The Influence of an Out-Of-School Learning Program on High School Students' Mathematics Identity Formation

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Abstract

Efforts aimed at improving mathematics learning for all students have tended to adopt a deficit-oriented perspective focusing on race-gap analysis or other social identifiers like socioeconomic status, SES, (Domina, et al. 2014; Loveless, 2008). This tendency is contrary to the view by situated learning theorists who consider learning as a process of becoming a member of a certain community of practice (Wenger, 1998). Doing well or not in a mathematics classroom, according to situated learning theorists, depends on the extent to which students identify with classroom norms (Boaler, 2002a, Cobb et al., 2009, Wood, 2013). Learning of mathematics involves students developing mathematical identities influenced by the classroom norms.

This study examined the influence of an out-of-school mathematics mentoring and tutoring program known as Prepare2Nspire (P2N) on 12 high school students' mathematical identities which served predominantly minority students from first generation, low SES families. This was accomplished by examining the mathematical identities of high school students' prior to and after participating in P2N. A mixed methods design was used. Additionally, in order to provide a richer analysis of the influence of P2N on high school students' mathematical identities, two interpretive frameworks by Cobb et al. (2009) and Nasir and Cooks (2009) were used. Results from this study indicate that less participatory pedagogies lead to high school students identifying themselves in three *zones namely, zones of inclusion, uncertainty, and exclusion*. Overall, results from this study indicate that mathematical identities are not fixed but fluid and that depending on the kind of pedagogy students can move across various zones. Whether high school students identify themselves with math or not depends on the kind of mathematical pedagogy and access to practice-linked identity resources.

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CHAPTER 1

Introduction

This study examines the influence of an out- of- school mathematics mentoring and tutoring program known as Prepare2Nspire (P2N) on high school students' mathematical identities. In order to achieve this objective, the pre-and-post mathematical identities of 11th graders (referred to as mentutees) are investigated by documenting the normative identities as doers of mathematics in the two learning environments participants are involved in namely, their mathematics classrooms and P2N. The aim is to unravel the general and sociomathematical norms prevalent in P2N and the influence these norms may have on high school students' personal mathematical identities. An underlying assumption is that students' underachievement in mathematics is a function of the pedagogy they experience since pedagogical practices send messages about what is valued, acceptable ways of learning and succeeding in a subject, say mathematics, and expected ways of participating in the learning environment.

This study therefore, seeks to investigate features of a learning environment (P2N) which has been observed, over the past two years, to have led to improvement in both middle and high school students' mathematical outcomes such as achievement and attitude towards mathematics. It therefore moves the discussion beyond studies which document what is not working or adopts a deficit-oriented perspective to concerns about general levels of achievement in mathematics (e.g. achievement gap) by focusing on what works. By so doing, the aim is to provide teacher educators and mathematics teachers with information regarding instructional practices likely to support all students' mathematical success as envisaged by various organizations and captured in various national documents (National Research Council [NRC], 2000, 2001; National Council of Teachers of Mathematics [NCTM], 2000, 2014; President's Council of Advisors on Science & Technology [PCAST], 2010).

This chapter is outlined as follows: concerns about enrolment into STEM disciplines and underlying reasons; identification and nature of mathematical identity; building mathematics learning communities: rationale for out-of-school programs; Prepare2Nspire: An exemplar of an out-of-school program. It ends with sections on purpose of the study; statement of the problem; research questions; significance of the study; and ends with a definition of terms.

Concerns about Enrolment into STEM Disciplines and Underlying Reasons

In recent times, concerns have been raised about the low number of students entering the Science, Technology, Engineering, and Mathematics (STEM) pipeline (English & Mousoulides, 2011). In a report to President Obama by his advisors on science and technology, the authors noted that only about a third of bachelor’s degrees earned in the USA are in STEM fields compared to about 63% in Japan (PCAST, 2010). In the USA, it is reported that if current rates of training scientists and engineers should persist, a deficit of 1,000,000 workers over the next decade is projected (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). It is argued that inability to produce the required number of STEM workers could stifle technological breakthroughs and the wellbeing of American citizens. Additionally, the global world is increasingly becoming reliant on data-driven decisions, sometimes involving sophisticated mathematical knowledge, whether in the media through advertisement, sports discussions, consumption patterns, or political decisions. In this regard, it is imperative that each individual is mathematically literate to comprehend information being generated on a daily basis in order to become critical citizens (Adler, Ball, Krainer, Lin, & Novotna, 2005). In order to ensure that all persons are mathematically literate, there is a need to stop the leakage in the mathematics pipeline which prevents students at all levels and especially, at the high school level from gaining access to advanced level mathematics curriculum (Martin, 2012). Additionally, it will require an understanding of the factors leading to the deficit and the leakages.

A number of studies have highlighted how institutional factors such lowered teacher expectations, tracking and counseling practices have led to high students of color being denied access to advanced mathematics courses at the high school (Engberg & Wolniak, 2013; Martin, 2012). These studies indicate that a disproportionate number of high school students of color, for instance, are denied access to high levels of mathematics with the concomitant effect being observed in terms of students' academic trajectory and career options (Burris, Heubert, & Levin, 2006; Nomi & Allensworth, 2012). For example, the lack of access to mathematics courses necessary for college-level STEM fields is reportedly more pronounced in certain minority groupings such as African Americans and Hispanics. Noguera (2014) notes that African American males are more likely to be overrepresented in special education programs suggesting that they are cut off the mainstream courses that prepare students for college and certain careers. As such, the underrepresentation of students of color in college-required mathematics courses at the high schools means very few of them stand the chance of pursuing STEM fields in college.

A second reason cited for the low numbers of students pursuing STEM disciplines has to do with an achievement gap among various population groups in mathematics, for example between students of color and their White counterparts (Ladson-Billings, 2006; Loveless, 2008; Palardy, 2015). For instance, eighth grade African American and Hispanics students are reported to possess mathematics knowledge equivalent to a typical second grader (Loveless, 2008). A third reason cited for the skills-gap in STEM fields is a lack of interest on the part of students. The U.S.A Department of Education reports that only 16 percent of U.S.A high school seniors are proficient in mathematics and interested in a STEM career (NCTM, 2014). Also, the PCAST report indicated a gender gap in interest in STEM fields resulting in more females drifting away from STEM-related programs (PCAST, 2010). Delpit (1995) argues that no child (person of color) is born incapable or less able of learning. The authors of the NRC (2001) report noted that preschoolers start their education with interest in learning mathematics and a motivation to learn. This begs the question, what factors cause some students to underperform or lose interest in STEM-related programs, especially mathematics?

The NCTM in its document, *Principles and Standards for School Mathematics*, argued that, "…students' understanding of mathematics, their ability to solve problems, and their confidence in, and dispositions toward, mathematics are all shaped by the teaching they encounter in school" (NCTM, 2000, pp.16-17). Furthermore, the NRC (2001) report also indicates that whether students have a productive disposition towards mathematics or not depends, to an extent, on the kinds of teaching and learning experiences they encounter in their mathematics classrooms. Productive disposition "refers to the tendency to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics" (NRC, 2001, p. 131). Doing well or not depends on the extent to which students identify (personal identity) with the mathematical practices being promoted and the learning environment. While negative learning environments lead to students feeing less capable of doing mathematics, a positive learning environment can support students to build productive dispositions. For this reason, if students lose interest in studying mathematics the longer they stay in school (Walker, 2012), then a focus should be on the nature of mathematics learning environment and instructional practices students experience and their influence on their personal mathematical identities.

Identification and Nature of Mathematical Identity

Bishop (2012) argues that, "Who we believe ourselves to be is a powerful influence on how we interact, engage, behave, and learn" (p.34). When we have a sense of not belonging we are more likely to avoid being in that environment while we tend relish the chance of being in environments which validate our sense of worth. Where we place our efforts all have to do with the extent to which we identify with the task at hand and our sense of belonging to the community.

Identifying has to do with how an individual gets access to and makes use of resources in the learning environment to undertake mathematics practices to develop a mathematical identity (Sfard & Prusak, 2005). Identification takes place as individuals get socialized into mathematical norms and obligations which has influence on individual's; a) sense of belonging; b) sense of achievement, and c) behavior (Boaler, William, & Zevenbergen, 2000). While good mathematics teachers are able to create learning environments that support of all students and enable all students to identify with mathematics, unskilled teachers are unable to do so leading to students dis-identifying with the study of the subject. In this regard, the learning of mathematics involves the formation of mathematical identities as students engage in mathematical practices.

Students who identify themselves with the norms being promoted tend to do well and succeed in their studies while noncompliance can have a negative effect on students' learning and motivation to persist on mathematics tasks. For students without a positive disposition towards mathematics, the mathematics classroom can become threatening to them and a source of constant frustration (Boaler, 2008b). This is because threatening environments serve as settings where individuals have a notion of how devalued, unappreciated, and discriminated they are (Inzlicht & Good, 2006). For instance, a student whose way of doing mathematics is not appreciated by a teacher may feel devalued and not find the mathematics classroom an enjoyable place to be. Additionally, the eclectic curricular offered at the high school such as the Advanced Placement (AP) or International Baccalaureate (IB), and regular mathematics classes lead to a categorization of students into mathematically competent and incompetent (Horn, 2008). This situation leads to students who are not in the advanced classes developing notions of not being mathematically competent which leads to some of them avoiding courses likely to challenge their sense of self-worth (NRC, 2001).

In summary, it has been argued that the design of mathematical learning environments should attend to both cognitive and affective domains of students. This is because the psychosocial issues can make a mathematics classroom to appear threatening to students and ultimately have a negative influence on their achievement and notions of self with regards to the study of mathematics. The NRC notes that an effective mathematics learning environment requires that teachers attend to the "knowledge, skills, attitudes, and beliefs that learners bring to the educational setting" (NRC, 2001, p.133). Also, Barton and Coley (2010) argue that if the social, psychological, and emotional needs of children are unmet "it will not be possible to produce sustained school improvement or higher levels of academic achievement for inner-city youth" (cited in Noguera, 2014). As such, the mathematics learning environment should attend to both the psychological and social needs of students in order to increase their level of interest in mathematics and achievement.

Building Mathematics Learning Communities: Rationale for Out-of-School Programs

With concerns raised about the quality of teachers serving urban schools (Darling-Hammond, 2010), a change in pedagogy will require re-training a good number of all mathematics teachers in the K-12 system (NRC, 2001). However, even if it is feasible to retrain the large number of teachers in the public school system, the students whose future depends on quality teaching cannot wait, especially high school students who have to be college-ready. It is for this reason that out-of-school mathematics programs can play a complementary role in supporting high school students to be mathematically competent and college-ready. The important role out-of-school programs can play is given credence in the NCLB Act under its “supplemental educational services.” NCLB makes provisions for schools deemed not to have made adequate yearly progress to receive “free afterschool tutoring” (cited in Good, Stewart, & Heinrich, 2014, p.2). These supplemental programs can be formal out-of-school programs or informal academic networks that students form to support each other to succeed academically and also promote resiliency in the face of systemic challenges at school.

Out-of-school learning environments can serve as sites where students who have had negative experiences with school mathematics can have their mathematical identities transformed. This is because such environments serve as mathematical spaces which socialize students into the mathematics community in terms of ways of knowing mathematics through the building of relations and interactions about mathematics (Walker, 2012). These environments therefore, can lead to a different socialization process thereby influencing students’ mathematical identities and development of positive dispositions towards achievement (E. N. Walker, 2006, 2012; Walker & Syed, 2013).

One reason noted for the success of out-of-school learning environments is that they foster a sense of belonging since learning is communal in nature thereby reducing any threats to individual’s images about self (Bishop, 2012; Walker, 2012). Additionally, some of the more intentional out-of-school learning programs targeting certain ethnic groups enable participants to develop a sense of belonging. This is because participants do not feel like they are in the minority for them to feel threatened due to their minority studies resulting from a low representation (Inzlicht & Good, 2006). For instance, in a study by Walker and Syed (2013) focusing on college students, the authors noted that ethnicity and academic environment play a major role in ethnic minority students' sense of belonging and pursuit of their academic careers.

Another reason for the success of out-of-school learning communities is that unlike formal school systems where authority is mostly distributed to teachers with students most of them being compliant to these centers of authority, these mathematical learning spaces tend to be more informal with students sharing ideas with learners' ways of learning being valued (Martin, 2012). Furthermore, by allowing students to incorporate their own learning styles and preferences, learners begin to view the learning of mathematics as important to them, worth pursuing for its own sake and not something they are doing out of compulsion (Cobb, Gresalfi, & Hodge, 2009; Sfard & Prusak, 2005). Therefore, the teaching and learning processes enable students to develop positive dispositions towards mathematics (NRC, 2001). The envisaged mathematics learning environment should enable students to view the learning of mathematics as important to them, worth pursuing because they want to and not something they are doing out of compulsion (Cobb et al., 2009; Sfard & Prusak, 2005).

Furthermore, out-of-school learning environments tend to have smaller group sizes relative to classroom sizes leading to more instructional support. The smaller groups offer students increased opportunities to reason mathematically and offer justification and explanation for their work a practices which is likely to help them develop the necessary competence, knowledge, and facility in mathematics (NCTM, 2014; NRC, 2001). This is in contrast with formal school systems where desks are lined in straight rows with regular exams which inform students how ‘smart’ they are leading to negative consequences on underachieving students (Holme, 2013). The use of near-peer tutors also creates a safe environment for tutors and tutees to share ideas and communicate challenges leading to better instructional support. Walker (2012) noted that when students belong to peer groups that support their mathematical learning rather than working alone, they are likely to gain better understanding of mathematical concepts through increased opportunities to talk about mathematics leading to improved achievement and confidence in their mathematical abilities.

In summary, if students are to learn mathematics meaningfully, the kinds of relationships they form (and a sense of belonging), the ideas communicated during the mathematics socialization process, and increased opportunities to share ideas with other learners are all crucial in the learning process. However, despite the reported success of out-of-school programs, there is a dearth of studies which focus on the nature of mathematical socialization that out-of-school mathematics programs engender, particularly formal settings (Walker, 2012). Issues such as the nature of mathematical norms promoted and the mathematical identities (including self-efficacy, attitude towards mathematics, and sense of belonging) participants form remain virtually unexplored. If these mathematical spaces are able to transform students’ mathematical identities and ultimately sense of achievement, then an understanding of the mechanisms for any such transformation can inform instructional practices and structuring of mathematics learning environments. It is for this reason that this study was carried out to investigate the mathematical identities that high school students who participated in P2N formed with the notion of identifying the characteristics of the program that led to any reported changes.

Prepare2Nspire: An Exemplar of an Out-of-School Program

Prepare2Nspire (P2N) is a mathematics tutoring and mentoring program. It is based upon a cascading, near-peer tutoring model where undergraduates tutor and mentor 11th graders with the 11th graders in turn tutoring and mentoring eighth graders. Participants are mostly first generation students of color or from low socioeconomic backgrounds attending urban schools who are struggling in mathematics. The structure of P2N (see Figure 1), in contrast to what pertains in schools, allows for smaller learning groups thereby creating a sense of belonging leading to increased opportunities for students to talk and engage in mathematical discussions.

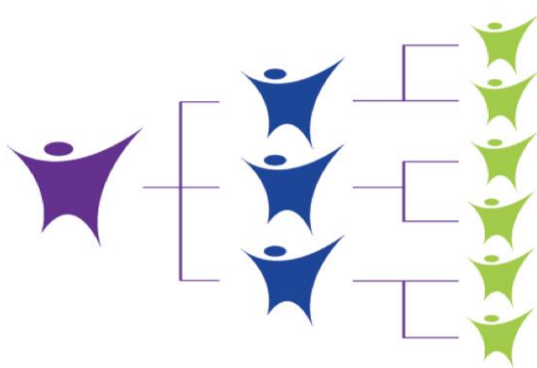


Figure 1. P2N program structure

One undergraduate (Purple) who works with three 11^{th} graders (Blue) with each of the 11^{th} graders in turn working with two eighth graders (Green). The 11^{th} graders (referred to as mentutees), meet twice a week on Mondays and Saturdays, with each session lasting two hours. Although Saturday sessions focused primarily on 8th graders, the 11th graders still had opportunities to study mathematics and receive any support needed. The bi-weekly tutoring sessions therefore, enabled the 11th graders to study mathematics more often thereby increasing their learning opportunities. Also, the mentors/tutors (mentutors) are mostly students of color in college pursuing mostly STEM programs thereby serving as role models for participants who might be suffering from the harmful effects of stereotyping groups of people.

In all, there are 15 communities comprising 10 members each made up of an undergraduate, three 11th graders, and six 8th graders. (see Covington Clarkson, Ntow, & Tackie, 2014 for details about nature of program). It is expected that through the constitution of new ways of learning mathematics, mentutees will develop new mathematical identities. This is because

> …as members of communities of practice experience changing (more engaged) identities, they come to learn new skills and bodies of knowledge, facilitating new ways of participating which, in turn, helps to create new identities relative to their community... [On the other hand,] increasing identification with an activity or with a community of practice motivates new learning. In this sense, identities can act as a motivator for new learning, prompting practice participants to seek out and gain the new skills they need to participate in their practice more effectively. (Nasir, 2002). p. 239–240.

