source of motivation for them.

Motivation and Enjoyment

The teachers were motivated about their students learning math and about teaching. They genuinely enjoyed JSMC and often used words like "love" and "fell in love" with the experience, etc. Mary emphasized JSMC was the "pump up" and motivation she needed each summer to make her return to school. She got a "fresh start." She loved using JSMC curriculum, the teaching experience, the interactions with professors and other teachers, and the PD. Mary's husband sensed that JSMC was important to her, and encouraged her to continue attending, even though he didn't enjoy the two-week separation.

> We were joking because this year he didn't come with me at all, and didn't come visit. Like I didn't go home. I went to my mom's instead. And we haven't been apart this long. By about Monday or Tuesday when I didn't go home for the weekend or anything. He was there the last two years. So he was kind of like you know, man, I'm ready for you to come home. Blah blah blah. And you know I'm like well maybe you know you can ride with me next year. Or I just can't do this anymore. And I was kind of like. And he was like, Yes, you are doing this next year. This is what keeps you going. So he even knows that it is kind of a pump up. And he's been here and he knows Martin and them. And so he sees that when I walk in I just feel totally appreciated.

Pilar had always loved teaching and left her electrical engineering degree to teach. A teacher in her school found she would be an excellent fit for JSMC and insisted she attend. Pilar was reluctant because she had negative experiences with PD in the past. When she didn't fill the application out by the deadline he filled it out for her and asked her to sign it. She finally relented because as a first-year teacher she didn't want to say no to a colleague. She later realized how happy she was that she had attended, because she fell in love with JSMC.

Allison enjoyed teaching in JSMC, but found it intense, and at times exhausting. This feeling of exhaustion was more prominent during the middle to late first week of JSMC. After the weekend between the two weeks of JSMC, she was rejuvenated and ready for the second week, which went by quickly.

Edgar enjoyed JSMC. He and his students had more fun teaching and learning in JSMC than in school. He opened himself up to interact with students more, and the students learned more and opened up more than in school.

Diane identified herself as a nerd and enjoyed this identity. She found it funny that some of the students in her class didn't understand her fascination and enjoyment of math.

> And then also when I am at school, you know, I have students that are in my class. And so we will talk about it and talk it up. And people are like, No, you all are nerds. That's weird. And we are like, No, it's fun. We get to do math. And so that is

what is cool. It is like, yeah, I am a nerd. It is cool. I don't care.

The teachers truly enjoyed JSMC and wanted to come back each year. This contributed to the positive environment created. There was a sense of excitement and joy about math and learning and attending JSMC which was created by these positive sentiments. I also experienced this when I attended and taught in JSMC.

Confidence-Building

The teachers observed students building confidence across the course of JSMC.

Mary noticed students expressing confidence in their answers in JSMC. She wrote about this as something that struck her in her daily reflections.

"We reviewed adding and subtracting integers with the car model. Most of the students were engaged. I love watching the confidence of a student's answer."

Allison believed that even if a particular student appeared to not be learning in JSMC, there was a hidden impact on the students confidence. The more the student saw a concept or became familiar with a topic, the more confident they became.

I might see a few of these in my classroom, and it is amazing though. Because then, I'll bring something up about the Pythagorean theorem. And it's like, you know there is this little…there is this little light behind your eyes. And you're like, okay. I know this one. So it builds confidence somewhere. So it is making a difference in those kiddos that are the ones that we don't think learn anything in

> math camp. Because the more you see something, the more you hear something, the more confident, the more comfortable that you are with, you know, experiencing it. Or doing it. Or you know all that stuff. And I feel like she is. You know. Whoever has her in the next few years might see a difference in. And it may not be all the time. It might just be the topics that I taught that she feels confident with. But maybe that will translate to something else that she's willing to try.

Allison didn't always know what previous knowledge students brought into JSMC. For example, when she taught the Pythagorean theorem, it was difficult to tell if they already knew this theorem. However, she would observe the classroom going from silent to a situation where everyone was contributing their ideas. She prompted these discussions by questioning the students to determine what they already knew.

> I asked him, Have you done the distance formula before? Nope. Have you ever done the Pythagorean theorem before? Nope. And then that way I'm like, I feel like I would have to ask those questions. So do I just know by the kid, knowledge wise? No, I don't. But confidence wise, I mean, I think you can tell the kids grow in confidence, because then they're you know volunteering information.

Allison reflected in a daily reflection on how to help students grow in their confidence and noted that in general, her students seemed to be becoming more comfortable sharing their ideas in JSMC. It seemed that as JSMC went on, some students began to stick out as

the ones who regularly shared, and others moved to the background. Allison focused on combating this.

> I'm starting to have a few kiddos try and "hide" from sharing and my questions. They lack confidence in their abilities. I'm going to try and check with them a little more and encourage them to share their ideas. Hopefully I can help promote more confidence.

"Kids are getting more comfortable and the same kiddos are coming up with ideas and sharing. I need to try and get everyone involved."

Edgar noticed his student's confidence grow in the conversations they had around math in JSMC.

> If we're learning something new and they don't know how to do it, and there's silence in the classroom and I'm trying to question them to see what they know about it, and just questioning, questioning, questioning, and pulling information. Then you can see that they are picking up on it. And their conversation starts to go. And then the ball gets rolling. And then so you can see their confidence level gets up and then you can see their knowledge of the content as well gets up. So yeah, you can definitely see that they are learning. And you can see that they are enjoying it too. So I think that it is beneficial.

The teachers saw the students expressing confidence, and witnessed their confidence in their answers and understanding of math grow in JSMC.

Student's Attitudes

The teachers noticed that the majority of students were excited about learning, enthusiastic about activities and had positive attitudes. They also noticed attitude changes in students who did not like math when they came to JSMC.

Allison found that about 85 percent of the students she taught wanted to be in JSMC. Some of them said that their moms made them go, but she could still tell that they were enjoying JSMC. The students in her class were driven to get things done because this is what has been "ingrained in them from their actual school year" where they were not allowed to have late assignments. Allison felt many JSMC had a special home environment, and their parents wanted them to learn math. One student reminded Allison of her school students by exhibiting a disinterested attitude that Allison was familiar with. She would roll her eyes when asked to do math.

> I don't know if she is around an environment that values education but she's here and that's what I told her. But she's here. So somebody does [even] if it's not her and the truth is she could have paid money to go to summer fun instead of math camp but she didn't. Somebody cared enough about her education to send her here even though she's not super super excited.

Edgar found the students enthusiastic and excited about being in JSMC.

"I see the excitement in the morning, I see the laughing and the energy and it is always mainly positive."

Pilar noticed two types of students. One type came to JSMC and already had "that sense of, Oh, I like math. I'm good at math." Other students came to JSMC not liking math but would often leave undergo a complete attitude change during JSMC. Pilar felt that this was a result of the students being away from school and surrounded by other students who liked math, the philosophy of the professors behind JSMC, teaching freedom, a lack of stress, and the curriculum. The students would say things like "I wish my teacher would have been teaching that way," and the students were discouraged when they went back and experienced the same thing at school. One student told Pilar that they were going use a math game Pilar had introduced in JSMC in her school and this type of incident occurred frequently. Pilar talked to students during lunch after JSMC about what they did in school and what they liked and didn't like about it. Some of the students believed they couldn't answer math questions in school because they would be laughed at by other students. The students liked not having to take notes in JSMC. She saw a relaxed attitude in the JSMC students compared to the same students in regular school and attributed some of the differences in attitude to their lack of success in regular math classes at school.

Pilar was happy to learn that some of the students she taught many years ago had become math teachers and were getting masters degrees and others were studying electrical, mechanical, or civil engineering. Some of these students explicitly told Pilar

that her teaching was what caused them to begin to like math. Many years ago one particular student had told her that he hated math and was never going to use it, and was now becoming a math teacher.

Edgar believed students' attitudes were very important to their success and enjoyment in JSMC. He found a direct correlation between their attitude about math and JSMC and their expression of math abilities. Most of the students wanted to come to JSMC, had fun, and were engaged. This made JSMC more enjoyable for him as a teacher and for the other students. It was a combined effect of the enjoyment of one party affecting the others.

Diane's students enjoyed JSMC and talked with her daughter (a JSMC student) each day to find out what she learned in and was looking forward to seeing how her daughters' JSMC knowledge translated to fifth grade.

"I'm really happy that my daughter likes it. That my kids are involved in it, and they experience it and they're happy.

"On her way home she tells me about what she learned during the day. And I'm like, and I don't try to correct her or anything like that. I'm just like, Okay, you tell me. You tell me what you learned.

"I can track her progress. I know exactly what she's doing. And so that's pretty cool. And I'm like, Wow, you are going to be really ahead of the rest of the people in your group. Because she's going in to fifth grade.

"She's trying to help me recruit our son. He's going into second grade. So for next year maybe trying to recruit him to come."

The teachers were motivated by the positive attitudes of the students, their excitement about interacting with other students and teachers in JSMC who shared a love of math, and willingness to work hard and learn. This was a refreshing change from what some of them had experienced in school. . Some students believed their ability to express themselves in JSMC and participate in conversations about math without being ridiculed was stronger in JSMC than in regular school. Other students appreciated the lack of requirements to take notes, tests, etc. The teachers witnessed the enthusiasm of the students to learn math through things they said, their participation in class, conversations during lunch, and a general feeling that the students were excited.