It is the anticipation that by modeling a different kind of teaching than usually exists in most mathematics classrooms, mentutees will experience a turnaround in mathematical competencies and mathematical identities leading to improved achievement in mathematics (NRC, 2001). Also, the lack of a clearly discernible display of power in these communities contrary to what happens in schools is expected to lead to the creation of nonthreatening learning spaces where mentutees can feel free to share ideas and not be bothered about losing face. Ultimately the question is, does this mathematics learning community known as P2N have the capability to be *identity-transforming* (Horn, 2008, emphasis in original)?

Purpose of the Study

The purpose of this study is to investigate the influence P2N had on the mathematical identities 11th graders formed by documenting the normative identities mentutees have to identify with and its effect on their personal identities (mentutees sense of belonging and achievement). This will enable the researcher to understand how the normative identities (expected ways of participating in a community of inquiry) as doers of mathematics in particular communities influenced the construction of selves as doers of mathematics.

A major assumption underlying this study is that by enacting a different mathematical pedagogy, mentutees who did not see themselves as mathematics persons will experience a transformation in their mathematical identities. There is an implicit assumption that there will be a change in identity because most of the high school students who participated in P2N over the years did so because they needed mathematics help. It was observed that former participants, predominantly students of color, experienced improvements in their mathematics scores and confidence after participating in P2N. For instance, some of the high school students were moved from regular mathematics courses into advanced courses due to the improvements their teachers observed in their mathematics scores. With the renewed confidence and/or interest, it is likely that some mentutees, at the end of their P2N experience, may change their mathematics course taking pattern. In effect, there is a potential for P2N to be an identity-transforming program considering the near-peer tutoring approach coupled with the mentoring component that fosters the building of productive relationships and interactions among community members (Nasir, 2002; Horn, 2008; Walker, 2012).

Statement of Problem

Despite the perceived importance of out-of-school programs there are concerns about their effectiveness due to a lack of monitoring of such programs (Burch, Steinberg, & Donovan, 2007). Additionally, Cobb, Stephan, McClain, and Gravemeijer (2001) in a critique noted that educational programs do not provide enough details as to the instructional practices that led to the reported gains for it to be useful to educators. If out-of-school mathematics programs such as P2N have positive influence on the mathematics socialization and learning outcomes of participants, especially students of color, it is imperative to find out the process of socialization that takes place in this learning environment.

The broad question to be answered at the end of this study is the influence P2N had on 11th graders' mathematical identity formation. If there are any changes in the mathematical identities of participants in P2N, what are the mechanisms that supported these changes? That is, how does P2N mathematical learning environment support high school students' mathematical identities formation and what are the mechanisms that support the development of a more productive mathematical dispositions, if any? Such a study and its findings will enable mathematics educators gain a better understanding of how changes in classroom norms can influence high school students' sense of achievement, sense of belonging, and affiliation with mathematical tasks

Research Questions

The following questions will guide this study;

1. What is the nature of mathematics learning experiences of 11^{th} graders prior to joining P2N?
2. How are normative identities as doers of mathematics constructed and negotiated within selected P2N communities?
3. How does mentutors' use of identity resources in P2N influence the formation of specific learning and identity trajectories?
4. What is the nature of mentutees' personal identities in mathematics prior to and after participating in P2N?

Significance of the Study

Despite the importance of identity in influencing students' attitude towards mathematics and beliefs about their mathematical abilities, "identity has not become a central focus of research in mathematics education" (Cobb, Gresalfi, & Hodge, 2009, p.41). In a review by Stentoft and Valero (2009), the authors noted that the majority of the studies on identity have centered on students' identity formation as enacted in mathematics classrooms (e.g. Boaler, 2000; Wood, 2013). The few studies that have focused on out-of-school environments have focused on understanding the informal networks that students of color have with regards to STEM program (e.g. Engberg & Wolniak, 2013; Walker, 2006). Walker, (2012) urged a move away from studies which focus on informal networks that individual students form to mathematical spaces specifically formed to foster large number of students socialization into mathematics. This study, therefore, is likely to contribute the field of mathematics by addressing this dearth of research related to the mathematical identities that students form in a specifically mathematics out-of-school learning environment.

This study will provide critical information on the processes by which an out-of-school program enables hitherto struggling mathematics students to succeed in mathematics and the nature of the mathematics socialization. A focus on mathematical identities will enable the researcher to understand reasons that inform individual mentutees to act differently despite being in the same learning environment and why irrespective of those (individual) differences, there is a sense of a common theme underlying individuals' actions (Sfard & Prusak, 2005). The use of two frameworks by Nasir and Cooks (2009) and (Cobb et al., 2009), it is argued, will help to determine the normative and personal identities that participants in P2N form and also help document the mechanisms by which particular identities are promoted in the learning communities to be studied. Previous studies on mathematics identities have tended to use only one of these frameworks (see Horn, 2008 for an exception) thereby limiting the scope and findings of the study. By providing greater details at the micro-level in the selected communities, it is expected that the findings from this study will help mathematics educators design mathematics classrooms where all students see themselves as capable of learning high level mathematics content and become successful in it. This will help increase the number of people entering the STEM pipeline which is crucial for both the individual and the comity of nations.

Definition of Terms

There are several terms, phrases, acronyms, and definitions that will be used throughout this study. They are listed below.

Identity resources: the resources namely material, ideational, and relational resources that are made available to community members which influence their identity trajectory.

Mathematical identity: is defined as the embodiment of an individual's knowledge, beliefs, values, commitments, intentions, and affect as they relate to one's participation within a mathematics community of inquiry; the ways members ought to behave and how an individual chooses to act, and interact.

Normative identities: classroom or tutoring norms which inform students or tutees about the nature of mathematics, what it means to know mathematics, and what counts as being a capable doer of mathematics. This "comprises both the general and the specifically mathematical obligations that delineate the role of an effective student in a particular classroom" (Cobb et al., 2009, p.43) or any learning environment such as an out-of-school program.

Personal identity: “the extent to which individual students identify with, merely comply with, or resist their classroom obligations, and thus with what it means to know and do mathematics in their classroom” (Cobb et al, 2009, p.44).

Practice-linked identity: refers to how an individual views the importance of participating in community practices in the formation of his or her identity.

Organization of the rest of the Dissertation

Chapter 2 of this dissertation reviews the literature that is relevant to this study. Chapter 3 explains the research design and the methodologies used in the quantitative and qualitative parts of the study. Chapter 4 presents the descriptive statistics and the findings from the analyses of the quantitative and qualitative data that address the research questions. Chapter 5 summarizes the findings, assertions, and implications, and recommendations for future research.

CHAPTER 2

Literature Review

This review of literature offers an overview of issues confronting mathematics education and students' achievement. It also helps situate this study within previous works related to the study of mathematical identities. This chapter is outlined as follows: an overview of the importance of mathematics and concerns about universal access to school mathematics and beliefs about mathematics and how such believes and stereotypes can create a threatening learning environment to students' mathematical identities. This chapter ends with a focus on how mathematical identities have been conceptualized, and how access to various identity resources have influence on the mathematical identities students form.

Importance of Mathematics

Dark (2003) pointed out that globalization and technology have dramatically changed the nature of problems confronting society. Dark identified four areas of skillfulness required for high performing workplaces in order to respond to the challenges of globalization and technology as follows; complex systems, communication, representational fluency, and self-management (independent judgment). Acquiring such skills requires high-level mathematics necessary for individuals to problem-solve and also due to its wide applicability in various disciplines such as engineering and economics. It is partly due to these reasons that various countries make the study of mathematics compulsory for its citizenry. The importance of mathematics is also captured in documents published by various organizations and scholars.

The National Council of Teachers of Mathematics (NCTM) in its document *Principles and Standards for School Mathematics* argues that individuals with mathematical understanding and ability to do mathematics are likely to have significantly improved lives (NCTM, 2000). The importance of mathematics to all individuals is re-echoed by in a report by the National Research Council (NRC) entitled *Adding It Up*: *Helping Children Learn Mathematics* where the authors argue that individuals who cannot reason mathematically face being sidelined from too many opportunities in life (NRC, 2001). Other scholars have suggested a correlation between economic wellbeing and mathematics. For instance, Klopfenstein (2005) notes that the more rigorous high school mathematics courses a student takes the greater the wages.

Mathematical literacy (possession of advanced mathematical knowledge) does not benefit only the individual; there are some who argue that its utilitarian value makes it imperative for all individuals to gain access to its knowledge. The general argument is that the society stands to benefit in terms of better economic prospects and general standard of living. For instance, Schoenfeld (2004) argues that the utilitarian value of mathematics makes it indispensable to the larger society and the world in general. According to him, mathematical concepts play an integral role in a nation's economic and military advancement as evident during the space-race in the early 60s. The space-race between the then Soviet Union and United States of America (USA), for instance, led to a number of mathematics curricular reforms.

To sum up it up, addressing the skills-gap in STEM fields will require enabling all students to pursue college-required mathematics in order to stand a chance at pursuing

STEM disciplines in college. In this regard, mathematics becomes an indispensable tool for creating a just and equitable society (Adler et al., 2005).

Concerns about Universal Access to School Mathematics

As noted earlier, the importance of mathematics to all persons has led to it being a compulsory subject in school curricular from K-12. However, universal access to mathematics instruction has led to its own challenges despite the good intentions. There are concerns that the "massification" of the study of mathematics has led to an increase in class sizes in some cases (Adler, et al., 2005, p.360). Adler et al argue that teachers are confronted with the task of teaching a diversified group of students who have a wide range of learning needs and backgrounds such as linguistic and cultural differences. As a result of these challenges there are concerns that there has been a decline in quality of mathematics instruction and achievement (Domina, A. M. Penner, E. K. Penner, & Conley, 2014; Loveless, 2008 Adler et al., 2005; NRC, 2001). The emergence of large scale comparison studies such as the National Assessment of Educational Progress (NAEP), the Trends in International Mathematics and Science Study (TIMSS), and the Programme for International Student Assessment (PISA) has enabled nations to assess the quality of the educational system relative to other countries vis-à-vis achievement scores.

Partly based on the USA's rankings on these examinations there is a general belief that mathematics achievement is on the decline at the K-12 level. In an attempt to identify factors likely to have contributed to the perceived decline in mathematics achievement, results from such large scale results are sometimes disaggregated in terms race, socioeconomic status, and gender leading to what Gutiérrez and Dixon-Román (2011) refer to as gap-gazing analyses. A gap-gazing approach to analyzing achievement scores is the tendency to focus on differentials in mathematics scores in terms of the race of students, socioeconomic background, and gender without examining the educational systems that students find themselves. The problem with a gap-gazing analysis is that it suggests a deficit in 'underachieving' groups of students with little consideration to the nature of mathematics instruction and the educational system that leads to some groups of students to consistently underachieve.

Popular Beliefs about Mathematics and Stereotyping of Underrepresented Groups

Popular culture regarding beliefs about who can or cannot do mathematics persists following dominant discourse surrounding the achievement gap. Despite the perceived relevance of mathematics to individuals and nations, it is considered a challenging subject and that not everyone who studies it can succeed. In this regard, certain mathematics courses deemed to be challenging are best left to those deemed to be possessing the relevant mathematical capability to study while the less challenging courses are made accessible to those 'lacking' the mathematical gene (Ladson-Billings, 1997).

In schools, the view that mathematics is an 'elitist' subject has meant that individuals deemed by counselors and/or teachers to be lacking the capability to succeed in certain mathematics courses are most often tracked into low level courses at the high school level. Schoenfeld (2004) in a review about access to mathematics courses at the high school level in the early 1900s to the 1980s comments as follows:

> There was, in essence, one viable track through high school mathematics: the traditional course sequence…designed for the "college intending." De facto, high school mathematics was (still) for the elite. Students who took the standard sequence were prepared for postsecondary education. (p.264).

From Schoenfeld's comment, we observe a dichotomy that exists in high school curriculum; rigorous mathematics courses required for STEM programs in college and a general mathematics course such as consumer mathematics which tends to serve graduation purposes only. For African American students and other minority students who suffer from stereotypes regarding their mathematics abilities as a result of the achievement gap discourse, this has meant lack of access to high-level mathematics courses (PCAST, 2010; NCTM, 2014). Schoenfeld's comment also portrays how high school students are categorized into 'capable' versus 'incapable' mathematics students. Horn (2008) noted that students who are placed in advanced mathematics courses are positioned as more able mathematics students while those placed in remedial or low-track courses are positioned as less able.

With little or no evidence to prove any genetic deficiencies in abilities, a whole race or gender are positioned as incapable of doing mathematics and stereotyped almost forever (Jencks & Phillips, 1998; Ladson-Billings, 1997). The constant comparison of various races to White (male) students regarding mathematics achievement has led to what Stinson (2013) refers to as the "White male math myth (p.71)." This myth positions White males as the standard measure of what counts as competence in mathematics thereby positioning mathematics as a discipline that is the preserve of White, middle-class, males. Loveless (2008) in a review of mathematics achievement on the NAEP test for eighth graders following the advent of the Algebra for All policy characterizes minority students who are African Americans (or Blacks) and Hispanics as “Misplaced students” relative to their White counterparts (p.8).

Another group that is most often stereotyped regarding mathematics capability is females. Dweck (1986) categorized females as having maladaptive motivational patterns as a reason their underachievement in mathematics relative to males. By maladaptive patterns, she refers to motivation patterns related to failure which includes inability to persist in the face of challenges in order to attain valued goals that are well within an individual’s capabilities. In comparing achievement patterns between both high achieving females and males, Dweck comments as follows: “Bright girls… tend to prefer tasks they are fairly certain they are good at and can do well on, whereas bright boys are more attracted to tasks that pose some challenge to mastery” (p.1045). Based upon the belief that females cannot persist in challenging mathematics courses when male students perform better than them it is accepted as the norm, however, when females outperform their male counterparts it is viewed as an anomaly (Boaler, 2002b). Boaler argues that while male students’ underachievement is blamed on something external to them, for example poor instructional practices, female students’ underachievement is perceived as something internal to them; a lack of mathematical traits.

The unfortunate thing is that using scores on a single test a whole group of people are categorized as incapable of doing mathematics leading to cascading effects on both students and their teachers (Boaler, 2002b). Prospective and in-service teachers, sometimes accept such narratives regarding who is a ‘math person’ which influences their instructional practices. For students of color and attending urban schools the tendency has been for their teachers based upon stereotypical images about their mathematics capabilities to adopt the pedagogy of poverty which results in a dumbing down of content (Haberman, 1991). By dumbing down mathematics content under the guise that students of color cannot do challenging mathematics content an already bad situation is made worse.

Another problem regarding narratives about who can or cannot do mathematics is the essentialist nature of the discourse. By taking an essentialist perspective to understanding mathematics achievement differentials an undue burden is placed on individuals or groups of students perceived to be underachieving. In some cases, intervention programs designed for underachieving individuals or groups to support their learning have sought to change them so they become mathematically-minded (Boaler & Sengupta-Irving, 2006; Boaler & Greeno, 2000).

To sum up, the authors of the NRC (2001) report noted that even with a more select few of the U.S.A population of students taking mathematics cries about underachievement were a constant theme after reviewing mathematics achievement from the 1900s to the time of publishing their report. They suggest that if there is a decline in mathematics achievement levels, it may not be a recent occurrence. There is a danger in looking at mathematics achievement from an essentialist perspective through the lens of a gap-gazing approach. First of all, who a person is cannot be changed easily. As such, a consideration of biological traits does not offer any practical strategies, for instance, pedagogical strategies needed to improve mathematics achievement for all students (Boaler & Sengupta-Irving, 2006). Secondly, an essentialist view is likely to produce students who have resigned themselves to their 'fate' especially if they internalize the 'mathematics genes discourse.' In this regard, it is important to look for factors which offer both theoretical and practical significance.

Some Reasons for Differentials in Mathematics Achievement

Perceptions about the Nature of Mathematics

Perceptions about the nature of mathematics has influence on how it is taught and presented in school curricular (Dossey, 1992). Dossey outlined some conceptions of mathematics held such as a mathematics as a static disciplined involving mainly abstraction and mathematics as a dynamic discipline whose development is based upon real-world abstractions and applications. Implicit in a perception that mathematics is pure abstraction is that its growth depends not depend on any real world application. For a teacher who believes that mathematics is purely an abstraction, its teaching is likely to involve students learning how to manipulate mathematical symbols and making abstractions without any understanding of its applicability. All that matters is that students know the procedures for manipulating symbols which will result in a desired answer and not whether the concepts being taught have any usefulness. This perception is best captured in a definition by Bertrand Russell who viewed mathematics as "the subject in which we never know what we are talking about nor whether what we say is true" (cited in Bell, 1993, p.5). For example, a high school student may be proficient in manipulating symbols using the right procedures but cannot explain why the procedures work if teaching involves the teaching of procedures and not why such procedures work and the importance of mathematical concepts.

Unfortunately, a perception that mathematics is something that we 'just do' amounts to a mischaracterization of mathematics. It presents mathematics as "motionless, static, compartmentalized, and predictable" (Freire, 1970, p. 257. The end result is that the beauty of mathematics is lost to students leading to a general belief by them that it is a subject which requires memorization with no use in real-world situations (Boaler, 2008b). Denied of enjoying the beauty of mathematics and the thrill inherent in solving mathematical tasks, it is not too surprising that students develop a dislike for the subject (Boaler, 2008b) and take mathematics for the sake of fulfilling graduation requirements (Boaler, 1998; Walker, 2012). For the few who are able to persist in its study and succeed, the possibility remains for them to opt out of studying mathematics once they get an opportunity (Horn, 2008).

Dienes (1960), on the other hand, conceptualizes mathematics as involving actual structural relationships between concepts with numbers (pure mathematics) and mathematical abstractions resulting from problems arising from real world situations. His definition implies that mathematical concepts have real world applications. The learning of mathematics, according to him, should enable students to make sense of relationships among concepts and their symbolic abstractions. Students should also develop the ability to apply derived concepts to real situations occurring in their environment. From the definition of mathematics by Dienes, we see that there is no need to separate the procedural knowledge from conceptual understanding, rather, both types of knowing are important. Also, his definition suggests that a purely procedural approach occasioned by teaching to test as noted earlier does a disservice to the nature of mathematics. Boaler (2008b) notes that when students gain an appreciation of the beauty of mathematics, have deep understanding of mathematical concepts and acquire a sense of its usefulness to everyday activities in the same way as mathematicians view the subject, they are more likely to develop interest in its study and persist on learning tasks. Therefore, the different perceptions of what is the nature of mathematics has implications for students learning. It also offers different views about how mathematics should be taught as evidenced from the math wars debate (Schoenfeld, 2004).

Nature of Mathematics Pedagogy

“We dispense knowledge. Bring your container” (Haberman, 1991, p.294).

The above quote sums up the nature of pedagogy prevalent in most urban mathematics classrooms despite calls by the NCTM and the NRC for effective instructional strategies that enable all students to see mathematics as worthwhile and capable of sense-making. Unfortunately, Bertrand Russel’s definition of mathematics as a subject without any meaning continues to dominate instructional strategies. The introduction of accountability measures contained in the NCLB Act of 2002 has meant that teachers are compelled to teach to the test leading to a narrow interpretation of the mathematics curriculum (Economic Policy Institute, 2010). As such, mathematical concepts are presented in atomistic forms with the teacher maintaining control over the teaching and learning process with very little input from students (Lesh & Doerr, 2003).

The nature of mathematics instruction prevalent in most USA schools is characterized by what Haberman (1991) referred to as the "pedagogy of poverty" (p.291) or the "banking concept of education" (Freire, 1970, p. 257). Pedagogy of poverty is characterized as an instructional approach where the teacher takes center stage in the teaching and learning process by teaching concepts most often procedurally without any attention to making connections within and across mathematics content. For instance, typical high school mathematics sequences present mathematics in fragmented form proceeding from algebra in year one, then geometry, and precalculus without any attempt at presenting mathematics as a coherent subject (NCTM, 2014). The role of a mathematics teachers is mostly teaching mathematical concepts in the form of a 'laundry list' by following a series of steps. The general belief, informed by a behaviorist perspective, is that the teacher's job is to teach, be in charge and to be seen to be in control since students are perceived to be too lazy or incapable of thinking for themselves (Haberman, 1991). The expectation is that when instructional materials are presented in a form that students can easily comprehend and memorize, then learning will take place. How well students learn is a function of how well a teacher is able to 'pour' mathematics content into their brain without any spillage.

Unfortunately, the pedagogy of poverty or the banking concept leads to a no-win situation; students do not learn and test scores do not improve leading to frustrated students and teachers (Nieto, 2003; Haberman, 1991). Boaler (1997) reported no significant differences in achievement between females and males at the beginning of a study which involved a comparison of two teaching approaches and their effect on students' learning. She noted that as instructional practices became more traditional-oriented (pedagogy of poverty) female students became more disaffected with the study of mathematics while males found a way to cope. In a different school with different learning environment she reported that both males and females reported same levels of interest in mathematics. It does not lead to students acquiring the skills being taught neither does it enable them to acquire conceptual understanding necessary for further learning (Haberman, 1991).

Teacher Quality and Resource-Gap

As part of efforts aimed at improving educational outcomes for all students, especially underserved and underrepresented student groups, policies such as the No Child Left Behind (NCLB) Act were introduced. While the passage of NCLB maybe well intentioned, it failed to address the complexities of teaching and education. Merely increasing accountability on the part of teachers without addressing systemic challenges such as lack of qualified teachers and funding inequities is not going to lead to the desired results (Darling-Hammond, 2010). The unfortunate situation is that teachers who have not been adequately prepared to teach in diverse classrooms or who are just beginning their practice are more likely to find themselves teaching in urban schools (Darling-Hammond, 2010; Walker, 2012).

Students of minority groups attending urban schools are hardest hit by ineffective pedagogies occasioned by lack of qualified teachers (Darling-Hammond, 2010), a lowered expectation for them (Noguera, 2014) and systemic challenges (negative learning environments) they face by attending under-funded and under-resourced schools

(Loveless, 2008; Darling-Hammond, 2010; Noguera, 2014). For instance, while the NCTM (2014) highlight the importance of curricular resources such as textbooks and access to educational technology in supporting students' mathematics learning, urban schools are reported to use out-of-date mathematics text books and lacking the necessary technologies.

Another challenge most urban mathematics high schools face is the twin challenge of large class sizes and a broad range in students' abilities coupled with a resource gap (Darling-Hammond, 2014). This situation can presenting a daunting challenge for even the highly qualified teacher. Confronted by such challenges in the face of mounting pressures to close the achievement gap, teaching in urban high schools has inadvertently been reduced to teaching to the test (Baker et al., 2010; Holme, 2013; Nomi & Allensworth, 2012). Teachers who are faced with students perceived not to be good in mathematics resort to the practicing of tests or 'tricks' to pass items on such tests by teaching procedurally. Unfortunately, test practice cannot substitute for good instruction. In addition, testing tends to reinforce in the minds of underperforming students how 'bad' they are (NRC, 2001).

Another issue that affects instructional practices and students' learning is a lack of a diversity in the teaching profession with the increasingly multiracial nature of classrooms across the nation (Ladson-Billings, 2006). Teachers whose racial, ethnic, linguistic, and cultural experiences differ from the students they teach are reported to have challenges connecting with their students and tend to have lowered expectations of their academic capability by operating from a deficit perspective (Gay & Kirkland, 2003).

On the other hand, culturally similar teachers tend to have high expectations for students of color and also serve as role models for their students because they can connect better with their students cultural values (Klopfenstein, 2005).

In summary, Delpit (2012) argued that at the beginning of schooling, there is no significant difference in achievement levels between African Americans and students from other races to suggest a genetic disorder. Additionally, there is no child who at birth hates mathematics. Individuals learn to develop an interest in a subject or disinterest based upon particular experiences they have. In this regard, the learning experiences arranged for students influence their motivation to learn mathematics rather than race or gender (NRC, 2001). There is an interplay between the learning environment and individual actions such as motivation and achievement. Any attempt aimed at solving the achievement gap in mathematics therefore, should focus on the learning environment prevalent in most urban schools, how mathematics is characterized and the nature of mathematics instruction. This is especially important considering that students enrolled in low-level mathematics reportedly suffer from poor learning environments (Nomi & Allensworth, 2012) which leads to a diminished interest in mathematics due to the pedagogies prevalent in their mathematics classrooms (Walker, 2012). Attention, therefore, should be paid to the mathematical practics being promoted in the process of students being socialized into what it means to know and do mathematics successfully.

Socialization into Mathematics Practices

Justice Alan Page, a Supreme Court Justice in the State of Minnesota made the following remarks:

> I don't know when children stop dreaming. But I do know when hope starts leaking away, because I've seen it happen….And I have seen the cloud of resignation move across their eyes as they travel through school without making any real progress…. At first the kids try to conceal their fear with defiance…. But we can make a difference if we go back into the schools and find the shy ones and the strugglers, the square pegs and the hard cases, before they give up on the system…and before the system has given up on them. (cited in McGrane, 2010, p.171).

Alan Page's comment captures the feelings of a number of students especially, students of color who have experienced school mathematics in under-resourced urban schools. It starts with a feeling of underachievement, leading to a sense of despair and hopelessness and finally a resignation to whatever fate befalls students. However, this statement also offers hopes in the sense that it gives a clue that with the right learning environment and curricular resources or support systems, there is a greater chance that more students will succeed in their studies. That is, help them regain the interest in mathematics that most of them had at the beginning of their formal education (NRC, 2001).

Sociocultural psychologists influenced by the work of Lev Vygotsky believe that learning is not solely an individual endeavor. The process of learning mathematics involves an attempt to socialize students into the mathematics community (Martin, 2000).

As with all social practices, the medium of interaction involves use of language. According to Lev Vygotsky, language is first of all externalized before becoming internalized (cited in Cole, John-Steiner, Scribner, & Souberman, 1978). It is through the process of externalization and internalization that new members get to learn the practices of the learning community or acquire an identity in practice (Wager, 2014; Nasir & Cooks, 2009).

Individuals engaged in a learning task with other people develop shared beliefs, norms, expectations, and cultural tools that they work with. In this regard, the learning process is mediated through cultural artifacts and tools (Anderson, Greeno, Reder, & Simon, 2000). The socialization process involves helping students learning practices perceived to be germane to mathematicians and the study of mathematics. Some of the socialization that takes place relates to issues such as the nature of mathematics and mathematical knowledge construction, who has authority to sanction that a particular answer is true or acceptable, and what counts as having mathematical competence (Cobb et al., 2009). It is the socialization process that informs students about what it means to do mathematics, how to be successful, and views about themselves as capable of persisting in its study over time. Students get positioned, through this process of socialization as either capable of incapable of doing mathematics by attaching meanings to discourses and, practices promoted within the mathematics learning environment (Horn, 2008).

In this situated perspective, learning is viewed as both an individual and social endeavor. As such, what takes place in mathematics classrooms goes beyond the learning of mathematics; learners also learn from each other and develop a sense of who they are. The norms valued in a particular classroom send messages to students as to whether they have the ability to succeed as a community member or not. If the classroom goal structure and the nature of mathematics instruction does not match students' expectations and beliefs, it is very likely that students will self-select out of pursuing further studies in mathematics which is evident from reports that students lose interest in studying mathematics and grab any opportunity that enables them to stop taking mathematics courses.

Doing well in mathematics or not depends on how a student gets positioned in their mathematics space which has influence on their motivation to persist on a learning task and their subsequent performance (Gutman, 2006; Greeno & Collins, 2008). As such, in mathematics classrooms, what happens there goes beyond the learning of mathematical concepts (Bishop, 2012). It involves a process of socialization into perceived mathematical practices. When a teacher portrays, whether overtly or covertly an attitude where mathematics is seen as being sacrosanct with one correct procedure leading to one correct answer, students are likely to identify with mathematics as a subject which is full of recipes on 'how to' do mathematics. On the other hand, if a teacher encourages students to engage in discussions about the mathematics they are learning and grants students autonomy over their learning thereby creating a community of inquiry (Jaworski, 2006), learners are more likely to identify with mathematics. In this regard, the learning process is not a purely psychological process as suggested by behaviorist theorists. There is both the psychological and sociological aspects which have significant influence on learners which depends on the extent to which a student gains access to relevant curricular resources.

In summary, the mathematical socialization process should enable students to see themselves as competent mathematicians by creating a community of inquiry. Such a community should enable students as members of the learning community to participate in mathematical activities central to what mathematicians do in their everyday work (Lave & Wenger, 1991). This is important because students undergo a change in selves as they learn mathematics through their in a social learning environment. Philipp (2007) argues that as students engage in the learning of mathematics, they also learn lessons about the nature of mathematics, its importance, how it is learned, and who can learn it. When the socialization is compatible with individual selves, it is likely to lead to sense of fulfilment and joy in being in that learning environment. On the other hand, if the socialization process invokes negative feelings and a doubtful sense of self, the learning environment can become threatening to students (Inzlicht, Aronson, Good, & McKay, 2006).

Threatening Learning Environments and its Effect on Students' Learning

Threatening environments are learning environments which pose a threat to students which leads to them questioning their academic capabilities and self-worth. For persons whose mathematics capabilities are constantly called into question, the very notion of them being in mathematics classroom can trigger feelings of self-doubt. For instance, through constant test taking practices promoted by the NCLB, students who constantly score below class average will over time find the mathematics classroom threatening to them due to the belief that a mathematics test will reveal how ‘dumb’ they are (NRC, 2001).

The fear of feeling dumb, not smart enough is especially prevalent for individuals belonging to a group with a "spoiled identity", that is, stigmatized and stereotyped groups (Goffman, 1963). Individuals from groups with spoiled identities such as females, Hispanics, and African American students accept the dominant narratives about them in terms of what they can and cannot do, especially in mathematics. For such individuals, finding themselves in the minority in a mathematics classroom can make the learning environment threatening to them. This is because their being in the minority in such an environment can lead to a reactivation of stereotypical images about their group identity (Inzlicht & Good, 2006). For instance, the only female student in an Advanced Placement class may find such an environment threatening to her since it may re-affirm stereotypical notions that challenging mathematics courses are for males only.

A problem with threatening mathematics learning environments is that stereotyped individuals who find themselves in such environments tend to have a less accurate, stable knowledge of their academic abilities (Inzlicht & Good, 2006). Inzlicht and Good argue that students from stereotyped groups are more likely to reject valuable feedback from a teacher who is not from their social group due to a feeling of bias or discrimination. Furthermore, such individuals can have an over exaggerated self-concept about their mathematics capabilities thereby clouding their sense of what they really know and what they need help with (Lichtenstein & Fishhoff, 1977; Inzlicht & Good, 2006).

Another problem associated with threatening environments is its propensity to activate what is known as stereotype threat (Steele & Aronson, 1995) which can lead to significant influence on a persons' performance. African American students, for example, on activation of stereotypical images about their group's performance on mathematics can prior to taking a mathematics test in a room with majority White are likely to underperform even if their performance is comparable to their White colleagues (Steele, Spencer, & Aronson, 2002). The drop in performance upon activation of a stereotype threat, according to Steele and Aronson (1995), is because individuals experience a feeling of discomfort when they are at risk of fulfilling single, negative, stereotypical narratives about their race or group.

In summary, the social environment that mathematics learning takes place can be threatening to students leading to a decline in academic performance, self-doubt, and a feeling of not belonging (Inzlicht & Good, 2006). Mathematics classrooms can be threatening to students in a number of ways including the disengaging nature of instruction (Walker, 2012). Also, the type of mathematics courses offered which end up sending signals to students as to how smart or dumb they are (Horn, 2008). In mathematics classrooms where there is a thick demarcation between smart and dumb students, this situation can be worrying as it has influence on the mathematical identities students develop.

Mathematical Identities and How it has been Conceptualized

Mathematical identity is generally conceptualized as involving two parts, personal and normative identities (Cobb et al. 2009). For instance, Horn (2008) viewed mathematical identities as students' self-understandings (personal identity) which they develop through the process of learning mathematics and the understandings assigned to them through their position and encounters in figured world (normative identity). Personal identities, therefore, are formed through participation in community practices. For instance, Martin (2000) defines mathematics identity as:

> The dispositions and deeply held beliefs that individuals develop about their ability to participate and perform effectively in mathematical contexts (i.e., perceived self-efficacy in mathematical contexts) and to use mathematics to change the conditions of their lives. A mathematics identity therefore encompasses how a person sees himself or herself in the context of doing mathematics (i.e. usually a choice between a competent performer who is able to do mathematics or as incompetent and unable to do mathematics. (p. 10).

When norms are established and individual actions and obligations communicated, students then have a choice to either identify with, comply with, or resist the general classroom norms and norms specifically related to the learning of mathematics (Gresalfi & Cobb, 2011). Wenger (1998) comments as follows:

> Because learning transforms who we are and what we can do, it is an experience of identity. It is not just an accumulation of skills and information, but a process of becoming---- to become a certain person or, conversely, to avoid becoming a certain person. Even the learning that we do entirely by ourselves contributes to making us into a specific kind of person. We accumulate skills and information, not in the abstract as ends in themselves, but in the service of an identity. (p.215).

In reviewing literature about identity, how identity/mathematical identity as a construct has been operationalized in previous studies will be discussed. A critique of such definitions will be offered and how it is operationalized in this study.

Individualized Perspective to Identity Formation

The first line of research uses a narrative perspective by focusing on stories individuals tell about themselves as members of a learning community (Gresalfi & Cobb, 2011). This line of research mostly focuses on individual students with the aim of understanding his or her process of becoming a learner in terms of particular identities they need to form in order to have a sense of belonging. It assumes that individuals get taught to assume particular beings and the stories they tell of their experiences are a reflection of who they are. This line of research is mostly views identity as located within an individual and immutable over time. An identity, once acquired, becomes part of a person's being. Such a conceptualization is fraught with a number of challenges. For instance, it has the tendency of attributing students' performance or non-performance in mathematics to something innate without critically examining the myriad of factors that could affect learning (Boaler, 2002b; Stentoft & Valero, 2009). The danger of using a definition of identity as individualized is that it can lead to overgeneralization e.g. race, gender, or socioeconomic status (Stentoft & Valero, 2009). Through generalizations of such studies, groups of students from particular groups are categorized in such a way that "it becomes almost impossible to think about these students outside of or beyond categories" (Stentoft & Valero, 2009, p.57). Cobb and Hodge (2002) argue as follows; "A crucial limitation of these institutionalized categories in our view is they do not necessarily correspond to people's own sense of identity" (p.258). It only creates stereotypical images which can hinder their performance.