Stress in JSMC

Most of the teachers experienced a lower level of stress in JSMC than in regular school. Pilar experienced this, and believed that the professors, students, teachers, and staff all came together to create a positive environment, stress-free environment where learning could take place. She didn't need to call student's parents to report that they were not working, as she often needed to do in school. Allison also ran her JSMC classroom in a more relaxed fashion than in school.

> But it is camp. And it is a little more relaxed. As we were lining up at the door, they were being loud. And I am like, Okay, we will just wait until you guys are kind of quiet and it is taking forever and it is kind of funny cause Debra was like, Oh my

gosh, can you guys just be quiet?

I was like Oh, I hope Debra does not think that this is the way I run my classroom, because I don't run it that way. Actually I am a little, no, a lot more strict. It's like I don't care that the bell just rang. My calculators aren't back. I'm not putting them back. I didn't take them out. Like I do a lot of making sure that they follow through with stuff. Which is not what I do here. Um, they don't have materials out. But it is different.

Allison did experience some stress during JSMC and attributed this stress to the frequent observations of her classroom that occurred in JSMC. She felt this stress was self-imposed, as she challenged herself to live up to the vision the professors had for JSMC, even though they often praised her teaching. This was compounded by the fact that Allison was often chosen to be the one classroom that was observed, due to her success teaching in JSMC. Allison wanted each observation "snapshot" to reflect learning, since the camp was only two weeks. In one incidence, she was observed for 45 minutes by appraisers who came to evaluate the worth of JSMC.

Mentoring by Professors

The professors provided mentoring to the teachers by praising their strengths and offering feedback on their teaching and their mathematical problem-solving. The professors also expressed excitement about learning, teaching, and doing math. They listened to the teachers and took their ideas into account in planning the program. The teacher's confidence was boosted.

Mary felt "totally appreciated" by the professors. They often told her, "We are so glad you are here," and provided similar praise in a genuine manner. Mary worked hard at teaching and felt her hard work was appreciated. Mary's confidence in her teaching abilities grew. They "validate[d] it through their actions." Mary's classroom was frequently observed by visitors to JSMC, including members of a foundation which funded JSMC. She received positive feedback from these observations and this encouragement also boosted her confidence.

> I always kind of felt when I first started coming, oh my goodness, I am not a master teacher. And every year, you'd come back and it is like, Oh we are so glad that you are here, and they genuinely it wasn't like, Oh, you're back. It was so genuine.

One year Mary participated in thirty-minute Skype sessions with Hana and Tom every week, which allowed Mary to provide input on the JSMC curriculum. This strengthened Mary's relationships with the professors. She found herself seeking input from Hana about career changes and asked her for a job reference and would communicate with Hana through social media. This relationship was a source of support for Mary.

Diane contrasted the lack of feedback she received in school with the JSMC experience.

> At least here you get people that come in and say, Hey, you did a good job. Or, Hey I really liked how you did this activity. So you get that fulfilling feedback. One way or another you get something.

Pilar's previous experience with math set the stage for JSMC to have a strong impact on

her beliefs about her mathematical abilities and her teaching. She was a teacher in the same place where she had attended school herself. She had never taken advanced courses in school, because culturally, wealthier students took these courses. Although she did well in school and passed tests, she was bored and never particularly challenged. She didn't gain confidence in her mathematical abilities. Even as a senior in high school, she never wanted to share her solutions with the class.

"I always passed my tests. I always did good, [but] I was always bored. I did my homework in five minutes, you know.

"I didn't feel very confident in my skills because nobody really told me like you know you are pretty good in math lets do something with you."

When Pilar became a teacher, she made sure that if she saw a bored student in her classroom, she took action.

"Now if I see a kid doing that I would say you know like let me give him some challenging stuff."

Since Pilar was not challenged or pushed in school, she lacked confidence when she majored in engineering in college.

> I don't think that was done with a lot of us back when I went to school so when I started going to my electrical engineering classes and we had to do physics and we had to do math I was always a little bit like hesitant like I didn't want to answer because I was afraid my answer was going to be wrong.

Pilar knew that math came naturally to her as she was good at solving puzzles and Rubik's cubes but her belief in her own mathematical abilities really became strong as a result of JSMC. She began to realize she something valid to say in problem-solving or mathematical discussions.

> I think what this program did for me was since I felt a little more free to answer questions and if they were wrong it was like too bad try something different. That approach it really made me open up a lot in terms of I guess what I had to offer.
>
> I feel more confident not only in my skills and my knowledge and my concepts but as a teacher I feel more confident. I feel like I know what I'm doing. I still feel like I don't know everything. I still can learn but I feel like I'm confident with what I can do and I think it is. I really owe it to JSMC.

Pilar found discussions with all of the professors and one professor in particular, Tom, about math and curriculum meaningful. He listened to and implemented her ideas about the curriculum. For example, they shortened the level one textbook because Pilar never reached the end in two weeks.

Allison appreciated working with high quality instructors and professors in JSMC who made her think.

> They know what they are talking about because that's what I tell my husband. I love doing this because sometimes I don't work with people that are smarter than me. And usually they are equivalent or not. So it's nice to work with very smart people because I think rubbing elbows and working with people that are smarter

than you makes you smarter. Makes you think. So I like thinking, and sometimes… And sometimes I think I'm on a little autopilot. Which I know I can still. I make a difference even though I know I'm a little on autopilot during the school year.

Allison felt her hard work was appreciated in JSMC as the professors said "great wonderful things" about her, and always invited her to return. They reassured Allison when she lacked confidence and called her a "star teacher."

In past years, well Hana is always helpful. Um, Martin is always very encouraging. And I love that because she's one that, Hana is one that I would ask her stuff. But I've like Sal come in here before, and we've talked about stuff. And it's kind of cool to hear him talk about things. Because his perspective is sometimes a little bit different too. And I like that.

The teachers opened up during JSMC and became comfortable sharing mathematical ideas, and working on problems that they may not know the answer to right away. Their beliefs in their own abilities as teachers were strengthened by positivity and encouragement from professors.

Mentoring by Teachers

The teachers sought advice from each other, observed each other's classes, and learned from each other. They developed lasting friendships. Mary found from listening to teachers explain their current and former classroom structure and strategies improved her understanding of teaching as she thought critically about how helpful these strategies were for students and examined her own practices.

As far as the professional development goes, for really professional development, um, that was really good. Because you are listening to what other teachers do, what other teachers have done in their classrooms. In the regular, you know not math camp only, in their classrooms. How they how they feel about how math is being taught. So you kind of have that. And I learned so much you know.

"You are learning from teachers who are in the classroom. Talking about their experiences. And questioning well how does that help a child?"

Pilar was given her own classroom her second year attending JSMC after an observation year and was initially nervous about teaching. She wanted to observe more classes to be prepared. Talking to other teachers made this transition go smoothly.

"Talking to the other master teachers about things that were happening in their class, and I was getting kind of visuals about things that were happening in the class, so that kind of helped me out as well."

Edgar developed a mentoring relationship with Allison and went to her for advice. They taught in the same school and Allison was his assigned mentor in school when he began teaching 8th grade, which helped build the relationship. They both found that shared a common belief in the importance of questioning and that whenever possible, it was better to allow students to discover things than to tell them.

Our teaching styles are very similar, you know. She likes to create things and she likes to be fun in the classroom. I always meet with her. I know when she did do

level two we always met with our level two math camp to discuss it, and then it just continued on to our school year, and I would always ask her for advice.

Not only did we do JSMC together but my first year she was my mentor as well. So she is one that I would always go to because I think we do a lot of similar things and you know she's experienced in math camp and I'm experienced in math camp. She has taught eighth grade. I have taught eighth grade one year. So I went to her last year for a lot of things. So she is really my go to if I needed any advice.

All the teachers benefitted from forming mentoring relationships with other teachers. They consulted each other about teaching and became friends.

Collaboration

The teachers participated in structured reflection sessions after teaching each day with fellows and other teachers in the PD as well as through social media, over dinner, and in school. Mary found the JSMC PD so valuable that she advocated to her school district to count them as official PD. She also benefitted from the structured reflection sessions with the fellows in her class.

"We met with the fellows and we were all together. And then we did not stay as master teachers, we did not stay, just the professional development teachers stayed. So that was good reflection. The reflection was always great."

Mary collaborated with four teachers, Pilar, Diane, Jocelyn and Marcy on

curriculum writing. They discussed teaching concepts and frameworks. Mary described the importance of the bonds she formed with Jocelyn, Pilar, Polly from the JSMC staff, and a student worker named Cathy. These were fostered by communicating through social media, staying in the dorms together, and going to dinner. Mary described her bond with Pilar.

> I talk to her a lot. Well, we have dinner in the commons and we are always, I mean even though we do talk about our home and try to get to know each other, what we've done over the years. We do sit and talk about, you know what, this is what I've done in my class today. You know what do you think? And all of that stuff.

Pilar had a unique co-teaching experience when she initially came to JSMC. She was assigned to observe level three which dealt with her school teaching assignment, algebra. The elementary teacher she observed her first year lacked the content knowledge to teach algebra so Pilar used her solid math background to assume a teaching role while the partner teacher managed the class and questioned students. This arrangement worked well for Pilar as she learned the philosophy and ideas behind JSMC, and was thrust into teaching.

> I was kind of like in charge of the concepts and stuff and she was kind of like, Okay, the questioning and things like that. So we kind of worked really well together to where she was teaching me about the program and the concepts. The philosophies kind of thing. And I was just doing the math.