Another challenge with this definition is the very idea that individuals get 'taught' how to be members of community of practice (Britzman, Dippo, Searle, & Pitt, 1997). It fails to fully appreciate the social milieu within which individuals assume a certain identity by treating the identity formation as purely psychological process. The process of identity formation is viewed as a mechanical one where community members are socialized into a dominant discourse without them playing any role in the process of enculturation.

Sociocultural Perspective to Identity Formation

The second line of research related to identity moves away from putting people in boxes based upon purely psychological analysis. Researchers in this line of inquiry view identities as fluid, continually negotiated and renegotiated. They view identities as a process; not something immutable. This line of inquiry is based upon a sociocultural influenced by Lev Vygotsky's work with a focus on the interactions between the individual, culture, and society (Grootenboer, Smith, & Lowrie, 2006). Bishop (2012), for example, considered identity as a "dynamic view of self, negotiated in a given social context and informed by past history, events, personal narratives, experiences, routines, and ways of participation" (p.38). The definition by Bishop is quite consistent with the definition offered by Martin (2000). A sociocultural perspective promotes "identity formation as being "steered" by society with the individual attempting to "navigate predetermined passages" (Grootenboer et al., 2006, p.613). According to Stentoft and

Valero (2009), it is appropriate to talk about "identities-in-action" to illustrate the shifting nature of identities and how it is constructed in multiple places or communities (p.65). In this regard, different mathematics learning environments will lead to different mathematical identities being formed. An example can be a student who likes an algebra class and dislikes a geometry class because different norms are prevalent in these two classes leading to the formation of different identities. This view of identities as situated in practice offers hope for mathematics education research as it offers both theoretical and pedagogical insights to improve mathematics learning for all. That is, if identity is not fixed but situated, then students can construct different mathematics identities based upon the classroom they find themselves and the norms promoted in such classrooms. It also suggests that students who have come to see themselves as not belonging to the mathematics community due to prevalent norms can learn to view themselves differently with the enactment of different norms.

The view that students are navigating predetermined passages is problematic. While norms represent particular ways of behaving or acting in a learning community, it is important to note that these norms are not predetermined. This is because as Cobb et al. (2001) argued, mathematical norms are not pre-existing (as suggested by Philipp, 2007), rather they are developed by particular members who constitute the learning community. Such a view of norms as negotiated among community members it possible for individual to have multiple *possible selves* (Markus & Nurius, 1986, emphasis in original). Possible selves connote that individuals can assume multiple identities depending on the extent to which an individual identifies with particular norms. For instance, the norms prevalent in a traditional mathematics classroom which emphasizes disciplinary agency can be different from a reform-based classroom which emphasizes conceptual agency (Cobb et al., 2009). In this sense, the process of identification with mathematics can lead to different learning and identity trajectories for members of the community depending on the particular norms they have to identify with (Wenger, 1998).

In classrooms where there is a heavy reliance on disciplinary agency, teachers and students come to associate the study of mathematics with following prescriptive steps with discussions centering on whether such steps have been followed religiously or not. On the other hand, classrooms that promote conceptual agency have students engaging in argumentation to justify why an approach is right or wrong. Students assume authority over what counts as acceptable ways of learning and doing mathematics. It is the amount of agentive roles that students exercise which determines whether they consent to, comply with or resist community norms related to the study of mathematics (Cobb et al., 2009).

Poststructural Perspective to Identity Formation

The third line adopts a poststructural view influenced by the work of Michel Foucault. This line of research views students' identity formation as nuanced and layered focusing on particular modes of operating, particular forms of knowledge, and particular positioning that takes place in social institutions like schools (Walshaw, 2004). The aim of this research agenda is to consider members of the learning community as moral agents who make meanings for themselves (individual agency) while being simultaneously shaped by others. It offers a view of how existing structures such as curriculum, school policies, and classroom practices end up positioning students and the roles individuals play. This view differs from the sociocultural perspective which ignores, in most cases, the ways individuals become subjective through power and discourse (Goos, 2006). An example of research in this category is studies that adopt a neo-Vygotskian perspective by Valsiner (1997). Valsiner, in addition to the Zone of Proximal Development (ZPD) promoted by Lev Vygotsky, added two more zones, Zone of Free Movement (ZFM) and Zone of Promoted Action (ZPA). The ZPD refers to a "symbolic space where the tutee's emerging mathematical identities are developed with the support of the tutor" (Goos, 2006; p.38). ZFM on the other hand, refers to the influence environmental constraints might have on instructional practices and the limits it imposes in terms of what is possible. Furthermore, the ZPA "represents the efforts of a teacher, or others to promote particular skills or approaches" (Galligan, 2008; p.213).

This line of inquiry seeks to provide a more comprehensive account of the learning environment by accounting for the roles played by individuals in the learning process, how individuals exercise agency, the nature of cultural tools available which can either facilitate or impede the activities of the learning community(Goos, 2005). It also permits an investigation into the learning environments in terms of the constraints a learner may face in seeking to learn in a community and the opportunities made possible for the learner (Galligan, 2008).

In summary, the discourse around mathematics can influence a student's feeling of mathematical competence or sense of learned helplessness (Maier & Seligman, 1976). It also has influence on the kind of mindset a student forms (Yeager & Dweck, 2012).

Another factor that influences the mathematical identities high school students are likely to form is the nature of mathematics instruction and the kind of agency made available to them. Agency determines how individuals acts irrespective if classroom norms, whether they are general classroom norms or norms regarding mathematics learning. A mathematics class that promotes disciplinary agency can lead to a number of students who are disinterested in mathematics and see themselves as failures in such classrooms. A class that promotes conceptual agency has students coming to see themselves as capable of doing as they take ownership over their learning. Additionally, the construct, identity, highlights the crucial role affective domains such as attitudes, beliefs, and confidence plays in an individual's learning of mathematics. In a mathematics classroom, the ideal is to make students to become competent mathematics learners after receiving instruction for a period of time. The teacher's task is to, at the end of the stipulated contact period (semester or end of school year), produce students who know what mathematics is, how to solve mathematical tasks, and hopefully, appreciate the usefulness of mathematics to their future careers and the larger society. Attaining such a goal implies helping novice mathematics students to become competent in doing mathematics.

Learning and Identity Trajectories

Wenger (1998) identifies various learning and identity trajectories individuals can develop through engaging in practices of a community including an inbound or peripheral learning and identity trajectories. Inbound trajectories is a situation whereby a novice in the learning of mathematics enrolls in mathematics class with the prospect of becoming a competent doer of mathematics by acquiring the practices crucial to the community of mathematicians. This is because with inbound trajectories, the novice is provided with all the support and learning experiences necessary to move him or her from the periphery to the core of community's practices. As such, while a beginner may enter a mathematics classroom with very little knowledge of the nature of mathematics, how to solve particular mathematics tasks, and the kinds of competencies required to succeed in its study, inbound trajectory ensures that individuals develop the necessary mathematical competencies for full participation in the practices of mathematicians. In effect, inbound learning and identity trajectories leads to students feeling competent in doing mathematics. Common comments include 'math comes to me easily because I get what is going on in the class.' Peripheral learning and identity trajectories, on the other hand, do not enable individuals to come to the center of the mathematics community's practices. With peripheral trajectories, the novice student begins learning of mathematics at the periphery of the practices of mathematicians and remains at the periphery with continuous instruction.

In this regard, ensuring that all students become mathematically competent will require presenting mathematical concepts in ways that connect with the everyday experiences of learners (Lave & Wenger, 1991) and the provision of the necessary resources that will lead to successful enculturation into the mathematical practices necessary for success. While some students, as members of the community of inquiry or learning community, will come to see themselves as capable in doing mathematics, others may come to resent its study through the socialization process depending on the extent to which they identify with classroom obligations. Ultimately, the expectation is that the socialization process will help students (mentutees) gain increasing competencies in the practices of mathematics and develop the necessary mathematical competencies. It requires moving students from a periphery participation in the learning of mathematics practice to them taking charge of the learning process through the acquisition of practices central to what it means to be a competent knower and doer of mathematics. Identifying or not identifying with mathematics depends on how students are positioned and the kinds of resources available to them in the social world of mathematics learning.

Nature of Identity Resources

Identity resources, or practice-linked, are particular resources that are essential for an individual to gain full access to the practices of a learning community and the denial of such resources is expected to impact an individual's learning experiences and sense of identity to the community's practices (Nasir & Cooks, 2009). The authors highlighted three identity resources namely *relational resources, material resources,* and *ideational resources.*

Relational resources refer to how community members relate to each other. In the context of this study, it would be the interrelationships between community members such as mentutors and mentutees and among mentutees. Do community members feel connected to each other or are they oppositional to each other? Material resources on the other hand refer to access to teaching and learning resources such as textbooks and technologies such as graphing calculator that are helpful in learning mathematics. Ideational resources refer to the ideas that mentutees as members of a community in P2N gain about themselves and others relative to the doing of mathematics. It also refers to ideas about what it means to do mathematics and the expectations of being a mathematics person in a particular community.

In a mathematics classroom, these resources can be the type of mathematics course a student is enrolled in and the ideas communicated about who can do mathematics in a learning environment. For instance, students in AP classes may see themselves as good in mathematics while those in remedial courses may come to believe that mathematics is not for them and come to accept underperformance in the subject as affirming their lack of mathematical abilities due to accumulated ideas about who can do AP mathematics courses (Horn, 2007). On the other hand, a lack of teaching and learning resources can also affect students' learning opportunities, as well as lack of teacher (mentutor) support due to a dysfunctional relationship with students or mentutees. Generally, the ideas (ideational resources) that mathematics classroom teachers and mentutors have regarding students mathematical abilities can influence how learning resources (material resources) are distributed and the amount of support provided (relational resources). Nasir and Cooks (2009) argue that the accumulated access to these resources, over time, is expected to have influence on the kinds of mathematical identities mentutees develop and ultimately their mathematical trajectories. The influence of access to relational support, curricular resources, and images about who can do mathematics on students mathematical learning and socialization have been documented in various documents and studies (Darling-Hammond, 2014; Martin, 2012; NCTM, 2014; Walker, 2012).

Summary of Literature Review

Access to college-required courses cannot be the preserve of a select few if the goal of diversifying the number of people entering the STEM fields is to be realized. Teaching of mathematics cannot continue as business as usual by adopting instructional strategies likely to end up grouping students into "mathematical elites and non-mathematicians” (Dienes & Golding, 1971, p.16). Walker (2012) indicated that students’ level of engagement in mathematics learning processes is a function of three things namely; behavior, emotion, and cognition. Behavior, for example, could refer to a student’s beliefs about mathematics, relationship with teacher(s) and other students. It also includes a student’s perceptions of the relative importance of mathematics and how beliefs about the importance of the subject is likely to influence his her motivation to invest in its study. Emotions on the other hand, include both negative and positive reactions towards members of a learning community which has influence on the level of effort a student is likely to put in. By cognitive engagement, Walker refers to the willingness of a student to invest his or her thought processes to make sense of a concept no matter how challenging it might be.

It has been argued that the process of mathematics learning involves socialization into the practices of mathematics. In the learning of mathematics, individuals become subjectified into certain norms about the nature of mathematics (through discourse) and mathematics practices (Stentoft & Valero, 2009). What takes place in mathematics classrooms goes beyond learning of mathematical concepts. Students form identities regarding who they are which in turn influences their motivation to learn. As such, identity is of great importance in understanding ways to improve mathematics learning for all students since it is related to individual beliefs, motivation, persistence, among other affective constructs which influence learning outcomes. An implication is that students' perceived achievement or underachievement is a function of the learning environment and students' behavior. If this argument holds, then it means that different mathematics learning environments will have different effect on students' mathematics learning experiences and achievement (Cobb et al., 2009). From the foregoing, the envisaged mathematics learning community (e.g. P2N) should have students' learning in mind. Such a learning environment should aim at helping students find the content to be learned simulating and engaging, have support systems in place in terms of curricular and human resources, and promote a culture that values and respects students' divergent views and cultures.

Also, a review of the works on mathematical identities suggests that most of the current work adopts a sociocultural view informed by a Vygotskian or a poststructural perspective. These researchers view identity as dynamic, constantly negotiated and renegotiated based upon the learning community an individual finds himself or herself. They view identity as situated in norms promoted in particular learning communities making available the creation of different possible selves. Identity formation is considered as a process of 'becoming' (Wenger, 1998). While the notion of 'becoming' offers hope, it must be noted that identities acquired can become plastic over time with repeated exposure to the particular norms (Bishop, 2012). Also, identity formation occurs in two parts; a social part (normative practices) and individual part (personal identities), (Cobb et al., 2009). While normative identities deals with the sociological view about identity formation, personal identities on the other hand, addresses the psychological view. The splitting up of identities into group and personal helps delineates the roles individuals are expected to play as well as what is expected of the group based upon structures existing. Cobb et al. (2009) refer to these two aspects of identity formation in terms of “obligations-to-oneself” and “obligations-to-others.” These two obligations deal with issues such as whether students have conceptual or disciplinary agency, to whom students are accountable during classroom discourse, and notions of what counts as having mathematical competence. As obligations, it requires that students become aware of the community’s expectations, know what they are obligated to do, and to act in certain ways as a community member.

In summary, whether students see themselves as capable of doing well in mathematics or not depends on the extent to which instructional practices and both general and sociomathematical norms attend to their psychosocial and sociological needs. The norms that students are obligated to and the practice-linked resources that are made available in various mathematical learning spaces can have influence on the mathematical identities they form. There is the likelihood that a mathematics space which enables students to take ownership of the learning situation can lead to a turnaround in mathematical identities of students who have had a negative mathematics learning experience.

Overview of Subsequent Chapters

So far, it has been argued that the mathematical identity high school students form is critical in terms of their motivation and achievement in mathematics. Also, the norms prevalent in a particular mathematics learning environment can lead to different mathematical identities. For this reason, a change in learning environments for students with negative mathematics learning environments can lead to a turnaround in students' mathematical identities and motivation to learn.

In Chapter 3, a description of the theoretical framework, research methodology, design, and development of research instruments are provided. The chapter ends with how data were analyzed. In Chapter 4, the findings of both the qualitative and quantitative data his study are presented and discussed. In Chapter 5, a summary of this study, conclusions, implications, and recommendations for further studies are provided.

CHAPTER 3

Research Methodology

In Chapters 1 and 2 it was argued that the importance of mathematics to all citizens makes it imperative that every high school student has access to rigorous and high level mathematics content because a lack of access to high level mathematics courses can have deleterious effect on both the student and society. It was also argued that all students, including those from historically underserved and underrepresented populations in STEM fields, should have increased opportunities and access to high level mathematics at the high school level. One factor that was identified as being a major cause of students' underachievement and subsequently underrepresentation in STEM fields is the pedagogy of poverty prevalent in urban schools. Rather than blaming students solely for underachievement in mathematics, it was proposed that their mathematics learning environments be investigated. This was premised on the fact that a non-participatory pedagogy (e.g. pedagogy of poverty) can lead to students' underachievement due to the formation of identities of marginalization (Solomon, 2007). A more participatory pedagogy (reform-based instruction), on the other hand, could lead to more students developing productive dispositions towards the subject and developing the necessary mathematical competencies. This study therefore, investigated the influence an out-of-school mathematics mentoring and tutoring program known as Prepare2Nspire (P2N) had on 11th graders' mathematical identities. Four research questions were formulated as follows:

1) What is the nature of the mathematics learning experiences of 11th graders prior to joining P2N? 2) How are normative identities as doers of mathematics constructed and negotiated within selected P2N communities? 3) How does mentutors' use of identity resources in P2N influence the formation of specific learning and identity trajectories? 4) What is the nature of mentutees' personal identities in mathematics prior to and after participating in P2N? In this chapter, the theoretical framework, context of study and participants, and the research design are discussed.

Context for Study

As briefly described in chapter one, P2N is a mathematics mentoring and tutoring program. It is based upon a cascading, near-peer tutoring model where undergraduates (mentutor) tutor and mentor 11th graders (mentutees) with the 11th graders in turn tutoring and mentoring eighth graders. The 11th graders received tutoring once a week on Mondays (during the data collection year) for a period of two hours. On Saturdays, the 11th graders tutored and mentored their assigned eighth graders. However, 11th graders could still receive tutoring support from their mentutors on Saturdays. Monday tutoring sessions begin with a review of an 11th grade benchmark. The 11th graders then answered a series of items related to the reviewed benchmark with the support of their mentutors and other mentutees. After the benchmark review, 11th graders were expected to work on their mathematics homework where support from their mentutor is available. In the absence of homework, students were expected to continue working on the benchmark reviewed.

Participation in P2N for most of the participants was voluntary, that is high school students chose to be part of the program based upon their need for math support. A project member in charge of recruitment visited high schools in the target region and talked to students, teachers and mathematics leads in these schools about the purpose of P2N and the benefits high school students stood to gain by being a part of it. For a student to be admitted into P2N, the basic requirements was that the student needed mathematics support. However, the recruitment target were persons of color, first generation, and from low SES family. The pretest ACT scores for 11th graders was 15.4.

Access to curricular resources can have differential influence on mathematical identities formed by students (Horn, 2008). Considering that most of the participants were from low socioeconomic (SES) families (measured based upon whether a student qualifies for free or reduced lunch at school) a number of resources were supplied to all participants in P2N. For instance, each 11th grader had a free copy of the ACT study guide to encourage regular learning of mathematics by them. Students could either revisit or learn new mathematical concepts on their own time and outside of tutoring sessions.

A number of researchers have highlighted the importance of enabling students to represent mathematical concepts in multiple forms so that they can gain a more coherent understanding of concept being learned (Cramer, 2003; Dienes, 1960; Lesh & Doerr, 2003). As part of attempts aimed at enabling students to move freely across various representations each participant was given a free TI- Nspire graphing calculator. It was expected that the use of this tool will enable students to for instance, have visual images of functions or equations they were dealing with in terms of their properties and behaviors under various constraints in addition its ability to support students in moving across various representations such as tabular, symbolic, and graphical representations. Also, the calculator is an allowable tool on the ACT examination which the mentutees were mandated to sit for in the state of Minnesota. In addition to the curricular support, there were other program components designed to motivate and encourage students to persist in their studies while urging them to consider pursuing STEM disciplines in college.

As part of efforts by P2N organizers to promote academic success of students, explicit messages that counteract stereotypes about them regarding their mathematics competence and resiliency are communicated. In this regard, P2N has a slogan aimed at helping students develop resiliency in learning mathematics which is as follows: *Math is hard, So is Life*; *We accept the challenge*. Another way in which explicit messages are communicated to mentutees about resiliency and importance of mathematics to their everyday lives and career prospects is a Speaker series.

During the Speaker series, individuals, mostly professionals who are from minority groups are invited to talk about how they use mathematics in their work and also how they overcame the odds as minority students. The use of persons of color served as a form of motivation for P2N participants who might have accepted stereotypical images about their affiliated social groups to have a change in perceptions regarding their academic potentials and capabilities. The use of undergraduates who were mostly students of color in STEM fields provided opportunities for mentutees to be motivated and encourage them to see the pursuit of programs in these disciplines as being within their capability.

Research Design

In order to inform instructional practices in terms of what works and what needs improvement in a learning environment the focus should be on capturing the nature of pedagogy in the environment, how community members are positioned, and the positions they assume. A focus on understanding the influence of learning environments will help identify particular instructional practices that influence high school students' perceptions of their sense of identification and competence in mathematics. However, an attempt at examining learning environments, with all its complexities, would require a design that makes it possible to adequately describe the normative practices that members are obligated to and their mathematical learning and identity trajectories. Such a complex task would also involve the collection of a variety of data.

A sequential mixed methods design is used for research question one (Cresswell & Clark, 2007). According to Cresswell and Clark, this design involves the use of both quantitative and the qualitative methods in a research activity with both methods being used at different points in the research. This design was deemed appropriate in carrying out this study since various methods were used in collecting data. First, a quantitative technique, that is, a survey was used to have a general perception of P2N mentutees' in-school mathematical identities. This survey was administered to all mentutees in P2N. The next phase involved a qualitative method, a multiple case design. In this phase, all mentutees completed a mathematics reflection after which 12 of them who were in the focus communities, Tyson, Daly, Graves, and Young were interviewed individually. Mixing of these methods also occurred at the analysis phase for research question one. In research question one, the quantitative method was used to have a general understanding of mentutees' mathematical identities prior to their participation in P2N while the qualitative methods used allowed for an in depth understanding of students' mathematical identities. In summary, the quantitative and qualitative methods were mixed at the data collection and data analysis phases. By adopting these techniques, it was possible to capture a broader aspect of the phenomenon studied.

Cobb et al.(2001) suggest that educational researchers should not only report that an educational program works but also the processes by which such programs work. For instance, different tutoring styles or pedagogies are hypothesized to lead to differentials in mathematical identities formed by mentutees. In this regard, it was envisaged that differences might arise in how each undergraduate (mentutor) engaged in socializing mentutees in their communities into mathematical activities and practices notwithstanding the common training they received at P2N. Therefore, the use of case study design made it possible for attention to be paid to contextual factors that influence on the mathematical identity phenomenon understudy (Yin, 2009). Also, this design makes it possible for within-and across case comparisons.

In order to understand how and why mentutees formed different mathematical identities, a multiple case design (embedded unit of analysis) was used for research questions two and four (Yin, 2009). An embedded (nested) model has a main unit, in this case each of the four selected communities with the three 11th graders nested within it. In this case, the main unit is a community, with mentutees nested in it which makes it possible to map particular identities to the influence of each community's normative practices of learning mathematics (See Fig. 2 for P2N Model Reproduced).

The use of an interpretive method enabled the researcher to make sense of the intersubjective meanings that result from the social milieu in which mentutors and mentutees found themselves in and acted (Eisenhart, 1988). Additionally, the use of a mixed methods design was helpful in ensuring both triangulation and complementarity of results so that more information were obtained about the phenomenon under study (Creswell & Plano, 2007). In summary, the use of multiple case (embedded) design for research questions two and four made it possible to engage in cross case analyses to understand the ways selected communities promoted particular mathematical identities with a focus on understanding 'how' and 'why' particular identities were formed.

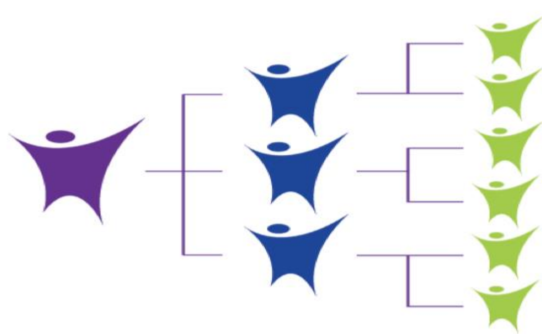


Fig 2. P2N Model Reproduced Showing Program Structure.

Training Opportunities for Undergraduates

The success of the P2N depends, to a large extent, on the mentutors. The mentutors' mathematics background, teaching/tutoring experiences, and preconceptions about tutoring/teaching all have significant influence on their enacted practices

(Akyeampong & Stephens, 2002; Hammerness et al., 2005; Nieto, 2003). With the exception of two undergraduates pursuing a bachelor's degree in mathematics education, the remaining 13 were pursuing non-education programs. As such, most of them had no formal pedagogical training.

An initial training was organized in July prior to the start of the tutoring program lasting a period of two weeks. Topics covered centered on how to mentor and tutor mentees/tutees (mentutees) through the creation of supportive learning communities where each member felt valued. The tutoring training focused on enabling the mentutors to engage in more participatory pedagogy with students playing an active role in making sense of mathematical concepts on their own (NCTM, 2000, 2014).

Two major topics treated during these trainings related to creating welcoming communities and facilitating mathematical discourse among community members. Creating welcoming communities, for instance, required that mentutors affirmed mentutees efforts rather than praising them for any perceived innate abilities (Dweck, 2010; Yeager & Dweck, 2012). This meant that instead of mentutors telling mentutees how smart they are, they were required to acknowledge the efforts 11th graders applied in solving a task thereby helping students to develop a productive disposition towards mathematics or a growth mindset (Dweck, 2010; NRC, 2001; Yeager & Dweck, 2012).

With regards to creating communities of inquiry where community members seek to make sense of mathematical tasks, share ideas and provide justification of their mathematical reasoning as promoted by the NCTM (2000, 2014) mentutors were expected to ask guided questions. This required that they learned how to formulate essential questions – what needs to be learned and open-ended questions – asking questions which requires more than a yes or no response. The access and equity principle by the NCTM requires that efforts are made to ensure that all students receive the same high-level instructional support and high expectations. Meeting this objective involved mentutors receiving training on how to provide differentiated instruction to mentutees who needed it. In order to promote equitable learning communities in P2N, mentutors received training related to identification of different learning styles and how to support each type of learner, for example, auditory learner, visual learner. (See Appendix A for sample of training material). Equitable communities of inquiry also required that community members treated each other with respect and responsibility, what Boaler (2008a) referred to as 'relational equity.'

These trainings were designed with the view that mentutors would enact tutoring practices that provided mentutees in their communities more learning opportunities so that 11th graders could construct their own mathematical knowledge. Meeting this goal required that mentutors allowed their community members to: 1) solve mathematical tasks on their own and 2) explain their reasoning using whatever representations made sense to them to others. This also meant that mentutors asked questions that elicited mentutees mathematical reasoning and justification of answers rather than asking closed-ended questions, for instance. Additionally, mentutors were not required to solve mathematical tasks for mentutees, they were expected to facilitate mentutees mathematical learning through scaffolding mathematical tasks and asking questions that enable mentutees to think about their own thinking and enable them to assess the reasonableness of answers given. A tutoring model adopted by P2N is summarized as follows: ‘I do one; you do one’ where the mentutors modeled a task followed by the mentutees also having opportunities to solve mathematical tasks on their own. After the pre-program training the mentutors received two hours of training bi-monthly. These trainings were modeled after the initial training with more time devoted to issues of concern to the mentutors such as motivating disengaged students and facilitating group discussions.

Participants

Prepare2Nspire had 45 eleventh graders (mentutees) who participated during the 2014/15 academic year. Data were collected on all the 45 mentutees in the initial phase of the study. However, in order to gain an in-depth understanding of their mathematics learning experiences in P2N and how that experience compare with their school mathematics learning experiences four communities were purposively sampled. As a result, there were 16 participants in all comprising 12 mentutees (11^{th} graders) and four mentutors. The breakdown is as follows: each P2N community sampled for this study comprised three 11^{th} graders who were nested in a mentor with the mentutor nested within the community. As indicated earlier, although each community comprised six 8th graders in carrying out this study the mentutees were the sole focus.

The choice of 11^{th} graders was because they were the main focus of P2N program, which is, to prepare them for college. Also, 11^{th} grade is the grade that students are free to decide whether to enroll in further mathematics courses as by the end of this grade even though most students would have satisfied the minimum of three mathematics courses necessary for high school graduation. Due to the crucial stage these students are in their high school program a change in their mathematics identities could result in immediate changes in their course taking patterns and motivation to persist in the study of mathematics for example.

In all, there were five males and seven females who served as the focal group. Since high schools offer a variety of mathematics courses which students are enrolled in or select based upon perceived competencies or interest, the participants were enrolled in a variety of courses. Nine of them were enrolled in advanced algebra 2 which they termed as ‘regular’ to denote that it is for students without ‘strong’ mathematics competencies. There were only three students who were enrolled in either IB or AP mathematics course, Pre-calculus.

Sample and Sampling Technique

Four communities were selected and used in this study. These communities were purposively selected (Patton, 2002). These communities had mentutors who varied in terms of the undergraduate programs being pursued namely; chemistry, engineering, mathematics, and mathematics education majors. They also varied in terms of gender, ethnicities, and number of years of tutoring experience. All these characteristics could influence the tutoring practices mentutors enacted considering that those who teach/tutor are influenced by their own learning and life experiences, values, beliefs, and preferences despite the formal trainings received (Hammerness et al., 2005; Nieto, 2003).

Additionally, the four communities had mentutees who were enrolled in different mathematics classes which could have influence on 11^{th} graders’ mathematical identities based upon how they assess their mathematical competency relative to the type of mathematics class they are enrolled in (Horn, 2008). While those in advanced mathematics classes are likely to identify themselves as mathematical proficient, those in regular mathematics may be less likely to do so. This assertion is made on the grounds that schools that offer an eclectic mathematics curricular, that is, IB or AP mathematics classes, 'regular' mathematics classes, tend to enroll students perceived to be mathematically proficient in such challenging mathematics courses whole students deemed not to be mathematically competent are enrolled in regular courses.

In summary, the purpose of this research was to document the influence that P2N has on high school students' mathematical identities and the mechanisms leading to any transformations in mentutees' identities (Horn, 2008; Stentoft & Valero, 2009). For instance, how does the characteristics of P2N structure and tutoring practices such as: 1) creating opportunities for mentutees to initiate their own approaches to solving mathematical tasks; 2) attending to individual learning styles; and 3) asking questions that enable learners to explain their mathematical reasoning; 4) creating learning communities account for any transformations in mentutees' mathematical identities. The demographics of students and course taking patterns for mentutors are shown in Table 1.

Table 1

Demographics of mentutors in focus communities

Name	*Male/Female*	*Major*	*Tutoring Experience (in years)*	*Ethnicity*
Fred R	M	Math Ed	1	Caucasian
Dorothy	F	Mech. Eng.	2	African
Mary	F	Math Ed	2	Caucasian
Belinda	F	Chemistry	1	African

Data Collection and Instruments

In order to capture, as much as possible, the complex nature of the tutoring settings, a number of data collection techniques were used. In all, four research instruments were administered involving use of surveys, observations, written reflections, and individual interviews (See Appendices B-F).

Observational Data Collection

The first data collection method involved a weekly observation of each the four selected communities. The interactions between mentutors and mentutees and among mentutees were video-taped as well as audio-recorded to serve as back up. By observing the tutoring practices in each of the four communities through the use of video-tapes it made it possible to see differences in tutoring practices and the nature of mathematical discourse. For example, the researcher observed general question techniques, closed or open –ended questions, who initiated solutions to tasks – mentutor or mentutee, and the nature of mathematical discussions. The conversations community members had regarding how mathematics should be learned in each community were also observed in addition to how specific curricular (material) resources such as the ACT study guide and TI Nspire calculators were used.

Each community was observed for a period of 10 weeks, started in February and ended in May, 2015. Each observation lasted two hours, that is, the duration of each tutoring session. As part of the observation, samples of the mathematical tasks mentutees were working on were obtained to gain an insight into the nature of mathematical tasks mentutees were learning. For instance, items which are mostly closed-ended are more likely to lead to a disciplinary agency while open-ended items are more likely to lead to conceptual agency (Cobb, et al., 2009; Waxman & Padron, 1995). The two interpretive frameworks that underpinned this study are discussed extensively later.

Self-Reflection Survey on Mathematics Experience

The second data source involved a *Self-Reflection on Mathematics Experience* (SRME) which was adapted from Robinson (2014). All mentutees in P2N completed this instrument (see Appendix B). The items on this instrument were used to understand students' in-school mathematics experiences. Mentutees responded to items asking about the nature of mathematics instruction they typically experience, what they perceive it will take to be successful in their mathematics classrooms, and whether they considered themselves as math persons. The items on this instrument were all open-ended thereby providing more details about the nature of mathematics instruction experienced by mentutees and their understanding and valuation of the normative practices.

Interview Guide

Various mathematical spaces can have different influences on the mathematics identities formed by members of the learning space (Cobb., et al., 2009; Horn, 2008; Walker, 2012). It was therefore, important to document the normative and personal identities across these spaces. The third data collection technique involved a two-part interview session with each mentutee and mentutor in the focus community (see Appendix C, D, and E). The interviews were used to provide insight into the normative practices in these two mathematics learning spaces and access to identity resources (ideational, material, and relational) and their influence on the mathematical identities formed by the 11th graders.

The first part of the interview session explored the mathematics learning experiences in their various schools. Cobb et al. (2009) indicated that students' interview responses were quite accurate in describing their classroom environment. As such, while it was not possible to observe mentutees' in their mathematics classrooms to obtain a first-hand experience of the normative teaching practices, their responses to interview items dealing with their classroom norms were taken reliable and valid interpretations of their lived experiences. The second part of the interview focused on mentutees and mentutors understanding of normative tutoring practices in each of the four communities and the influence of identity resources on mentutees mathematical identities.

All the interviews were audio-taped and lasted about 40 minutes on average per participant. The interviews lasted a total of 574 minutes.

Mathematics Identity Survey Instrument

The fourth data collection method was a *Mathematics Identity Survey* (MIS) which contained both closed and open-ended items (see Appendix F). The survey items covered items related to mentutees' in-school mathematics learning experiences. In all, the MIS had five subscales related to: perceptions about mathematicians and mathematics; interest in mathematics activities; teacher expectations and mathematics competence; interest in mathematics-related programs; and self-confidence.

This survey instrument was adapted from Aschbacher, Li, and Roth's (2009) identity survey instrument. One reason for the adaptation was that the items related to factors such as family education, educational resources available to students at home, which were deemed irrelevant to my study. Another reason for the adaptation had to do with items containing two ideas in their stem. For example, on Part G on the original instrument students were asked to indicate the number of mathematics or science courses they are likely to take by end of high school and college respectively. This item was split into two, an item for mathematics and another item for science and for each education level. Another reason for the adaption has to with the fact that the original instrument was focused on science identity formation while this study focused on mathematics identity formation. For this reason, most of the items which contained science in its stem, for example, “My teacher thinks I could be a good scientist one day” was modified as follows: “My teacher thinks I could be good in mathematics.” Table 2 presents research questions, data sources, and data analysis techniques used.