Pilar found ample opportunities to talk to other teachers in formal and informal contexts existed in JSMC and Pilar wished this were the case in regular school. Pilar and Allison attended JSMC together for roughly the same number of years and they developed a friendship. They discussed their classes, shared new strategies and activities and implemented these activities and discussed how to tweak them. Outside JSMC, Pilar messaged other teachers on social media and email. She discussed cognitive ideas and ways of being more problem-centered rather than answer-centered with these teachers.

Allison discussed her class with other teachers during the structured reflections.

> I think it was fun today to see what other people saw. And again not that I need people to be like, You are so awesome, all the time. But it is nice to get people to be like, I like how that worked. I like to hear specifics. So talking about things that went well, um that maybe I didn't think went as well as maybe somebody else thought you know. I think that was fun to talk about. So the actual reflections. That was good. I liked it. And that's new this year and I do like that.

Allison also talked regularly with other teachers in her grade level in school.

> We do we usually talk about what are you doing next year? What are you doing here? Okay, here's this material. I'm going to play this and do this with that. So we do Pilar and I do a little bit and then during the school year I collaborate. So we all are constantly meeting together as a department.

Allison formed friendships with Diane, Monica, Pilar, and Mary. She discussed projects she assigned in school with Diane and Monica, who were both teachers at her school. Monica also taught in JSMC. Allison also enjoyed reuniting with the professors each summer, but missed this connection during the school year. Her relationships with professors and teachers, and a fear of missing out kept her returning to JSMC each year.

"It's nice to meet new people and the teachers are great. Yeah so it is like a little reunion sometimes.

"During the school year I don't get, I don't get to really talk to Martin or Hana or Tom or anyone. And so it is nice to see them."

"I think that is the problem is if I were to not do this anymore it would, I'd be sad. I'd be like, I wonder how they did that? Even though it is so hard and intense. But it is so great."

These relationships built in JSMC and sustained in school helped to create the JSMC community. These relationships contributed to the teachers return to JSMC each year. The teachers discussed issues that arose around teaching in school and JSMC, and the differences between the two settings.

Observing Teaching

Mary observed each of the five JSMC levels for two days her first year. This gave her a picture of content taught in each level, even though it was fragmented as the two days occurred at different points in the two weeks. Mary enjoyed watching Allison teach

in particular, as she found the way Allison conducted her class, engaged her students and delivered the content to be refreshing.

During this observation year, Mary was fascinated by the advanced students in a level five class taught by Calvin, and was frustrated that her seventh grade students struggled with material that younger JSMC students often mastered. The students in this class grasped challenging math, and Mary became a student alongside as she solved math problems with students that she had not seen in twenty years and also encountered math she had never been exposed to. Calvin encouraged Mary. She was impressed by his mathematical explanations and the interesting, complex problems he posed.

"He was teaching level five. In fact, I even told him, I was like, I don't want to leave this level. That was back when he would write his problems."

Edgar previously believed teaching is an art that cannot be taught. In school, he was used to teaching in a traditional format, including lecturing and providing worksheets for independent practice. After observing level two his first year, and observing teachers and interacting with students, he began to adapt his teaching practices to JSMC students, whom he found different than his regular students. He began using questioning techniques to understand student thinking. He wanted his students to be creative, so he invented activities, interactive games, and had them make posters. He became more outgoing and less strict and interacted with students more. He tried to make his classroom fun and stopped rushing to the next topic. He took these new practices back to JSMC the next year. The observation year was significant in shaping Edgar's teaching.

Diane observed level one with Mary teaching and enjoyed the experience. “This is my second time teaching level four. I’ve also taught level two. And then I did my teacher trainee year with level one with Mary. That was pretty awesome. Good experience.”

Observing other teachers allowed new teachers to learn about the camp philosophies and curriculum, as well as learn teaching strategies.

Influence of JSMC

The teachers brought teaching strategies, lessons, and content specific teaching ideas to school and also brought teaching strategies, activities, and knowledge about student thinking from school to JSMC. Mary began teaching in JSMC the year she became a teacher. This allowed her to bring ideas back and forth. Mary observed how students “got it” in JSMC and wanted this for her regular students.

“It makes me drained, but this is the way I would love to teach. I literally am not joking.

“It’s not about what you are teaching though. It truly is how you are teaching them.”

“Honestly I will tell you, in this math camp, even though it is for the kids, I sometimes feel that it is my-it is where I teach the way I wish I could teach every day.”

Mary taught seventh grade for seven years, and was transitioning from teaching seventh grade in junior high to fourth-grade in elementary school. She was excited that she would be teaching the same age student in JSMC and school, and could compare

settings. Mary found that her seventh grade students believed they couldn't do math, a feeling that was reinforced over their school years. School was fast-paced and Mary lacked time to interact individually with students to reverse this attitude. Mary felt that fourth-grade students were young enough that she could have a positive influence even if they struggled.

Pilar researched the best teaching practices her first year teaching and developed a "discovery" teaching style. This was motivated by her negative experience of being bored and feeling unchallenged in math in school, where her teachers lectured through each chapter. Pilar knew then that when she became a teacher, she wanted to allow students to discover ideas and not spoon feed information to students. Pilar adopted what she called a "half and half" strategy of providing information to students and letting them discover ideas. Since Pilar already used a discovery method already, and JSMC encouraged students to discover knowledge on their own, JSMC was a natural fit for Pilar. She resonated with and fell in love with the program. Pilar began coming to JSMC at the beginning of her teaching career and her growth as a teacher was shaped by JSMC philosophies.

Allison came to JSMC after one-year teaching, and had not fully developed her teaching style yet. She lacked confidence in her teaching and did not feel she was using best practices yet. She also felt the teachers surrounded her in school were not using best practices. This changed in JSMC as she gained confidence in her teaching abilities and overcame her fear of mistakes that shrouded her first couple years teaching. She initially

laughed at the title master teacher, and still found the title underserved. However, she made a sincere effort to teach the camp. She was motivated by the fact that the professors had invited her to teach in JSMC. Eventually, as she grew in her teaching, she began to believe she was a master teacher. She put work into teaching and thought about the conversations she wanted to have with students and how to implement curriculum. She had fun during the summer and it was a very different experience than the regular classroom.

"I have more confidence in my teaching again. It was just my first couple years that I constantly had to be like you cannot mess up. And now I don't mind messing up.

"Even though I am in a professional career-a teacher, I'm a professional-It just feels like I'm not surrounded by people that use best practices, that know a whole lot, that are always helping the kids."

"It makes me feel like I'm growing, I'm getting smarter, and that I know more and that I'm able to just help my students even more even though it seems like behaviorally they are worse and worse."

Allison reflected on how some students were able to explain their thinking among their table group but not to the whole class. She wrote about this issue in a daily reflection and considered ways to combat this, such as asking students to explain their thinking in words to help them overcome their anxiety about sharing with the whole class.

"I have students that struggle with sharing as a whole group. They say great and

amazing things in their small groups but won't repeat it to the group."

Edgar used a traditional lecture-based classroom format with bookwork, notes, examples problems and independent practice before coming to JSMC. His classroom had rare opportunities for students to talk or discuss math and he was doing all the talking.

"My first year teaching I didn't have as much classroom discussions. It was more like, Alright, we're going to do this section, we are going to do this page, and we are going to do our homework.

> Here's some examples on how to do it. Here's some notes. And this and that. And it was mainly more of I guess lecture-based and then me talking and then sometimes I get student opinions here and there or they had questions. And I'll just answer the questions.

Edgar incorporated teaching strategies and activities he saw implemented in JSMC into his classroom. These activities included creating coordinate planes to plot points and equations, posters demonstrating student solutions to problems, cereal boxes taken apart to find the surface area, and interactive games that reviewed specific concepts. He shifted the responsibility to solve problems to his students. Edgar began to solicit answers and strategies from the students and engage them in discussions. Edgar's teaching style drastically changed as a result of JSMC and he began to enjoy teaching more. He felt his classroom became a better learning environment for his students.

> Why can't we just have this tape and put it on the ground and have the students

create their own number line, have the students create their own coordinate plane, have the students create their own poster? Because it's the student's creation. It's how the students are thinking about it. So that's just one thing from JSMC that I installed in my classroom.

It used to be more traditional with notes and example problems. And you know independent practice and then whole group practice. And then homework and that was pretty much it. Now it is just a lot more activities. And that's where I got it from, I got it from JSMC. Just seeing different teachers do it. I think it is great.

If you were to walk into my classroom for a regular seventh grade class you will see posters that students create are on my wall or sometimes on the ground. You might see a four corner grid or on the wall or you might see boxes from cereal boxes that we took apart and they are finding the surface area of those boxes. So I think we do a lot more hands-on activities and a lot more creation by the students then instead of by myself. And it is just something that I enjoy, something that I l like, and that I have learned from JSMC.

After being exposed to math camp it's like why can't I just present a problem and have the students tell me what they know about the problem? Or have the students tell me, how do you think you could solve that problem?

"With JSMC I definitely bring classroom discussions more into my all-around school year."

In JSMC, Edgar realized that correcting students for incorrect answers caused them to shut down as they would expect to be wrong again. He began emphasizing that their participation was more important than the correctness of the answer and asking another student to comment on the answer and encouraged alternative strategies. He became more patient and comfortable with silence in the classroom while the students were thinking.

> I've realized that I do love wrong answers. I think wrong answers are awesome. I think wrong answers are great. Because if you get exposed to a wrong answer, someone might see where they are coming from and then they might click and understand the correct way to do it or they might get an idea in their head. So now I think from JSMC into my school year, I do have a lot more classroom discussions. I do present a problem. And sometimes I notice during school year if I have complete silence I would be like, that's okay with me. I will take the complete silence. And hey, you all think about it for a little bit. You all take a minute or two if you have to. And you all think about this problem. Compared to like my first year when I got exposed to JSMC, if there was complete silence then I would be uncomfortable. And I would be like, Alright, let me tell you how to do this. Let me show you how

to do this. And like that. So now it is definitely changed me to be more patient.

Diane also adopted several strategies from JSMC. She found that she could test interesting ideas in JSMC and bring them to her classroom if they worked. She began comfortable using group-work in JSMC and exchanged the desks in her classroom for tables to facilitate group-work. She began using posters and a coordinate grid on the floor of her classroom after seeing it used when she observed Mary's class.

"The grid that they do on the floor. I think that's very useful for them to visualize and see. That was another thing that we did.

Yes, in Mary's class. Though where we did the number line. I've actually done that in eighth grade. So getting the kids to do that. And when we also started putting in square roots, because they had a hard time visualizing where square roots would go. Or I'll take a clothesline and pin it up on the board. And then I'll have them take clothespins. And they have to pin them up where they think they go. So I've taken those ideas back and used them at the beginning of the year.

"I have actually moved to using groups in my classrooms. Now like all my classes have tables instead of desks.

I want to try this in class. So I'm going to try it out at math camp. Hey it worked well. Let me try it in class and see if it works. So it's like I can try it on a smaller scale of students that I know are willing to try it and see how it goes. And

then I can apply it in the classroom.

Well, I try to make them make the posters to try and explain their thinking. And I think I started doing that more often once I got here. And you know we were trying to have every group do their thing.

The teachers found their teaching evolved and improved over the years as a result of JSMC. They adopted new teaching strategies including grouping students, asking students to explain their thinking, and conducting hands-on activities. They honed their teaching skills. They became more confident in their teaching. Their classrooms became more engaging and interactive.

Fellows

The teachers, who were used to teaching alone, benefitted from the new experience of having undergraduate assistants (fellows) assisting with teaching by individually helping students. The fellows also enjoyed helping and gained classroom experience. This was valuable as this was the first time many of them had been inside a classroom since their K-12 years and were often unfamiliar with classroom norms. In Mary's class, a fellow named Debra was not interested in math and Mary worried how she would fit in. To overcome this, Debra paid close attention to Mary's teaching strategies and by the end, she enjoyed JSMC and learned from the experience. She decided to return the next year.

She was kind of like, um, I just kind of fell into this. And like I'm not even a math

person. Um cause she really wasn't. And so she would be really watching to see what I was doing. But she learned so much and we had fun. And I had a couple others with her. I think we had two that year. It was Debra and someone else. I can't remember. Um, we had fun, but she really learned a lot and actually came back last year. She was like I tried to get in your class again, and I said you don't want to get bored, so she went to level two last year and now she's in level three. She's learning a lot but it's, from what I can tell it's very beneficial.

For Allison, the challenges of a large class size were mitigated by the fellows' presence. They assisted individual students while Allison was teaching, and this helped her stay focused. She had taught up to thirty-two students in school but found JSMC activities were better suited for smaller classes.

"And it is fine. It is doable. Especially because I've got really great fellows. And I think that's what they call them. But the helpers in here. And they walk around and help out so it is fine."

The relationship between the fellows and teachers was mutually beneficial. The fellows gained practical hands-on experience working with students, and learned about the classroom environment. The teachers found it easier to teach because the fellows walked around helping students during instruction time.

School Structure

The teachers discussed constraints present in school, including time, testing, grading, and administrative pressures. Interactions with administration were an important part of their school experience.

Mary found that at a district wide level, there was a push to "cookie-cut" teachers by requesting them to follow procedures they had observed working for another successful teacher. This method ignored specific factors that contributed to the successful teacher's situation, such as using practices suitable for their pre-AP students, or that matched the teachers' personality. If the new practice didn't work for a particular teacher, they were labeled a bad teacher.

"It seems like they have tried to cookie cut teachers. Where, like, they are saying this worked for this teacher. Well, let's make everyone do that."

The biggest difference between school and JSMC for Mary was her fear that, in school, her students would not master the required content in time. She came up with games relevant to her teaching, but time constraints made it difficult to implement this games.

In the regular year, I have to give procedures faster. Like I might start an exploration and try to get them thinking but if they don't get it fast enough I can't just sit back and start a tangent of something to try to get them there. It seems like I don't have the time frame so I find that I like that at math camp. Ok so we need a

little more practice of this let me make a game where we can practice this.

This frustration was compounded by a schedule cut that halved Mary's instructional time from ninety minutes to forty-five minutes. The 90-minute time frame had reminded Mary of JSMC. After the cut, the felt the administration expected the same or stronger results from her teaching.

> That's when I could pretend I was at math camp, because you could do the concept, you could do your teaching part, and I'm helping you, but you have time for that exploration at the beginning, and you had time for that game practice or something in the after. So I loved it. And then they just cut cut cut to where you've got this little bit of time to get all this stuff in.

Mary was frustrated that her seventh grade students were not fluent with fourth grade material. These topics included double-digit multiplication, division, long division, and fractions.

> I looked back at the fourth-grade curriculum right at the end just last week or whatever the week before. And all the things that are in the fourth-grade curriculum, all the things that my seventh-graders need to know, they don't know. It is literally double-digit multiplication, division, long division, fractions, going you know. It is stuff they should already have. They have been doing it since fourth

grade. But I have them and they still can't do it. Math facts. They can't do their math facts. You know you've got seven times three and they're counting on their fingers.

Allison noticed that it took two weeks to teach her 8th grade students the Pythagorean theorem and a few weeks later half of them had forgotten it. She believed this was due to a lack of practice at home. She found it difficult to focus on student growth as she felt "bogged down" by grading.

Pilar faced difficulties implementing some of the activities she saw in JSMC in her classroom and also keeping pace with the required schedule and found herself hurrying students through activities. Pilar needed to ensure her students performed well on standardized tests because teachers were held responsible if students didn't pass the 8th grade test which allowed them to move to high school. Pilar modified her instructional style in order to ensure her students did well on the test. She frequently repeated information but avoided a "kill and drill" approach.

"You are kind of held responsible if your kids don't pass this test. Especially in 8th grade because then they don't get promoted supposedly."

Pilar had some students who had difficulty adding integers and contrasted this with her first and second grade level one JSMC students who were adept at this skill. However, over the sixteen years that Pilar taught in JSMC, she realized that it was not the students who were different in JSMC, but it was the teaching that was different. This was

something that she wrote about in the initial survey I conducted when beginning to plan this study.

> When I first was introduced to this program, I thought it was great. I found it very refreshing and looked forward to the summers because I loved teaching students who loved mathematics. I thought these students were different (brighter and more eager to learn) from the students I had throughout the school year. After a couple of years, and after integrating more and more of the JSMC program into my teaching, I realized that the students were not really that much different; it was the teachers and their teaching that was different, which I guess resulted in the students changing their attitudes and perceptions of mathematics.

Edgar cited keeping up with the schedule, the scope and sequence, and the required TEKS for the state assessment in March as reasons that making learning fun was harder in school than JSMC.

> It's tough to have more fun while you are learning because during the school year you know you have a pacing schedule and a scope and sequence to go by and you have to, you have to teach all the TEKS before their state assessment test in March.

Even though the two settings were difficult for Edgar to compare, overall, the pressures in school made teaching in JSMC more enjoyable for Edgar.

> "My teaching here at math camp is more enjoyable than the regular school year."
>
> Edgar frequently encountered struggling students and would take additional time to

help this student. This sometimes caused him to fall behind in the curriculum. He modified his teaching due to worries that he would be blamed if students didn't pass standardized tests and attended math department meetings where they insisted that teachers remain on the same topic and to get "caught up" if they were not. Edgar initially avoided classroom discussions because they took time, however, after JSMC, Edgar rebelled against the notion that all classes needed to move at the same pace.

> If a kid doesn't do well on the scores, you know with the STAAR (State of Texas Assessments of Academic Readiness) then they might come down on the teacher. Or, you know, parents might be upset at the teacher.
>
> This classroom is a different level of students compared to my classroom and compared to your classroom so I don't really agree that my classroom has to be exactly where you are and doing the same exact same homework problems as you are and doing the exact same example problems or exact same notes. You know my students want to do something else or create something else.

Edgar wanted to know what factors contributed to the JSMC students doing math at a high level and why his school students struggled. This frustrated him. "My seventh graders don't even know what I'm teaching in level two."

> Last year it would take them a month to cover a topic. For them to fully understand it. And these kids come in and they already have you know some vocabulary. Or they already know something about it. Or they might already know it. And it always just makes me think.

Edgar wanted to learn about his student's home lives, previous teachers, or extracurricular math practice or the lack of this practice. He wanted to spend more time with JSMC students and understand the reasons behind the discrepancy in performance between the two groups of students.

"What are they doing that my seventh graders in the school year are not doing?"