Table 2

Research questions and associated data sources

Research Question	*Data Source*	*Data Analysis*
1. What is nature of the mathematics learning experiences of 11th graders (mentutees) prior to joining Prepare2Nspire (P2N)	Mathematics Identity Survey (MIS) Self-Reflection on Math Experiences (SRME) Individual Interviews	Compute percentages of responses to items Code field notes, interviews transcripts and students reflections and identify patterns and emerging themes. Compare codes for consistencies
2. How are normative identities as doers of mathematics constructed and negotiated within selected P2N communities?	Video-taped tutoring sessions; Scratch notes and memos, and Interviews (mentutees and mentutors)	Code field notes, interviews transcripts and students reflections and identify patterns and emerging themes. Compare codes for consistencies

Table 2 Continued

3. How does mentutors in P2N use of identity resources influence the formation of specific learning and identity trajectories?	Interviews (both mentutees and mentutors) and observational data	Same as earlier
4. What is the nature of mentutees' personal identities in mathematics prior to and after participating in P2N?	Self-Reflection Survey on Math Experiences (SRME) Mathematics Identity Survey (MIS) Individual Interviews	Same as earlier

Validity and Reliability of Instruments

In order to ensure that the findings and conclusions drawn from this study are valid and reliable, a number of measures were implemented with the aim of increasing the trustworthiness and credibility of assertions made. It also means that relevant data are collected using the right instruments so that questions about the phenomenon understudy, is students' mathematics identity formation, could be adequately answered. The first measure to judge the quality of the instruments used is their validity.

Validity "is the meaning that subjects give to the data and inferences from the data" (Cohen, Manion, & Morrison, 2007; p. 134). It also means that the findings and interpretations made from the data obtained from the research instruments are reliable.

To judge the quality of findings and conclusions, four measures of validity were used namely, construct, content, internal, and external validities.

Construct validity of an instrument deals with how terminologies used are operationalized. It also helps the researcher to clarify what a construct which is abstract in nature used in a study mean so that there is a shared understanding (Cohen, et al., 2007). Identity, as noted in chapter two (literature review) does not have a common definition which has sometimes it intractable to measure or lacking uniformity as various researchers have tended to operationalize it in different ways.

In carrying out this study, various terminologies used such identity, mathematical identity, general and specifically mathematical obligations were all defined to ensure that readers have a fair understanding of what usage of these construct based upon their operational definitions. Also, in line with the caution by Cohen et al. (2007) that the usage of various constructs are not mere articulations of the researcher, these constructs were defined based upon their general usage as reported in the literature on mathematics identities. In the appendices (A-D), references for various definitions are provided. Additionally, to improve construct validity, multiple data sources were used such as video tapes of tutoring sessions, surveys, and interviews and also by establishing a chain of evidence. Another way that construct validity was improved apart from relying on the literature was the use of member checking. This was done by giving the instruments, surveys and interviews, to committee members for critique. Through this process items which for example started with ‘why’ were modified where necessary since they could appear judgmental and also tended to suggest a ‘correct’ answer. Committee members also looked at the alignment between each research question and specific items to be used in answering them.

Content validity on the other hand refers to an instrument having items that "comprehensively covers the domain or items that it purports to cover" (Cohen, et al., 2007; p.138). Comprehensiveness of an instrument also implies that the items cover both width and breadth so that the construct under investigation are studied in sufficient depth and detail.

In order to ensure content validity in carrying out this instrument, a number of strategies were implemented. The first was the use of triangulation using a survey, a reflection, observations of tutoring sessions which were all videotaped, and individual interviews. These various methods were to ensure a broadening of the range of aspects of the phenomenon understudy. For instance, while observational data enabled me to glean an understanding of the normative tutoring practices in each of the four sampled communities, the selection reflections and interviews enabled me to understanding how and why mentutees (11^{th} graders) formed specific mathematical identities.

Internal validity measures the degree to which the assertions made can be supported by the data (Cohen, et al., 2007). In effect, are findings and conclusions made grounded in the data collected? Is there sufficient evidentiary warrant for assertions or conclusions made (Freeman, DeMarrais, Preissle, Roulston, & St. Pierre, 2007)? In effect, does the data provided help explain the relationship between the dependent variable and the independent variable?

Furthermore, in order to ensure internal validity of the findings, the researcher should be able to account for how tutoring practices enacted in a particular community influenced the formation of specific mathematical identities. This required that mentutees' prior mathematical identities were accounted for in addition to their post-P2N identities. This required that the researcher provided confirmatory evidence and any other alternative analysis from the normative practices as experienced by the mentutees in these two learning spaces, school and P2N, and their personal identities. In this study, triangulation was used to ensure that internal validity was ensured by looking various data sources.

External validity refers "to the degree to which the results can be generalized to the wider population, cases or situations" (Cohen, et al., 2007; p.136). While the findings of a qualitative study such as this study may not be widely transferrable, the use of "thick descriptions" can help enhance the external validity of the findings (Anfara, Brown, & Mangione, 2002). In presenting findings of this study, rich descriptions of cases and phenomenon are provided so that connections can be made to similar cases or phenomenon.

Reliability or confirmability is a "measure of consistency over time and over similar samples" (Cohen, et al., 2007; p.146). While in quantitative studies a survey developed can be used repeatedly to check its consistency through the use of a statistical process such as factor analysis, there is no such statistical procedure for qualitative methodologies. However, dependability of qualitative methodologies can be improved through measures such as: creating an audit trail, triangulation, and peer examination

(Anfara, et al., 2002). Dependability can also be improved by making public the instrument development process, for example, how interview protocol was developed and the comprehensiveness of its content. In the case of the survey (quantitative method), reliability was ensured by conducting a pretesting of the instrument.

Pretesting of Mathematics Identity Survey Instrument (MIS)

Despite the original instrument having been pilot tested and its factors confirmed through statistical procedures by the developers Aschbacher, et al.(2009), due to the modifications made to the original instrument, the MIS instrument was pretested to ensure internal reliability. The adapted survey instrument was administered on a group of 11th graders who were not part of P2N. They were 25 in number and shared similar characteristics as the target population. Most of the students in the pretest group were from minority groups and from low-income families. Results of the pretest indicated that the Cronbach Alpha coefficients ranged from 0.50 to 0.82 (see Table Two).

While Nunnally (1978) suggests that an acceptable reliability estimate for internal consistency for multidimensional instruments should be greater than 0.70, the inability to meet this condition for all the scales was not considered to have any serious limitation on results and conclusions from the survey. This is because the number of students used for the pretesting was small which could have affected the results. In terms of clarity and comprehensibility of language used there were no major concerns raised by participants indicating that the language used was appropriate. The results of the reliability estimates are shown in Table 3.

Table 3

Cronbach alpha for inter-item reliability for each subscale

Scale	No. of items	Cronbach Alpha estimate
Perceptions about Math and Mathematicians	7	0.50
Interest in Math Activities	6	0.73
Teacher Expectations and Math Competency	12	0.82
Interest in Math-related programs	5	0.56
Self-confidence in Mathematics	7	0.67
Overall	37	

Data Analysis

In seeking to account for mentutees' processes of becoming mathematics persons, the data analyses process seeks to unite the psychological and sociomathematical norms as enacted in the two mathematical spaces, students mathematics classrooms and their assigned P2N community. In this section, the data analyses procedures used in answering the four research questions that guided this study are discussed.

Research Question One: What is the nature of mathematics learning experiences of 11th graders prior to joining P2N?

In order to answer the first research question, three data sources were used namely, the MIS, SRME, and interviews. These instruments were used to describe the nature of school mathematics teaching as experienced by P2N participants and the personal identities mentutees formed as a result of fulfilling normative ways of participating in their respective learning communities. The MIS, a survey, was administered to all 45 11th graders (mentutees) to determine their entry characteristics such as nature of mathematics instruction in their schools and the mathematical identities formed.

The MIS instrument, the identity survey instrument, had items which were on the Likert scale. Items were coded 1- Strongly Disagree, 2- Disagree, 3- Agree, and 4- Strongly Agree or 0 – No such Opportunity, 1- Never, 2- Sometimes, 3- Most of the Time, and 4- Always. All negatively worded items were reverse coded. For example, an item, “Good mathematicians don’t look like me” which is negatively worded was reverse coded with a selection “Strongly Agree” receiving the lowest score of one. Frequency counts were obtained for each item to obtain the general responses to each item. This helped me to determine the general perception of 11th graders regarding their mathematics identities.

The mathematics perception survey (SRME) and the interview guide contained open-ended items that mentutees responded to. All the items were transcribed and analyzed using NVIVO software. The coding process followed an inductive-deductive. All qualitative data were open-coded. The codes were constantly refined as various cases were analyzed and also during across case analyses. Using two analytic frameworks (to be discussed into details later when describing the analysis procedure for research questions two and three), codes were clustered based upon the constructs suggested by the two frameworks. This involved engaging in cross case analyses to identify common themes that could support any theoretical assertions made regarding students' in-school mathematics learning and identities. The analyses of these data corpus were carried out using a modified version of the grounded theory approach suggested by Cobb et al. (2001). It is modified in the sense that while an open coding process (inductive coding) was used with the aim of obtaining new themes, there was also a deductive coding process. A theme that resulted from the open coding was *Affordances Created by Various Institutional Structures.* The deductive process involved the use of two analytic frameworks which meant that there were pre-existing codes suggested by these frameworks.

Research question two: How are normative identities as doers of mathematics constructed and negotiated within selected P2N communities?

Cobb et al. (2001) gave three criteria that should inform the selection of an analytic framework. The framework should: 1) enable us to document the collective mathematical development of the classroom community over the extended periods of time covered by instructional sequences, 2) make it possible to document the developing mathematical reasoning of individual students as they participate in the practices of the classroom community, and 3) generate analyses that feed back to inform the improvement of our instructional designs. In analyzing data related to research question two, an analytic framework by Cobb et al. (2009) was used to document the microcultures in each and across the four sampled P2N mathematics communities. Before outlining how this research question was answered, a brief review of the analytic framework used is presented.

Interpretive Framework by Cobb et al. (2009): A Social and Psychological Perspective of Mathematics Classrooms

Cobb et al. (2001) noted that there are two distinct, yet interrelated theoretical perspectives that must guide investigations of classroom activities namely, the ‘Social Perspective’ and the ‘Psychological Perspective.’ All social communities of practice have their own norms that regulate what is an acceptable way of acting and behaving. Mathematics classrooms, according to Cobb et al. are social environments and therefore have their own normative forms of classroom practice. These classroom practices are delineated into two constructs.

The first construct, general classroom practices, refers to classroom practices which are not specifically related to the teaching and learning of mathematics. Classroom practices such as who has authority in the classroom to speak and initiate conversation, how community members are expected to behave, and what counts as acceptable classroom behavior fall into this category. The second construct, specifically mathematical obligations, are classroom practices specifically related to the teaching and learning of mathematics. It helps to delineate student obligations related to the learning of mathematics such as what it means to do mathematics and to reason with mathematical symbols. Unlike scholars (e.g. Boaler, 2000; Grootenboer et al., 2006) who have the normative practices as pre-determined with community members learning to identify with established norms, Cobb and his colleagues argue that normative ways of participation evolve through the mutual agreement of participants. As such, instead of positioning students as naïve participants in learning community, they should be seen as playing an active role in the construction of classroom norms and in some cases ensuring its compliance. It is when norms for participating in a mathematics learning space have been established that individual members determine the extent of agreement or disagreement. Therefore, the social norms influence the personal identities formed by participants in the learning space marking a shift from a sociological perspective (group norms) to a psychological perspective (individual focus).

Cobb et al. (2001) view community norms as taken-as-shared practices. They are taken-as shared practices in the sense that while they may constitute ways that members are expected to engage with the study of mathematics for instance, individuals still have a sense of agency to either accept, comply with or reject such norms (Cobb et al., 2001; Yackel & Cobb, 1996). A psychological perspective of mathematics classroom investigation therefore, deals with the role the individual plays as s/he decides on the extent to which to affiliate with the normative practices in a learning environment. As a result, while the mathematics classroom or any other learning environment is social in nature with 'rules' regulating how members are expected to behave and participate in group activities, each member still retains an agentive power to decide the degree of identification and affiliation (Boaler, 2000). This study aligns with other studies in which the researchers viewed mathematics classrooms as media for socializing students into mathematical practices (Boaler & Staples, 2008; Cobb et al., 2001; Gresalfi & Cobb, 2011). These researchers view the learning of mathematics as participation in a social practice with an individual identifying with social norms. In this regard, an investigation into classroom microcultures should focus on both the social and psychological aspects

(Cobb et al., 2001). Cobb et al. (2009) delineated the normative identity into two: general classroom obligations and specifically mathematical obligations (see Figure 2).

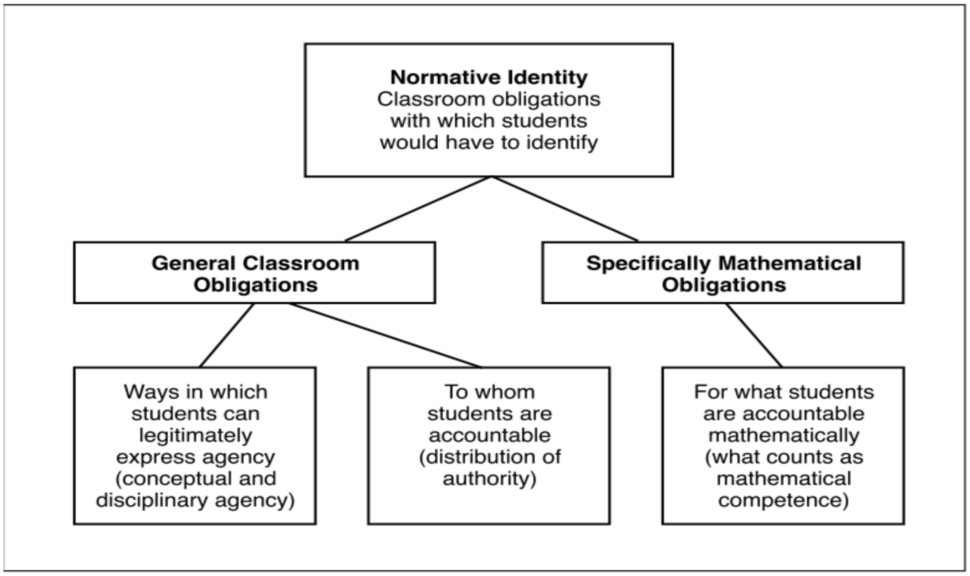


Figure 2. Normative identity as a doer of mathematics in a particular classroom (adopted from Cobb et al., 2009).

In summary, the framework by Cobb et al. (2009) was useful in documenting the normative identities in each of the four communities sampled for this study and mentutees understanding and valuation of their school mathematics normative identities. In documenting the normative identities mentutees experienced, particular attention was paid to tutoring practices such as whether mentutees were more involved in initiating approaches to mathematical tasks and explaining their reasoning or they mostly sat and listened to their teachers solve mathematical tasks (that is, distribution of authority). Also, coded for were the type of agency mentutees could legitimately exercise, was it specifying steps for solving a mathematical task (disciplinary agency) or how and why a given task was solved (conceptual agency)? An example is a student who indicated that "in my class you should ask the teacher every single doubt." In this case, authority was seen as being mostly distributed to the teacher such that he determines what students should do and what counts as mathematically correct approach to use. An indication of mentutees understanding of their general classroom obligations were their use of phrases such as: "in my class" "the new student has to." These phrases were taken as mentutees' understanding of expected ways of participation in their classrooms that is, their taken-as-shared ways of acting and participating (Cobb et al., 2009).

Specifically mathematical obligations, on the other hand, focused on what mentutees had to do to succeed in mathematics, that is, what counts as mathematical competence? Since the researcher could not observe classroom mathematical practices, mentutees' responses to items related to what a new student should expect on the very first of being in their mathematics classrooms and what it took to be successful in their classrooms were used to determine document 11th graders' specifically mathematical obligations. The analysis focused on the nature patterns of instructional practice from the moment mentutees entered their classrooms to the end of a class, whether the sequence of activities as recounted by mentutees were common mathematical practices in their schools or atypical (they compared a typical mathematics class to an atypical class). For example, statements such as "I will tell the new student to practice," "make sure you do all assignments," or "the teacher will show us how to solve the questions" were taken as mentutees' understanding and valuation of their specifically mathematical obligations which involved being good students, or engaging in instrumental learning – knowledge of procedures.

The second research question was used to determine the tutoring practices in each of the four communities sampled. Using the framework by Cobb et al. (2009), normative identities for each community were analyzed for the general tutoring and specifically mathematical obligations. In analyzing for normative ways of doing mathematics observational data (videotaped sessions) of various communities and individual interviews were used. The observational data were partitioned into three parts, the first part looking at initial tutoring practices, second and third parts looking at any possible changes and/or regularities (Cobb, et al., 2009; Robinson, 2014).

In analyzing the video-taped sessions, regularities in tutoring practices for each community were coded for across the 10 weeks of observation. For instance, what was the nature of interaction among community members during the first few weeks of observation, were they always relying on their mentutor? Has there been any shift in community interactions which could serve as some indication that authority was more widely distributed to community members with mentutees exercising conceptual agency? The transcribed observational data were also coded for mentutees valuation and understanding of their general and specifically mathematical obligations in terms of the type of agency mentutees could legitimately exercise in their respective communities, to whom mentutees were accountable to, and discussions about mathematics in terms of how to reason with mathematical symbols and what counted as being mathematically competent. For instance, do mentutees sit and watch their mentutors solve mathematical tasks? Do mentutors always have to sanction what counted as a mathematically correct answer or mentutees were expected to engage in mathematical argumentation? The procedure for analyzing the data followed a modified version of the grounded theory.

Research question three: How does a mentutor's use of identity resources influence the formation of specific learning and identity trajectories?