It struck Edgar that JSMC students were more prepared to articulate their knowledge than the students he was used to working with in school. In one of his daily reflections, he wrote:

> When we were introducing the vocabulary of the coordinate plane, students were already knowledgeable in various things containing the coordinate plane. It stood out to me because teaching 7th grade during the school year, they wouldn't be able to express what the students [4th-6th] did.

The teachers compared the math that students were doing in JSMC and in regular school and the student's perceived levels of ability and mathematical proficiency. There teachers faced pressures in school that were absent in JSMC, and there was a general consensus that JSMC was a freer environment than regular school as concerns about passing a test, remaining on the same page as other classes, and rushing through a topic were absent. The teachers imposed pressure on themselves to implement the curriculum with fidelity in JSMC, but this was secondary to ensuring that their students were actively engaged and thinking deeply about math.

School Culture

The teachers voiced concerns over student motivation, behavior, and confidence in math problem-solving abilities. They also expressed concern for how successful the students felt in school, and the amount and type of communication about math students engaged in. They found many students exhibiting apathy towards math.

Mary had a negative impression the year before our interview and warned me that she was more pessimistic than usual about school. Her class was "out of control" and her students' apathy was overwhelming. She felt efforts to engage her students and generate excitement about math were in vain. She tried to create activities that were relevant to her students lives, but received papers back with "IDK", short for I don't know, written all over them. Mary felt frustrated and discouraged. She attributed their apathy to several sources.

> I think our society. I mean I do. I think part of it is family oriented. I think some families just you go to school because that's what you have to do. Get up and go. And when you call home about situations, it is, well, I can't do a thing, you know I can't do anything for you because they don't behave at home either, you know what I'm saying.

Mary had difficulty generating classroom discussions about math, and worried this hampered the students learning. Students were often off topic and discussed weekend plans and movies. She missed the fellows in her classroom during JSMC because they helped students stay on task.

Pilar also sensed apathy and a dislike for math in students. She frequently called parents to discuss the student's unwillingness to do the assigned work. Students treated math like a chore. As a math lover, she found it refreshing to teach students in JSMC who sincerely wanted to learn, and she enjoyed not having to call parents in JSMC.

> I'm just bogged down with some of the way the kids handle math. Like they don't like it. And I'm trying to get them to like it and it's a constant struggle back home. And here I don't have to struggle as much so that's kind of something that I need I think for me to keep me going.

Allison realized that the relationships she formed with students improved their behavior and spent the first semester of school building these relationships, establishing trust, and creating the classroom culture. The students needed to know that someone cared about them.

> Right now they're awful. They are terrible. But even then it is like I'm doing something right because it took me until about Christmas to make sure that all my classes, which is a long time. And believe me it's a long [one], it's a whole semester, um, to make sure that I've got these kids where I want them. And for them to know that I care about them and that when they mess up, you know, we'll fix it. But you better say you're sorry. You know. To really create these relationships with these kiddos.

Allison collaborated with teachers in school, discussing lessons and activities. Discussions about lesson plans were mandated by the department.

"We will get together during the school year with other teachers and I mean, like, we have department meetings and we collaborate and collaborating is great and fantastic."

Edgar was also bothered that some students didn't like math or want to be in class, and were not concerned about grades. He wished they could adopt a positive attitude towards learning. He had students with a "rough home life" which he blamed for their attitudes, and was sympathetic to these students as they had difficulty focusing on school with so many outside distractions.

Diane and Edgar encountered JSMC students in regular school. Edgar recognized and "high-fived" these students. Diane had the same students in levels one, two, and four in JSMC, and then in algebra at school. She was able to track their progress from JSMC to school.

The apathy regarding school in general and specifically math discouraged and frustrated the teachers, and was in sharp contrast with the experience they had in JSMC. Ironically, these students came from the same population of students from the district that three of the teachers taught in. However, these students applied to attend camp and those who did not receive a scholarship paid a fee to attend, so the population in JSMC was narrowed to those who liked math. The teachers wanted to teach students who were willing and eager to learn all the time.

Being Sustained

The teachers desire to continue teaching strengthened and waned across the years.

They loved teaching, but factors discussed in the previous section-such as student behavior, apathy, time constraints, administration, testing, and unsupportive school culture made them consider quitting. Despite being worn out at times from stress, they stayed in their positions, and all five participants considered JSMC to be a primary factor.

Mary cited the apathy she sensed in students as a primary reason she considered quitting teaching as this apathy sapped her energy. The reward for teaching and her hard work was missing. She considered waiting tables with her own children. Despite these struggles, Mary stayed, and attributed this decision to JSMC.

> JSMC, this camp, has kept me teaching, like really kept me. I think it has made me a better teacher because it made me realize that it can be fun and that with the right, I think with the right thinking processes, you can teach your kids to think. I think that's been the biggest thing you know.

She was revitalized and inspired to teach school the following year. Her effort was appreciated by the professors, and her worth as a teacher was validated.

> I thought, Do I really want to do this anymore? You know. But coming to the camp, it is like you know, it is like summers, you know teachers teach and their exhausted and they have their summer, and every year you're pepped back up. I find that this, when I'm through teaching, I'm worn out, I'm tired. But I come here and I still teach, but it is so different that it kind of pumps me up. And then I really have enjoyed the rest of my summer, because I'm not worried about getting pumped up for the, I'm like well I'm pumped, I'm ready, this is fun, I'm going to go enjoy the

> rest of my summer and then I will go next year, but I really don't know what I would be able to do that without all the strategies. And they make me feel very worthwhile, that I am a positive, you know, what's the word I'm looking for? Like I help math camp, does that makes sense? They are very appreciative. I mean, and it is not just like, Oh you're back. Great. It's like, Of course you're back!

Pilar explicitly stated that JSMC was what had kept her in the teaching profession for seventeen years. Like Mary, Pilar had tough years at school. However, Pilar loved teaching, and she specifically left her electrical engineering degree to teach. The year just prior to our interview was especially trying for Pilar as she had trouble communicating with parents and became depressed. JSMC motivated her to continue teaching and helped her forget about the previous year.

> [JSMC] sustained me for seventeen years. Because I think I would have quit already like if I didn't have [math camp]. Some years I feel like I want to quit. I do. There are some years like this last year was such a tough year for me. But not with students it was more with parents.

"You know it is these things you go through. I think they kind of get you down. So yeah, now I'm back up again because I came to math camp."

Allison also had a negative experience in school the previous year. She considered quitting teaching to stay at home with her three children as a healthy step for her family. She claimed that despite the struggles she faced, this was the only reason she would leave teaching, as teaching was her passion and something she excelled at. She had considered

teaching in other capacities, such as teaching teachers. When she finished each school year she would remember how much she cared about the students, especially when she ran into one of her regular students in JSMC.

> But the sad thing is while you are living them they are so difficult. But once you are done with them. I just ran into another kid in the cafeteria actually that I had this year. That I forget you know because you think of all the bad things that happen. I'm like oh my god I love that kid. So there are always great things.

Edgar, despite expressing frustration with administration and other aspects of school, had no thoughts of quitting teaching in his relatively short four-year career. He also planned to teach in JSMC each summer. He considered working in administration after fifteen or twenty years of teaching. His immediate goal was to try teaching high school.

> I plan to retire a teacher. I always think about going to administration. Uh maybe I can't be a principal but maybe going to being an assistant principal. But that is like way down maybe fifteen twenty years down the road.

For Diane, being able to interact with students who loved math and wanted to learn contributed to keeping her in the profession. It was hard for her to go back to school and see hatred of math in her students.

> It's good to know that there are kids out there who still love math and still love learning. Because, without attending this, it would just be so hard to go back to a normal school year where kids are like I hate math.

The teachers were strongly motivated to stay in the teaching profession due to the influence of JSMC. There were motivated by the environment, students who were engaged, interested in math, and wanted to learn, and the appreciation they received from the professors. They felt their hard work and teaching skills were valued, and they were supported in teaching the way they wanted to, without worrying about grades or testing.

In the following table, I summarize the benefits that the teachers received in JSMC that contributed to sustaining them in the profession.

Table 4. Benefits to Participants.

Benefit Category	**Benefit Subcategory**	**Example**
Learning Mathematics	Working on mathematics problems that enhance the teacher's own knowledge	Edgar worked on creating a scale to determine how equilateral a triangle was in the PD.
Teaching	Learning mathematics applicable to the teachers school classroom	Mary learned a new way of proving the Pythagorean Theorem in the PD
Questioning Strategies	Learning how to question students to understand their thinking or emphasize the problem-solving process.	Diane learned to question students to consider alternate solution strategies.
Wait Time	Becoming comfortable with silence in the classroom.	Edgar learned to see silence as a learning opportunity.
Multiple Solutions	Using problems with multiple solution strategies or solutions to focus on the problem-solving process and deemphasize the answer.	Edgar used finding an expression for determining the perimeter of a box in his classroom to focus on the problem-solving process.
Confidence-Building	Witnessing students confidence as a result of JSMC.	Allison encountered students in school who learned the Pythagorean theorem in camp and were excited to share when this topic was introduced in school.
Student Attitudes	Witnessing positive attitudes or changes in attitude from students.	One of Pilar's student used a game she introduced to them in school.

Mentoring by Professors	Forming relationships, seeking advice, and viewing professors as a source of support	Mary sought career advice from Hana and requested job references.
Mentoring by Teachers	Relationships between novice and experienced teachers formed in camp.	Edgar formed a mentoring relationship with Allison, who was his official mentor in school as well.
Collaboration	Working on lesson plans, teaching strategies, or sharing ideas with teachers and professors.	Mary collaborated with Diane, Pilar, Jocelyn, and Marcy to help write the JSMC level one curriculum.
Observing Teachers	Learning from observing another teacher teach.	Allison learned how to question students from observing a JSMC teacher teach.

V. DISCUSSION

My initial motivation for this research was to understand how a math camp-involving opportunities for teaching, learning, reflection, collaboration, and mentoring-can impact teachers desire to stay in the profession. This is situated n the context of the high turnover rate of K-12 teachers today. Teachers face myriad of challenges in school and often lack meaningful support. Research has shown that support structures such as PD, mentoring, learning experiences, and a strong community can make a difference in teachers decision to stay and satisfaction (Tickle et al., 2011). There is very little research on how summer camps can influence teachers job satisfaction and desire to stay in the profession. This study explored the experiences of teachers over the many years they attended JSMC, how the setting contributed to these experiences, and how these experiences sustained the teachers.

The intent of this study is not to compare the JSMC setting to a school math class, or to suggest that JSMC is better than school. It would be irrational to compare school to JSMC, as the two settings have completely different populations, purposes, constraints, and structures. However, this study revealed key elements of JSMC that can and should be introduced into the school setting. These elements are the aspects of JSMC that benefitted the teachers in this study, and they are the focus of this discussion, which is organized by my research questions,

1) What are the experiences of the teachers in the camp?

2) What elements of the setting contribute to the teachers having those experiences?

3) Do the teachers interpret these experiences as beneficial towards sustaining their career?

Research Question One

The first research question deals with discovering and categorizing the experiences the teachers had. In JSMC, I found the teachers worked on math problems, taught class sessions, attended PD sessions, reflected on teaching, collaborated with each other, and attended social events.

The teachers worked on math problems in the PD, oftentimes in a group setting that allowed them to shared strategies with other math teachers. Many of the problems were interesting, unusual, and novel for the teachers, such as considering whether there could be two zeroes on a number line and what the implications would be as such. They took some problems back to school, while other problems helped them develop and hone their math knowledge.

A central component of JSMC was teaching. Each teacher taught for approximately four hours each day, with breaks for a snack, from eight to noon in one of the five levels. They used the curriculum designed by the professors and some graduate students and supplemented the curriculum with their own activities.

The second major component of JSMC was the PD, which were held each afternoon after JSMC. The teachers attended for a short time and a longer PD continued for PSTs and other non-JSMC teachers. This PD involved discussing teaching, watching videos of teaching episodes, discussing research, and solving math problems.

The teachers met with fellows each day after camp to discuss teaching. They wrote a structured reflection that was collected and read by the professors.

Social activities were important in JSMC. The teachers formed relationships that continued in school. They texted, called, messaged on social media, and went to dinner. They bonded with staff, including Polly and student workers. They sought advice from the professors and looked to them as mentors.

Research Question Two

The second question asks how the elements of the setting contributed to the teachers' overall experiences. This refers to the unique environment in JSMC created by the professors and their philosophies, the staff and student workers, fellows, other teachers, and the structured and unstructured opportunities provided by JSMC for teachers.

Professors, teachers, staff, fellows, and students all contributed to the culture in JSMC. I began to understand the importance of the role the professors played in JSMC from the interviews, my own observations, and many informal conversations with the professors. They were constantly present each camp day, monitoring classes, interacting with teachers and students, and running JSMC. They used research-based practices to teach the PD, write the curriculum, and set the tone of learning for JSMC. They had a clear vision for the instruction they wanted students to receive in JSMC. This vision involved a focus on conceptual understanding of mathematics rather than procedures, to "think deeply about simple things," and to spark joy in students about learning and

developing a love for math. This was communicated to the teachers and others through various channels, including discussions in the PD, the guiding principles, casual conversations with teachers in the hallways or over a meal, and in responses to reflections. The teachers sensed positivity, encouragement, sincerity and dedication from the professors. This made them want to teach well.

In turn, the teacher's enthusiasm, desire to be effective, and teaching skills and experience all helped to shape JSMC. They took advantage of the learning opportunities in JSMC and constantly experimented with and improved their teaching. They emphasized conceptual understanding over quantity of content covered. They wanted students to remember JSMC math when they saw it in school. Mostly, they wanted students to enjoy JSMC and develop a strong interest in math. They brought many ideas from JSMC to school and created discovery-based learning environments in their classrooms.

The students made JSMC special. Many of them loved math and were excited about learning. They were motivated and willing to work hard. This type of student inspired the teachers.

Literature suggests that PSTs suffer from the indoctrination of their K-12 years, and that it may be difficult for them to adopt practices that do not align with their own experiences. Researchers found that in the first year of teaching, teachers with a bachelor's degree but little or no pedagogical preparation left the teaching profession at a rate twice as high as those with a bachelors degree and pedagogical preparation

(Conference Board of the Mathematical Sciences, 2010). These deficits perpetuate the cycle of low mathematics achievement. One of the reasons why university-level preparation of mathematics teachers does not have its desired outcome is that during their K-12 years, these PSTs develop a lasting impression of what it means to teach and learn math which is hard to dispel or change (Groth, Bergner, Burgess, Austin, & Holdai, 2016).

I propose that observing and teaching in JSMC as a PST and in-service teacher can dispel the indoctrination from teachers' K-12 years. JSMC is a model of a math classroom focused on conceptual understanding and one that lacks "drill and kill" teaching that many of the teachers experienced in their own schooling.

The professors offered mentoring to the teachers, both formally and informally. They provided teaching feedback and advice, praise, encouragement, and were extremely supportive. There is an "emerging consensus among U.S. educators and policymakers that the retention of new teachers depends on effective mentors and induction programs." (Feiman-Nemser, 2003).

Since all five teachers began teaching in JSMC around the same time as school, JSMC served as an effective induction program. Early in their careers, they received mentoring by professors, validation about their teaching abilities, and learning opportunities. This is also true for the PSTs who attended JSMC. They observed and assisted in teaching in JSMC, learned from experienced teachers and professors, reflected on best teaching practices, and learned mathematics. JSMC impacts PSTs and beginning

teachers, and also provides continued support for veteran teachers.

Collaboration and friendship between teachers contributed to their experience. They discussed teaching, became friends, collaborated on lessons, and shared how they managed their class. They learned from observing each other teach. Mentoring relationships were formed between novice and experienced teachers, such as Edgar and Allison. These formed personal friendships and kept in touch, went to dinner, and communicated through social media and text in school. They celebrated the opportunity to reunite each summer. As McLaughlin (1993) found, the character of the community of practice created in a teacher's workplace effects the quality and type of teaching practices they use in the classroom. Communities allow supportive relationships to build among teachers, and establish norms for reflection and feedback. In JSMC, this type of community was developed as the teachers formed these types of mentoring and collaborative relationships.

Feiman-Nemser (2003) explains how the traditional set up of schools does not create opportunities for teachers to collaborate, and in fact, can discourage communication between teachers, and highlights the need for teachers to communicate with one another. Little (1999) uses a metaphor of a parking lot connecting classrooms to depict the isolating environment schools can create. This environment often keeps teachers separated and nurtures feelings of isolation. Teachers may feel it is better to rely on their own knowledge then ask for help, and may not know how to productively discuss teaching when they do talk to other teachers. They may avoid expressing a difference of opinion to maintain harmony in collegial relations (Feiman-Nemser, 2003).

Allison was isolated in school and became her own island so that she could teach the way she wanted to. In contrast, in JSMC she benefitted from discussing ideas about teaching with the other teachers and professors, who displayed the type of teaching practices she valued.

The setting provided the opportunity for the teachers to reflect on teaching. There was scheduled time in JSMC for teachers to meet and discuss the class and lesson plans, and make changes or improvements therein. The teachers were encouraged by professors to take ownership of their teaching, make suggestions for feedback to improve JSMC and be active participants in curriculum development. This provides insight into what PD should look like for modern-day teachers: Little (1993) suggests that a measure of the quality of professional development is in its ability to provide teachers tools to shape their own teaching and critique reform efforts.

Mathematics learning opportunities were provided in the problem-solving sessions in the afternoon PD, run by math and math education professors. They posed interesting and challenging problems, some relevant to the classroom, and others for teacher's mathematical growth.

Mary worried that she lacked the prior knowledge to solve a problem, but was encouraged by professors to solve the problem just by thinking. They emphasized that she didn't need to recognize the problem or remember any formula. This made her realize she could rely on her own problem-solving skills and her confidence grew as a result.

The opportunities for discussions about math problems in the PD influenced the

teachers' thinking. They learned to listen to one another and consider alternate strategies. They then created this opportunity in school for their students. Fennema et al. (1996) discusses how professional development can encourage teachers to develop knowledge of mathematics and pedagogical knowledge by incorporating this knowledge and pedagogies in the running of the PD sessions. The teachers then recreate these strategies and use this knowledge in their teaching.

The professors did exactly this in the JSMC PD. They used ideas they wanted teachers to implement in their classrooms in the problem-solving sessions. They wanted teachers to focus on the problem-solving process rather than focusing on the answer. To encourage this, the professors presented problems with multiple solutions, strategies or open-ended problems, such as creating a scale for how equilateral a triangle was, considering the implications of having two zeros on a number line or coming up with an expression for the perimeter of an object. Working on this problem naturally forced considering the endless possible answers and each other's strategies. The teachers used this type of problem with their students.