Although Cobb et al.'s (2009) Interpretive Framework was helpful in document classroom norms in terms of normative identities and its influence on the personal identities formed by 11th graders, it did not take into account the mechanisms leading to the formation of specific personal identities. In a community, individuals interact through both verbal and nonverbal gestures (ideas sharing), share cultural artifacts (material resources), and form relationships with each other. These ways of interaction go beyond the immediate motivation for people to be in a community. For instance, in a mathematics classroom while students and teachers' immediate goal is the learning of mathematics, there are other practices that members have to engage in and learn to navigate in order to become a full member. However, these cultural practices in terms of messages about what it means to know mathematics, access to material resources, and relations formed in a particular learning community are not made explicit in the framework by Cobb et al. (2009). It also does not help adequately capture how specific curricular resources are distributed and made accessible to learners which all can influence how students identify with mathematics. In view of these limitations identified with the interpretive framework by Cobb et al. a second analytic framework by Nasir and Cooks (2009) was used to make the interaction between sociological and psychological perspectives more concrete and explicit.

The Identity Resources framework by Nasir and Cooks (2009) has three resources. The first resource, ideational resource, considers mentutors' perceptions their mentutees' mathematical abilities. The second resource, relational resource, focuses on the nature of the relationship between community members (e.g. did they bond or were there tensions?). The third resource identified by Nasir and Cooks is material resources which, in this context of this study, deals with curricular resources such as textbooks, graphing calculators and other teaching and learning resources likely to influence students' mathematics learning.

In using this second framework, explicit messages communicated in target communities were coded for. For example, a key component of P2N is the use of near-peer mentoring so that the undergraduates who are mostly students of color will motivate and encourage their mentutees to succeed in doing mathematics, encourage conversations about college prospects and pursuit of STEM disciplines in college. Also, mentutors are expected to share their own mathematics learning experiences with their mentutees with the belief that such shared experiences will encourage their 11th graders to persist I studying mathematics and not engage in self-elimination. In order to document the kinds of messages mentutors shared with community members specifically related to mathematics, interview questions (primary data source) related to ideas related to what it takes to be successful in mathematics were coded for as ideational resources. For example, a mentutor who told his mentutee to try his very best is seeking to instill the idea of self-belief in the 11th grader. In effect, how was P2N's slogan of "Math is hard…So is life. We accept the challenge!" translated to mentutees? What kinds of messages were communicated to mentutees that enabled mentutees who did not identify with mathematical tasks to accept the challenge and ultimately experience a transformation in their mathematical identities?

With regards to material resources, items on the interview guide related to the importance of access to these resources were coded for. Follow up questions related to the effect of the graphing calculator and ACT study guide that were made available to all participants were also analyzed. Specifically, how did access to these material resources support their mathematical learning? Additionally, the relational resources in each community were coded. Specifically, did mentutees have a sense of belonging? What was mentutees' valuation of the relational resources that were made available to them resulting from assigning them to specific communities? The expectation was that once mentutees were assigned to a particular community for a relatively long period of time, community members will form a bond with each other. Through this bonding process community members were more likely to share mathematical ideas thereby increasing their learning opportunities as they have more avenues to communicate their mathematical ideas to others, whether one-to-one or whole group discussions. For instance, did mentutees feel they were legitimate members in their assigned communities? Did the training on promoting welcoming communities based upon the principle of equitable practices apply?

Although a framework was used to code for these three identity or practice-linked resources, the coding process involved an open coding to determine for instance, the kinds of ideational resources that were made available to mentutees.

Research question four: What is the nature of mentutees' personal identities in mathematics prior to and after participating in P2N?

Personal identity is defined as "the extent to which students identify with their classroom obligations, merely cooperate with the teacher, or resist engaging in class-room activities" (Cobb et al. 2009). Taken-as-shared according to Cobb et al. refers to normative ways of doing things in a learning community which although all members are obligated to, individual members can choose to abide by or reject them. In that case, despite students the shared normative ways of doing mathematics for a particular community or learning space different personal identities were noted.

In analyzing for the personal identities, the two analytic frameworks were combined to make explicit connections across the data corpus; surveys, observation, interviews, and field notes. Mentutees' responses to items about their valuation and understanding of what it means to know and do mathematics were analyzed. Also, their evaluation of their competence in mathematics were noted. Additionally, trajectories of mentutees' mathematical identities were characterized in terms of typologies. These typologies were used to categorize students based upon the extent to which they believed themselves to belong the community of mathematics, their sense of achievement and evaluation and understanding of their normative obligations.

These typologies were used to identify students who either identified with, merely complied, or resisted engagement in mathematics activities. Since personal identities deals with the extent to which community members aligned with normative ways of doing mathematics it was important to create these typologies to understand what and why mentutees identified with mathematics in different ways. The first typology focused on mentutees' personal identities formed based upon their interpretations of the normative ways of doing mathematics in their schools. The second typology relates to the personal identities mentutees formed in P2N. These two typologies were necessary since the purpose of carrying out this study was to find out how tutoring practices promoted in P2N could influence the mathematics identities of participants.

Furthermore, the type of agency mentutees were able to exercise, whether conceptual or disciplinary and how authority was distributed in the two learning environments were analyzed. While conceptual agency meant that instructional practices were more student-centered, disciplinary agency indicated that the instructional practices were more teacher-centered. According to Cobb et al. (2009) instructional practices that are more participatory in nature enable more students to feel competent in doing mathematics while a more teacher-centered approach leads to few students feeling mathematically competent.

Additionally, interview data for what students' counted as being mathematically competent in the two learning environments were analyzed using both deductive-inductive coding processes. Also analyzed were mentutees' evaluation of their mathematics competence drawing on survey, video-and-audio-taped data. By contrasting the normative identities promoted at P2N with school normative identities, it was possible to document differences and similarities that different pedagogies had on mentutees' mathematical identities. These analyses enabled me to have portraits of the personal identities formed by each student based upon their sense of belonging, sense of achievement, and images of what it means to do mathematics (see Appendix H for excerpts of codes).

Summary

In summary, the use of the different analytic frameworks helped in gaining a broader perspective about the instructional practices in the various learning spaces and their resultant effect on the mathematical identities mentutees formed. While the framework by Cobb et al.(2009) was particularly useful in documenting the normative practices in each microculture, that of Nasir and Cooks (2009) was used to account for the cultural practices mentutees were engaged in, the distribution of identity resources and how these resources led to the development of specific learning and identity trajectories (Wenger, 1998). The various data collected played a complementary role in triangulating across various sources thereby improving the reliability and validity of findings. In Chapter 4 the findings of this study are presented. Results are presented for each research question and discussed. Also, results for each community are presented as well as across cases, that is, across communities. In Chapter 5, summaries, conclusions, and implications of findings are presented.

CHAPTER 4

Findings and Discussion

A mixed methods design involving an embedded multiple case study design and a survey were used to investigate the influence of an out-of-school mathematics program on high school students' mathematical identities. The major hypothesis underpinning this study was that different pedagogies leads to students forming different personal identities due to the varying normative identities they engender. In order to uncover any changes in the mathematical identities of mentutees different instruments were administered including a survey containing mostly closed-ended items, a math reflection survey (open-ended written responses), and individual interviews. These various data were analyzed using both quantitative and qualitative data analysis techniques as appropriate in order to answer the four research questions that underpinned this study. For instance, the qualitative data were analyzed using two interpretive frameworks by Cobb et al. (2009) and Nasir and Cooks (2009) using an open coding process. In this Chapter, the findings for each of the research questions are presented and discussed by drawing on relevant data source(s) to support various assertions made. In chapter 5, a summary, conclusion, and suggestions for further research are presented.

Research Question One: What is the nature of the mathematics learning experience of 11th graders prior to joining P2N?

In order to answer research question one, all mentutees first responded to a quantitative survey instrument *Mathematics Identity Survey* (MIS). After this, qualitative data were collected using a *Self-Reflection on Math Experiences* (SRME) instrument and individual interviews. The individual interviews were conducted with mentutees in the four focal communities close to the end of the tutoring program, which was in April, 2015. The quantitative data results are first presented followed by the qualitative data results.

Quantitative Data

Mentutees were enrolled in seven different schools. Therefore, the survey instrument was administered to gain a general understanding of their mathematics learning experiences and how that experience might have influenced their decision to participate in P2N. Additionally, the administration of this instrument enabled the researcher to have a cross sectional view of mentutees' mathematical identities prior to *P2N* regarding their perceptions about the nature of mathematics pedagogy, interest in mathematics-related disciplines among other identity-related factors. Results for each of the five factors mentutees responded to on the MIS instrument are presented and discussed.

Perceptions about Nature of Mathematics and Mathematicians

The majority of mentutees reported finding mathematics interesting with 67.9% of them choosing either 'somewhat agree' or 'strongly agree.' In effect, the stereotypical images that minority students do not find mathematics interesting and may require 'special attention' through the implementation of special curricular or culturally relevant pedagogy appear to be untrue for the majority of participants in P2N (Ladson-Billings, 1995; Martin, 2012; NCTM, 2014; PCAST, 2010). Additionally, almost all of them (97.1%) perceived mathematicians as having a chance to make a difference in the world with 55.9% choosing ‘strongly agree’ and 41.2% choosing ‘agree somewhat.’ This finding indicates that mentutees considered the work of mathematicians to be important and that mathematical concepts can be used to address real-world situations. Despite students reporting that they find mathematics interesting and perceive that mathematicians, through their work, can make a difference in the world, most of them held negative perceptions about the work of mathematicians and their sense of identification.

In response to a statement about whether they perceived mathematicians to work alone, the majority of them agreed. While 70.6% of respondents chose either ‘somewhat agree’ or ‘strongly agree,’ only 5.9% strongly disagreed with the statement. Such a perception is contrary to the collaborative nature of the work of mathematicians and probably illustrative of the effect of classroom practices where students work alone or television programs that depict mathematicians as lonely individuals stuck in their office performing weird computations. Most mathematics classrooms have desks neatly arranged in rows and columns compelling students to work individually. As a result, mentutees perceptions of mathematicians as sole geniuses working alone in an obscure office rather than a more collaboratively view may be more reflective of mathematics classroom practices which stress individualism over cooperative learning. This finding is consistent with other studies that have reported a mismatch between students’ perceptions about how mathematicians work and that of mathematicians (Boaler, 2008b; Carraher, Carraher, & Schliemann, 1985).

On whether they perceived good mathematicians to look like them, while the majority of them (67.7%) responded in the affirmative, nearly a third (32.3%) responded in the negative. Additionally, on the item "I see myself as a math person," 23.5% of respondents either strongly disagreed or disagreed with the statement. Only 17.6% of mentutees strongly agreed with the statement. The results on these two items are quite worrying considering that students' sense of belonging has influence on their level of interest and motivation to persist on mathematical tasks (Eccles, 2009). It also raises concerns about any possible effect conversations about the achievement gap in mathematics might be having on students in terms of images about who can succeed in mathematics (Gutiérrez & Dixon-Román, 2011; Inzlicht & Good, 2006; Ladson-Billings, 1997; Stinson, 2013).

In summary, mentutees' responses revealed interesting patterns about how high school students' perceived the usefulness of mathematics and their images about mathematicians. While some of their responses were contrary to dominant narratives that suggest that minority students lack interest in mathematics, responses to other items particularly whether good mathematicians looked like them indicated that nearly a third did not identify themselves with images about who a good mathematics person is. The results are presented in Table 4.

Table 4

Perception about nature of mathematics and Mathematicians [1]

Statement	*SD (%)*	*DS (%)*	*AS (%)*	*SA (%)*
Math is interesting to me	1(2.9)	2(5.9)	19(55.9)	12(35.3)
I see myself as a math person	1(2.9)	7(20.6)	20(58.8)	6(17.6)
Mathematicians have a chance to make a difference in the world	-	1(2.9)	14(41.2)	19(55.9)
Mathematicians spend most of their time working by themselves	3(8.8)	7(20.6)	20(58.8)	4(11.8)
Mathematicians spend most of their time working indoors	2(5.9)	10(29.4)	16(47.1)	6(17.6)
Good mathematicians don't look like me	1(2.9)	10(29.4)	19(55.9)	4(11.8)
The media (television, movies, etc.) make math seem fun to learn	2(5.9)	14(41.2)	15(44.1)	3(8.8)

Interest in Mathematics Activities

One way of determining whether students find a mathematical activity interesting is through their engagement in mathematics tasks. If students find an activity interesting, they are more likely to engage and persist in it (Eccles, 2009). In order to determine mentutees' engagement in mathematics activities, they responded to statements about doing of homework, doing work for extra credit, and their level of participation in the teaching and learning process.

[1] Although there were 45 mentutees, 34 is used for all whole group discussions. This is because this number represents mentutees who completed both sets of initial instruments.

While a majority of mentutees (67.6%) responded doing homework, nearly a third (32.4%) responded in the negative. Also, only 23.5% responded always doing work for extra credit with 11.8% indicating that they never did that. Responses to these items suggest that the sometimes strict requirement for submitting homework maybe accounting for the relatively high percentage of students doing their mathematics. However, in terms of volunteering to do work for extra credit, only about a third (32.3%) did that on a regular basis.

Responses to items on mentutees' participation in mathematics learning and teaching in their classrooms that while 61.8% indicated either 'always' or 'most of the time' doing so. However, a majority of them responded feeling bored in their mathematics classrooms. About 52% responded feeling bored 'most of the time' with only 14.7% responding that it was never the case. Results are presented in Table 5.

In summary, while it may be possible that institutional practices may be compelling students to engage in mathematics activities such as doing homework, doing work for extra credit, which can signal interest in mathematics is not a practice engaged in by most of them. Again, similar to concerns by Walker (2012) that students do not find mathematics classrooms engaging, this appeared to be the case with this group of students.

Table 5

Interest in mathematics activities

Statement	*Always*	*Mostly*	*Sometimes*	*Never*	*N. A*
Do the homework for this class	15(44.1)	8(23.5)	11(32.4)	-	-
Do work for extra credit	8(23.5)	3(8.8)	10(29.4)	4(11.8)	9(26.5)
Participate in class discussions	10(29.4)	11(32.4)	8(23.5)	3(8.8)	2(5.9)
Ask questions in class	11(32.4)	6(17.6)	13(38.2)	4(11.8)	-
Make up work when you miss class	16(47.1)	9(26.5)	9(26.5)	-	-
Feel bored in class	4(11.8)	18(52.9)	6(17.6)	5(14.7)	1(2.9)

Teacher Expectations and Mathematics Competence

In order for students to feel valued and motivated to persist in a task, there is a need for mutual respect. It is important that teachers have high expectations of students and hold them to a higher standard rather than doubt their mathematics competencies (Delpit, 1988; Martin, 2012).

In general, a majority of the students reported that their teachers held high expectations for them (91.2%) and believed that they are good in mathematics (94.2%). These results suggest that mathematics instruction in urban schools is not all gloomy as sometime suggested in the literature. There are some teachers who have believe in their students and have high expectations for their learning (Chazan, Brantlinger, Clark, & Edwards, 2013; Cobb & Jackson, 2013). Their responses to items about their mathematics learning experiences suggest the fluidity of students' mathematics identities

(Sfard & Prusak, 2005) and how different learning environments can have varying influence on their interest in mathematics (Boaler, 2000; Cobb & Gresalfi, Hodge, 2009; Horn, 2008). For instance, while 58.8% of mentutees reported having teachers who made them not like mathematics with about a fifth (20.6%) strongly disagreeing, 85.3% of them indicated that they enjoyed learning mathematics during the semester in which data were collected. Results are presented in Table 6.

Table 6

Teacher expectations and mathematics competence

Statement	*SD (%)*	*DS (%)*	*AS (%)*	*SA (%)*
My teacher thinks I could be good in mathematics	-	2(5.9)	21(61.8)	11(32.4)
I enjoy learning math this year	2(5.9)	3(8.8)	18(52.9)	11(32.4)
My teacher cares if I think math is interesting	1(2.9)	7(20.6)	17(50.0)	9(26.5)
You need to have special abilities in math to well in this class	3(8.8)	6(17.6)	19(55.9)	6(17.6)
It is important to me that my math teacher believes in me	1(2.9)	7(20.6)	15(44.1)	11(32.4)
My math teacher has high expectations for me	-	3(8.8)	19(55.9)	12(35.3)
In this math class, I am learning how math applies to real life	1(2.9)	8(23.5)	10(29.4)	15(44.2)
Doing well in this math class is important for my future career goals	-	2(5.9)	17(50.0)	15(44.1)
My math teacher seems to enjoy teaching the subject	1(2.9)	2((5.9)	14(41.2)	17(50.0)

Table 6 Continued

Statement	*SD (%)*	*DS (%)*	*AS (%)*	*SA (%)*
In this math class, we talk about what everyday mathematicians do	2(5.9)	13(38.2)	14(41.2)	5(14.7)
My current math teacher makes math exciting to learn	2(5.9)	13(38.2)	14(41.2)	5(14.7)
I had a math teacher who made me **not** like math	7(20.6)	7(20.6)	14(41.2)	6(17.6)

Interest in Mathematics-related Disciplines

As part of attempts to stop the leakage in the STEM pipeline and increase number of people entering STEM fields and also have mathematically literate citizenry (NCTM, 2014; PCAST, 2010), it is important for high students to develop interest in mathematics. It is when individuals find an activity interesting that they are more likely to persist in the face of challenges.