The teachers learned teaching strategies that they used in class. Mary adopted the car model and number line for teaching adding and subtracting integers and learned a new way to prove the Pythagorean theorem. Feiman-Nemser advocates for the need for teacher learning:

> But we misrepresent the process of learning to teach when we consider new teachers as finished products, when we assume that they mostly need to refine

> existing skills, or when we treat their learning needs as signs of deficiency in their preparation. Beginning teachers have legitimate learning needs that cannot be grasped in advanced or outside the contexts of teaching (Feiman-Nemser, 2003, p. 26).

The teachers learned how to question students in JSMC to check for understanding and prompt explanations of thinking. They moved away from telling students answers. They encouraged consideration of different approaches.

The professors listened to and incorporated the teacher's suggestions. This feedback was provided feedback in written reflections, meetings, and group discussions. Suggestions involved increased planning time, reducing class size, implementing pre and post-tests, and changing the curriculum sequence. They were free to modify the curriculum to meet their students' needs. For example, Mary adjusted the amount of time spent on the number line and adding and subtracting integers. This freedom gave the teachers autonomy and an ownership of their teaching, which was sometimes lacking in school.

Research Question Three

The third research question addresses how JSMC contributed to sustaining teachers. I found that JSMC was overwhelmingly one of the most important factors that kept the teachers teaching. They explicitly stated this and it was also evidenced by their descriptions of how motivated they were by learning opportunities, encouragement from professors, the supportive community formed, and the positive attitudes towards math

from students.

The teachers' school classroom practices and strategies, confidence in mathematical abilities, problem-solving, and teaching abilities were influenced by what they learned in JSMC. They learned to teach in a "discovery" style. This involved focusing on the problem-solving process, not the answer. It involved not telling students how to solve a problem but let them discover it on their own through activities and open-ended problems, using questioning to generate discussions and probe for understanding while also using group work. They also changed their responses to questions by asking a student to respond rather than answering the question. These influences reflect the practices that Cohen and Ball (1990) stress as important aspects of reform-minded mathematics teaching, including an emphasis on a deep understanding of math, improving students reasoning abilities, and appreciation of math. All of these elements of teaching were adopted by the teachers and observed in the teachers teaching and reflections in JSMC. These principles were also included in the guiding principles that governed the running of the camp and incorporated into the way the PD was conducted.

Edgar changed his classroom environment significantly. He switched from a lecture-based format of notes, examples, and independent practice to using activities, group work, and classroom discussions. Diane reorganized her desks into groups in her classroom after JSMC. These changes in instructional practices learned in JSMC made the teachers happier with their school classrooms. This satisfaction made them want to continue teaching.

The teachers adopted a discovery-based approach to teaching which encompassed the idea of "no wrong answers" from the JSMC PD and from observing other teachers. They witnessed this in the way the PD was taught, the problems they worked on, and in the curriculum. Posing a problem to a student and responding with "yes" or "no" based on the answer had no merit. Every answer given was a valuable and a learning opportunity. Schoenfeld (1994) was able to create a mathematical community among his students, where they engaged in the sense-making that comes with doing mathematics and found as a result, the students no longer saw him as the authority needed to certify the correctness of their solutions.

The teachers found the PD more relevant to their teaching than other non-math PDs they had attended. Star and Strickland found that courses involving teachers viewing videos of teaching episodes can help teacher's notice more substantive features of the classroom rather than static features (Star & Strickland, 2008). These type of video episodes were viewed and discussed in the PD. Teachers began to notice more about their students thinking and mathematical strategies after JSMC. Mary began to notice student thinking and pick up on nuances in their strategies. She began to consider the basis of her student's conjectures and why they chose a strategy and this was eye-opening for her. Mary experienced this in a conversation about negative numbers on the number line. This noticing became natural as the students were constantly explaining their thinking in JSMC.

I found evidence that the practices that the teachers adopted from JSMC made their

teaching more effective. This was seen in the engagement, learning, growth, attitude changes, and increases in confidence in the students. Smith et al. (2005) found that in research examining the relationship between what characteristics we can observe that make quality teachers, and student achievement, effective teaching is often left out. Since it is more difficult to measure effective teaching, there is often an emphasis on college coursework, certification, and other tangible credentials to gauge teacher quality (Smith, et al., 2005). However, in this study, I found that the emphasis in reflections and feedback on teaching in JSMC focused on the delivery of the content, and the student's responses and thinking to this delivery, and how students interacted with each other in class. In this sense, JSMC provides an environment where effective teaching is measured in concrete, tangible ways.

Research also indicates that teachers change and adapt their practices as a result of learning about student thinking. Fennema et al. (1996) conducted a study involving 21 primary grade teachers who participated in a CGI teacher development program which sought to help teachers understand children's mathematical thinking and examined changes in teacher's beliefs as a result of this understanding. They concluded that knowledge about children's thinking has a large impact on teachers as they make decisions about instruction.

Liping Ma (2010) found that teachers in China attain mathematical competence that cycles upward. They obtain competence in school mathematics, connect it to student learning in teacher education programs, and when they start teaching, they empower their

students with mathematical competence and attain mathematical knowledge for teaching. However, Ma found that in the US, low-quality math education and poor teacher knowledge reinforce each other (Ma, 2010).

In JSMC, the opposite of what Ma conjectured about US education is occurring. Teachers gain high-quality mathematics knowledge in the professional development sessions which they can implement in the classroom the very next day (Grossman, et al., 2009). They empower the JSMC students with mathematical competence and strengthen their mathematical knowledge for teaching. Teachers engage in the cycle of teaching, reflecting on teaching, learning mathematics and about student thinking, and repeat the process the next day, across multiple summers. The JSMC teacher's knowledge and mathematical competence is cycling upward in the same way that Ma found happening with teachers in China.

JSMC was motivating for teachers. They came every summer worn out from school and were rejuvenated. The special environment and strong community created in JSMC inspired them. Their students were excited about learning and worked hard. The teaching environment was supportive and the possibilities for learning were exciting. The teachers formed lasting friendships. A positive attitude and enjoyment of JSMC permeated the environment and was expressed by teachers, professors, and students. The students were eager to share what they learned in JSMC in school.

Differences between JSMC and school contributed to teachers' lack of stress in JSMC. They worked hard and were under pressure, but some of the distractions and

constraints of school were absent. For example, they didn't have to call parents because of behavior as JSMC staff handled serious behavior issues, and the teachers often let minor behavior problems slide. There was no testing in JSMC, and therefore no pressure to "teach to the test". There was also no push to speed through the curriculum, and the teachers could adjust their pacing for struggling or advanced students. The pressure that they felt to teach well was self-imposed. Allison found that the professors had a definite vision for JSMC, and she felt an obligation to live up to this vision. Although the four-hour instructional time was sometimes tiring, the teachers wanted each snapshot of their classroom to reflect learning.

Most importantly, the teachers were supported by the administration (the professors) in JSMC, and this was a large factor contributing to keeping them in the profession. They were free to teach the way they wanted and their instructional choices were respected. They were treated as master teachers. They felt the professors valued and appreciated their hard work, and recognized their mathematical, and teaching abilities. This sense of appreciation was lacking in regular school. In JSMC, they were told that they were doing a good job, were called master teachers, and their ideas about teaching were trusted. Diane enjoyed being observed in JSMC as she never received but often craved feedback in school. She explained that even negative feedback was welcome, as long as she got something. The teachers benefitted from listening to professors discuss math and interacting with highly educated mathematicians and mathematics education professors who provided them with guidance and new perspectives on math topics. They consulted professors outside JSMC, and the teachers provided input on the JSMC

curriculum while in school. Mary even went to Hana for career advice. These relationships were sustained and deepened over the years.

Literature indicates that teachers at all career stages need support and feedback, starting with their induction years. They need mentoring opportunities, opportunities for growth, and to feel their hard work is being appreciated. Darling-Hammond (2003) explains that although low pay, large class sizes, and a lack of preparation often cause teachers to leave, teachers need to feel appreciated. Teachers tend to seek out jobs in schools where they feel they will be appreciated.

Although there is existing literature on this topic, Tickle et al. (2011) found that it is sparse and that there is a lack of research on how working conditions in school, and especially administrative support, contribute to teacher's desire to stay in the profession. They conducted a study to understand this and found that administrative support is the single most important factor that keeps teachers teaching. This support can mediate other troublesome aspects of teaching, such as student behavior, lack of teaching experience, and low pay. In JSMC, this strong administrative support network provided by the professors, and supported by the teachers and staff, was a large source of motivation. The encouragement, constructive feedback and positive relationships with the professors were one of the main reasons that teachers returned to JSMC each year. This finding supports the work of Tickle et al. (2011) in emphasizing the importance of administrative support.

Seeing growth in students in JSMC was another large factor in sustaining the teachers. This growth was in terms of both knowledge and confidence. Some students

didn't like math, and attended JSMC because their parents forced them to, but began to love math by the end and were enthusiastic about returning the following year. Often these students were successful for the first time in their lives in JSMC, and Pilar credited this success with their attitude changes. Students who were initially unwilling to share would be actively discussing math with their classmates by the end. Many other students came to JSMC with a strong interest in math. Even for these students, the teachers noticed growth in confidence. Pilar believed that the growth she noticed in her student's confidence was more important than knowledge growth as they would have the confidence to tackle problems in the future.

Krumboltz's theory of career decision-making identifies six factors leading to career satisfaction: teacher's personal characteristics, educational preparation, initial commitment to teaching, quality of first teaching experience, professional and social integration into teaching, and external influences including employment climate (Chapman & Green, 1986). The JSMC addressed almost all of these points. Math learning in the PD contributed to the teacher's educational preparation. Teaching for JSMC early in their careers strengthened their initial commitment to teaching and provided a quality first teaching experience. Social integration into teaching occurred in JSMC, as teachers formed strong friendships with each other and staff and collaborated on lessons and teaching strategies with teachers and professors. This professional and social integration into teaching helped teachers grow into the profession and decide to stay.

Implications for Professional Development Programs

Many challenges are encountered when creating effective PD for teachers. Designing content that is relevant to teachers and applicable in their classroom, while engaging them and enhancing their knowledge, is a difficult task. Many PD sessions are focused on pedagogical techniques such as ways to organize notes or group students. While these have value, math teachers need opportunities to discuss teaching strategies, student thinking and how to get students to gain conceptual understanding. Some math departments do mandate that teachers plan together, but this usually focuses on the following day's lesson rather than student thinking.

The features of the JSMC PD environment suggest a model that can be used to improve math education in schools. Teachers need the opportunities that exist in JSMC in school. Some of these opportunities are:

- Engaging in problem-solving to further their own mathematical knowledge
- Reflecting on their teaching
- Engaging in discussions about research-based practices to increase students understanding of math.
- Developing problem-centered thinking skills
- Experiencing mentoring by veteran teachers and professors
- Watching other teachers teach and video episodes of teaching and discussing these

- Providing feedback on curriculum and school structure
- Interacting and learning from highly educated professors
- Collaborating with other teachers
- Having undergraduate PSTs assist in classes
- Having social interactions with their colleagues

In conclusion, this study suggests that when teachers are provided with rich learning opportunities in a supportive environment, they are motivated to become better teachers. When they are introduced to research-based practices in this environment, they adopt these practices. They align with current trends in mathematics education that deviate from the procedural "drill and kill" approach of previous generations and begin to adopt a teaching style based on inquiry and discovery. This is despite the traditional learning they experienced in school. Teachers have already demonstrated their willingness to work hard by simply being in the extremely demanding profession, but they often work hard in isolation, defeated by the pressures of testing, administration, student behavior, and a lack of a supportive community, mentoring opportunities, and meaningful, relevant learning opportunities. This study has shown that when teachers are given these opportunities, they benefit greatly. They thrive and are sustained in the profession.

Further Research

That teachers need and value the opportunities discussed in the previous section is clear, based on the teachers' vivid descriptions of how these experiences in JSMC motivated and supported them. This suggests several directions for future research. Here I outline three.

Research is needed to understand how partnerships between schools and nearby universities can be fostered and implemented. These partnerships can allow professors to mentor and collaborate with K-12 teachers, and can also allow graduate students to interact with K-12 teachers and students. This type of partnership is mutually beneficial for teachers and professors, as professors who study mathematics education can see topics that they research being enacted in the teacher's classrooms, and this can inform and enhance their research. They also interact with K-12 students, who are the focus of much of the research in math education in an authentic environment. The impact of this partnership on the professors and graduate students own research and teaching in the university can be investigated. The teachers also benefit from the professor's extensive years of study and experience. They can learn about research-based teaching practices, receive feedback on their teaching, and implement new teaching strategies specific to math, in partnership with the professors.

The benefits the teacher's received from JSMC suggest a research direction that focuses on measuring the affective qualities of the teachers' experience, such as confidence in teaching, problem-solving abilities, knowledge of math and a sense of

validation and appreciation from students and mentors. An instrument could be developed to gauge particular aspects of the teacher's experiences. This may reveal clear patterns and characteristics of professional development that may be beneficial for teacher retention.

This study focused on the experiences of the teachers in JSMC. However, this study also revealed that K-12 students, PSTs, graduate students, and professors all had meaningful experiences in JSMC. Further studies could investigate the influence of JSMC on K-12 students mathematical growth and attitudes towards math. There is evidence from the teachers that this growth was experienced by the students. It would be valuable to create an instrument to measure this growth and a survey to understand how student's attitudes towards math changed over the course of JSMC.

The impact on PSTs views about teaching, and success in their first classroom teaching assignments after JSMC could also be investigated. The teachers noticed that the PSTs experienced the classroom environment, often for the first time since their K-12 year. The PSTs witnessed a research-based math curriculum being implemented in a highly successful summer camp. They saw new and innovative ways of approaching math concepts and had the opportunity to reflect on teaching and practice teaching alongside the teachers and professors. The JSMC camp provided many of the experiences that an induction program offers, including experience interacting with real students and teachers. From this perspective, research investigating how JSMC serves as an enhancement of these PSTs university education related to teaching and as an induction program would be valuable.

Conclusion

In conclusion, this study addresses a critically important problem in society, that of retaining highly qualified teachers in the field of mathematics. Mathematics is a subject that serves as the foundation of knowledge for all STEM fields, and by studying mathematics, students in all majors build problem-solving and critical thinking skills. Their teachers are the ones who spark their interest, motivate them, and carry them through the process of acquiring these math skills and knowledge. This study has shown that in order to be successful, teachers need meaningful learning opportunities, strong mentors, and to be able to collaborate with other teachers. They also need to witness their students grow in knowledge and confidence. Programs like the one under study provide an opportunity for these to happen, which are missing in schools. This study adds to knowledge about the types of opportunities that are meaningful for teachers and provides a model that can be used to create this type of opportunities in other settings.

APPENDIX SECTION

APPENDIX A

Participant Consent Form

Participant's Printed Name: _____

I consent to participate in the research project entitled: Investigating How an Informal Summer Program Sustains Teachers in Their Profession. I was provided with an explanation of the data collection procedures, and the purpose of collecting these data by Sonalee Bhattacharyya, a doctoral candidate in Mathematics Education at Texas State University, San Marcos, Texas. I give Sonalee Bhattacharyya and Texas State University permission to audio record our interview for her dissertation.

I understand that a fictitious name will be provided for me in the interviews, and that confidentiality will be provided, and my identity will not be revealed. I understand that I may withdraw from the study at any time, with no penalties. I understand that the transcripts or excerpts of the transcripts may be used in the public presentations. I understand that the transcripts may be published in the form of books, articles, or newsletters.

Signature of Interviewee: _____

Date: _____

Contact Number/Email: _____

APPENDIX B

Interview Protocol

1) What is your position in school?
2) Describe what the experience of teaching has been like for you.
3) Has teaching at math camp impacted your attitude towards teaching overall, and if so, in what ways?
4) What aspects of the math camp experience are the most meaningful to you?
5) Was there anything from last year teaching in the camp that stood out as meaningful to you?
6) Are there any practices that you have seen another teacher doing that stood out to you?
7) Do you engage in collaboration with the other JSMC teachers during or outside of camp, or during the school year?
8) What suggestions for change do you have for JSMC regarding improving the camp or professional development?
9) How do you compare the JSMC PD to others that you have attended?
10) Do you plan to continue teaching long term?
11) Is there anything else that you feel is important to the JSMC experience or anything else you want to add?

APPENDIX C

Initial Survey

1) How many years have you been in the teaching profession?
2) What grade level(s) have you taught in mathematics?
3) How many summers have you taught in JSMC?
4) Please describe your overall impressions of your teaching experience at JSMC.
5) Please describe the most important aspects of this experience to you.
6) Please describe your experience teaching in JSMC in relation to the following areas:
    a. Teaching Strategies
    b. Student Thinking
    c. Problem Solving
    d. Growth Mindset
    e. Interest in Mathematics
    f. Struggle in Mathematics
    g. Equity
7) Please add anything about your experience teaching in JSMC that is significant to you or that you would like to add.

APPENDIX D

Guiding Principles

1. **Doing mathematics** is about making sense of and thinking deeply about fundamental concepts. Students should learn to "think deeply of simple things," (Arnold Ross). Students need to:
    a. Build on prior knowledge by making connections that follow the flow of ideas from what they previously understood to new ideas being studied
    b. Promote a deep understanding for why things work using visual models
    c. Focus on the math problems, not the answers
    d. Reflect on what they have learned to make sense of the mathematics
2. **Persistence** is critical to success in problem solving and doing mathematics. Students need to:
    a. Develop a "growth mindset," understand and believe that ability can be developed with hard work
    b. Be willing to take risks and understand that mistakes present opportunities for learning
    c. Take ownership of their own learning
    d. Develop confidence to tackle new situations without giving up easily
3. Teachers need to establish a **classroom culture** that develops students' curiosity and imagination. The keys to establishing this culture are to:

a. Make math interesting, fun and relevant with challenging, well-sequenced problems

b. Support student's productive struggle by responding to student questions with appropriate guidance

c. Allow sufficient time for learning ideas deeply

d. Use techniques to engage all students

e. Balance individual and group work; both can be appropriate depending on the task

4. **Communication** between students and teachers is critical for learning. To facilitate this, teachers should:

    a. Ask probing questions to develop student understanding, and encourage students to question why things work

    b. Expect students to present their work and defend their reasoning using precise mathematical language

    c. Take student attempts seriously, and examine both right and wrong approaches

    d. Expect students to articulate and explain the key math concepts

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