Generally, most of the students appear to be only moderately interested in careers with a mathematics-focus. For instance only 58.8% of respondents were either very interested in or fairly interested in careers requiring analyzing data to draw conclusions. However, most of them (79.4%) were interested in discovering new things that can help the environment or people's health.

Interestingly, 47.0% of them either had a little interest in or no interest at all in spending lots of time and energy on a problem until a problem is solved. This finding may be indicative that students may be predisposed to a performance goal orientation where they do not want to exert too much effort on solving a task (Carol S. Dweck, 1986; Gutman, 2006; Yeager & Dweck, 2012). Results are presented in Table 7.

In summary, mentutees do not appear to have much interest in the pursuit of STEM disciplines. Particularly worrisome is the high number of students who do not want to exert themselves in solving problems especially in a world which requires sophisticated problem solving skills (Lesh & Doerr, 2003).

Table 7

Interest in mathematics-related disciplines

Statement	*Very interested*	*Fairly interested*	*A little interested*	*Not interested*
Design, invent, or develop new products or tools	13(38.2)	6(17.6)	10(29.4)	5(14.7)
Spend a lot of time and energy on a problem until you solve it	5(14.7)	13(38.2)	8(23.5)	8(23.5)
Discover new things that help the environment or people's health	12(35.3)	15(44.1)	5(14.7)	2(5.9)
Teach other students math at middle or high school	4(11.8)	8(23.5)	9(26.5)	13(38.2)
Analyze data to draw conclusions	10(29.4)	10(29.4)	7(20.6)	7(20.6)

Self-confidence in Mathematics

When students have a sense of personal identity in mathematics, they are more likely to feel confident in their mathematics competences and have a sense of achievement (Boaler, William & Zevenbergen, 2000b; Cobb, Gresalfi & Hodge, 2009). Additionally, as community members, they should be able to participate in community practices without feeling like outsiders (Lave & Wenger, 1991). In a mathematics classroom, such participation could be being able to share ideas to facilitate mathematical reasoning, being open to feedback or critique, and also being resilient in the face of challenging tasks.

The results obtained suggest that the majority of students (85.3%) are able to share their ideas in class and also like it when their classmates critique their work which is 82.3% of respondents. However, on whether they like easy classes, 52.9% chose either ‘agreed somewhat’ or ‘strongly agree.’ Students’ likely tendency to avoid challenging tasks is reinforced on their responses to a statement on their reaction to assignments which are challenging. While only 2.9% of them chose ‘strongly disagree,’ nearly a fifth of them (20.6%) of them chose ‘strongly agree.’ Overall, 82.4% of them agreed with the statement. Results are presented in Table 8.

In summary, while it is refreshing for students to have opportunities to engage in mathematical discourse and explain their thinking to other, the possibility that students might avoid taking challenging tasks is worrisome. This is because if attempts aimed at increasing the number of people entering the STEM pipeline is to be fruitful, it is expected that students take college-required mathematics classes to qualify for these programs.

Table 8

Self-confidence in mathematics

Statement	*SD (%)*	*DS (%)*	*AS (%)*	*SA (%)*
During class, I like to share my ideas with other friends	-	5(14.7)	18(52.9)	11(32.4)
I like classes that are easy for me more than classes that challenge me	8(23.5)	8(23.5)	13(38.2)	5(14.7)
When an assignment turns out to be harder than I expected, I usually don't complete it	1(2.9)	5(14.7)	21(61.8)	7(20.6)
If I'm in a class that is not right for me, I can get switched to another one	3(8.8)	10(29.4)	17(50.0)	4(11.8)
I feel comfortable asking my math teacher to explain ideas that are unclear	1(2.9)	3(8.8)	14(41.2)	16(47.1)
I am free to take any math class I want	6(17.6)	9(26.5)	11(32.4)	8(23.5)
I like it when my classmates critique my work	1(2.9)	5(14.7)	22(64.7)	6(17.6)

Results from Qualitative Analyses for Research Question 1

The results from the qualitative data sources to back the findings from the quantitative analyses are represented. In presenting the results of the qualitative data, both observational and interviews, the nature of mathematics instruction as experienced by the 34 mentutees in their various schools are described. It is noteworthy that despite the fact that these 11th graders attended various schools (about seven in all), analyses of mentutees mathematical learning experiences (their understanding and valuation of their normative identities) revealed some general instructional patterns across these schools and mathematics classrooms.

Instructional Practices in Schools

Analyses of written responses on the Self-Reflection Survey on Math Experiences (SRME) indicated that the nature of mathematics instruction as experienced by mentutees can be divided into three phases. These phases are similar to what Cobb et al. (2009) identified in their study. The first phase involved teacher performing routine classroom management practices such as checking attendance or making announcements about upcoming quizzes. After classroom management concerns have been sorted out, mathematics teachers then engage students in a review session. Reviews can be about a previous day's homework or warm up students did within the first few minutes of class. The instructional practice at this phase tends to be that both students and teachers review answers to items. Answers or procedures for solving these items are provided by the teacher. In some instances, "someone who solved it" is called upon to "demonstrate" how to solve a particular task. The following comment exemplifies the role teachers' play at the review stage: “if we had homework that night, we give the teacher the questions, and she goes through it, and answers the questions we had (Amina).” Teachers’ going through these tasks, according to Fred sometimes involves a focus on “problems people had trouble” with. With a general class period of about 50 minutes, this phase, can take from 5 minutes to 30 minutes. Grace sums up the nature of phase one instructional practice: “When we enter class we greet the teacher and immediately start our ACT practice quiz. After this, we go over it with Mr. Walker and immediately start our lesson for the day.”

The second phase involves teachers introducing the topic or new concept to be learned that day. This is usually in the form of a lecture. Kingsley notes that, “when teaching begins we learn a lot in a short time. It is usually dense material.” At this phase of the lesson, almost all the students noted that they are required to take notes. All 34 mentutees commented that this phase is mostly teacher – centered in that it takes the form of a lecture. Anise comments about what a new student in her mathematics class should expect: “She [the new student] would have to expect lecturing. A lot!” After the introduction, teachers then introduces students to some problems and “demonstrate” how to solve them.

The third phase of the lesson involved teachers giving students more questions to practice or homework to do. During this stage, which is mostly done individually, students are able to ask for “extra support” from their teachers. Only two students mentioned being given “exit tickets” at the end of class. This phase involved teachers giving students questions similar to those they demonstrated so that students can familiarize themselves with the procedures for solving particular problem types. All students commented about the normative nature of this practice and their general classroom obligation. Grace comments: “With our notes, we start off with a theorem and then comes examples. For the rest of the class, we practice the curriculum.”

General Classroom Normative Obligations

In analyzing for general classroom normative obligations, Cobb et al. (2009) delineated two aspects of this normative practice namely distribution of authority and type of agency exercised legitimately by students. Obligations are community norms that members are expected to adhere to and any forms of deviation is likely to receive sanctions.

Distribution of Authority

Mentutees’ responses to questions about instructional practices prevalent in their typical (general nature of mathematics instruction) mathematics classroom and any atypical mathematics classroom revealed no marked differences in their general mathematics obligations in these classrooms. The slight differences were related to the amount of notes students wrote, homework support received or time to play mathematics games or puzzles for those who referred to their middle school level mathematics classes. The following excerpt from Oliseh sums up the general nature of mathematics instruction experienced by these mentutees in that there is no markedly different changes in pedagogy: “My typical math class is different from my other math classes because it includes bigger work load and longer note taking.” In effect, mentutees continued their general classroom obligation of taking notes with the only variation being the number of pages of notes they have to write.

Mentutees' responses to the SRME instrument indicate that instructional practices in most of their mathematics classrooms were teacher-centered. As a result, most of the authority for initiating and facilitating learning was distributed to mathematics teachers. Students' responses revealed that their general mathematics classroom obligations were as follows:

1. Sitting still, being attentive, and taking notes as teacher lectures
2. Asking teachers questions
3. Repeating demonstrated methods through practice problems.

The first obligation of sitting still, being attentive, and taking notes was evident from students' responses to a question on the SRME which is; "what does it take to be successful in your mathematics classrooms." Students' responses were typically 'listening attentively' and taking "good notes." Rachel comments about the importance of note books as follows: "In my class you will be assigned a seat then you will be told you need a math notebook and a homework notebook." The importance of notes taking was also evident from the second phase of instruction with students commenting that immediately the warm up session is over their teachers most often introduce them to new topics which they write notes on. Mei, indicates the importance of taking notes by commenting that "Student *must* take notes. These notes will help with the homework." However, for those with teachers who "mumble" the task of taking notes can become an arduous task which is moderated by the use of technology. Khadija comments about the difficulty of taking notes in her class as follows: "You most likely will not understand what he is saying because he mumbles. You don't have to take notes in class because he writes on a paper then uploads the paper onto his website."

Other students stressed the importance of listening in order to 'understand' what the teacher is saying. Chantell comments: "Just pay attention in class. Don't get off task." Students' obligation to bring note books to class, to sit still, and listen attentively are part of what Cobb et al. (2009) termed as being a 'good student.' Good students are expected to be well behaved, have their school supplies ready, and to sit calmly in class in deference to the teacher, a figure of authority. The following comment by Grace sums up the nature of students' obligation and how authority is distributed to the teacher: "All you have to do is listen and take notes."

The second obligation of asking teachers questions, ostensibly to clarify what was said or demonstrated was evident in the second phase of instruction. Li comments: "Make sure you attend classes and ask your teachers questions." His response not only indicates the crucial nature of being in class but also the centrality of the teacher in students' mathematical learning. The need for students to see the teacher as the authority on mathematics knowledge is further supported by Claire who comments: "If you have questions, you must ask the teacher, any single doubt." Her view is taken a step further by Mei who said: "if a teacher explains something to you and you do not understand the concept, continue to ask the teacher."

In all instances, students viewed the source of mathematical learning to reside in their mathematics teachers for which reason "any single doubt" should be clarified by them.

Teachers are positioned as the ‘only ones’ who can help mentutees understand the mathematical concept being taught or the mathematical activity the class maybe engaged in. The use of the word *must* by Mei indicate that students view these as an obligation. As such, not taking notes or asking teachers questions maybe contrary to classroom expectations. In effect, students are required to exercise a disciplinary agency, reliance on notes and teachers since a lack of good notes may lead to mentutees inability to do assigned homework or any other mathematical activity for that matter.

The third obligation of practicing problems was apparent in the third phase of mathematics instructions. This could be in the form of working on “free response question from past AP tests,” “textbook,” or “worksheets.” During this phase, the distribution of authority to mostly teachers is more apparent with mentutees reporting that teachers demonstrated procedures to solve particular mathematical tasks which sometimes included “pointing out tricky questions.” Grace comments as follows: “With our notes, we start off with a theorem and then comes examples. For the rest of the class, we practice the curriculum.” The drill and practice nature of mathematics instruction experienced by students is evident from Richard’s comment about what his teacher did: “Well the teacher goes over the problems and shows us how to solve them.”

During these practice sessions, students are obligated to call on their teachers for assistance. Kacey comments: “Following this lecture, students will have time to practice this new material, and there will be an opportunity to receive extra attention from the teacher.” The teachers, therefore, get to exercise disciplinary agency by making “sure that all his students understand the questions (Selma).” As a consequence of this, all that students need to do to be ‘successful’ in mathematics is to practice. Maria comments: “This class isn’t hard, to maintain a good grade do all the homework, classwork and study for the test. The test you shouldn’t worry because it’s similar to the review.”

Specifically Mathematical Obligations

Students’ responses to the items on the nature of mathematics instruction and what it takes to be successful in their mathematics classrooms indicate that their specific mathematical obligation is following demonstrated procedures through regular practice. With the exception of two out of the 34 mentutees who commented about the need to look for patterns and to understand underlying concepts or the “fundamentals”, most of them indicated that doing well in mathematics requires some form of constant practice or memorization of procedures. In the absence of any conceptual understanding, their reasoning with mathematical symbols comprised practicing steps or methods shown by their teachers.

Richard comments about the normative nature of how to reason with mathematics symbols as follows: “Well my teacher is having us memorize the trigonometry identities and proving them…. It’s an all or nothing test so we have to memorize them.” However, such a procedural nature of instruction, it has been noted does not appeal to a lot of students and can hinder students’ mathematics learning. Amira recounts her difficulty in in a geometry class related to trigonometry identities. She comments: “Yeah, I heard about them [referring to SOHCAHTOA] but I didn’t’ know what they were. You know? I was really, really confused. I didn’t even know what they stood for in the first place.” Comments such as those expressed by a majority of mentutees reveal how a lack of conceptual understanding about the mathematical symbols students are expected to manipulate can be a hindrance to their mathematical learning. It is therefore not surprising to hear Richard talk about his teacher asking them to memorize trigonometric ratio identities for a test.

As noted earlier, an obligation becomes a community norm when members help in its enforcement. As such, while mentutees may interpret an obligation as something being forced on them by their teachers they are also complicit in its constitution and compliance. Mentutees understanding of their general classroom obligation is evident from their responses to an item on the SRME regarding what a new student had to do in order to be successful in their mathematics classrooms. Responses such as she must be attentive, take good notes, and ask teacher any question they have indicate their understanding and valuation of these obligations.

Additionally, students, by either identifying with or being compliant exercising disciplinary agency ensures that mathematics teachers become the repository of mathematical knowledge and who should be consulted to clear “every doubt.” Amira, for example, commented about how she ‘surrendered’ legitimacy of what counts as acceptable way of doing a mathematical activity as follows: “I will try my way to solve it. Then I will call her [referring to her mathematics teacher] and ask if this is the way to do it and if she says no then I will do it the way she did it.” Comments such as: “you have to call the teacher if you have any problem”, the “teacher then checks our answers to see if it correct” or the “teacher shows us how to solve it” are all indicative of how authority is distributed mostly to the teacher and the disciplinary agency mentutees were expected to exercise in their mathematics classrooms.

Mentutees' Pre-P2N Valuation and Understanding of their General and Specifically Mathematical Obligations

Mentutees' specifically mathematical obligation, what counts as mathematical competence, in this case norms for engaging in mathematical argumentation and reasoning with mathematical symbols involved following procedures prescribed by their mathematics teachers. Evidence for these assertions is grounded in the fact that out of the 34 mentutees, only four of them mentioned the need for conceptual understanding or identifying patterns, which are crucial aspects of the practice of mathematicians. The majority of them saw the nature of mathematics as following procedures introduced by their teachers. In order to fulfill their obligations, a number of them stressed the importance of attending class and being on time in order to take "good notes." Anise comments about the crucial nature of these obligations of having note books ready to take notes and also listening attentively without which it would be difficult to be successful in mathematics:

> This whole year math is easy, I only have to come [that is school], but not being there in a week I am just like 'oh my god I missed a lot' you know… I should have been there; I should have seen what she did step by step you know.

She continues by describing the nature of mathematics instruction and the step-by-nature of instruction commenting:

> It’s mainly just a PowerPoint and she says ‘oh for this stuff I’m going to show you what to do here and here. You do this, you do this, you do this’ and she’s like ‘do you guys understand it?’ I’m like ‘yeah we all understand’ and she’s like ‘okay, now, it’s your turn to try this.

Mathematical symbols only served as providing cues as to the kind of method to use rather than conceptualizing them as having meanings on their own. The following excerpt from Mai sums up students’ evaluation and understanding of their general and specifically mathematical obligations in terms of how to reason with mathematical symbols and engagement in mathematical tasks:

> So I would look at the problem and you know in math class we learnt by section and topic. Since we are learning this section, like we are learning about solving quadratics, I will look at the problem and I will be like okay how is this problem related to quadratics and what am I supposed to solve for?

In summary, the nature of mathematics instruction experienced by most of these students led to them seeing mathematics activities as looking for clues, practicing procedures introduced by teacher by following steps and sometimes just memorizing them. The nature of their general and specifically mathematical obligations meant that they could only exercise disciplinary agency most of the time. It is, therefore, not surprising that they felt that writing notes, doing homework and class work is important since these activities offer opportunities for them to practice so that they do not forget demonstrated procedures.

Reflections on Mentutees' Pre-P2N Understanding and Valuation of their General and Specifically Mathematical Obligations

Generally, mentutees' understanding and valuation of their normative identities as doers of mathematics suggest that the nature of mathematics instruction as experienced by them bears some resemblance to the characteristics of the pedagogy of poverty such as giving information (demonstrated procedures), asking questions, giving and reviewing assignments (Haberman, 1991). Mathematics learning in these classrooms involved mentutees observing teacher demonstrated procedures leading to the acquisition of procedural knowledge. Such procedural knowledge involves students knowing about procedures (rules, algorithms, or syntax) that are superficial in nature(Star, 2005). Mathematical competence, based upon the acquisition of procedural knowledge, led to most mentutees to deem mathematical competence as being dependent on an ability to remember teacher demonstrated steps as evident in the following comment by: "all I need are the equations and I will be fine" or through engagement in repeated practice of demonstrated procedures. Mentutees believed that through repeated practice and identification of clues in order to get a "hang" of things, learning of mathematics will become "really easy and fun." The following comment sums up students understanding of their specifically mathematical obligation when asked what it will take to be successful in their mathematics classes: "practice, practice, Practice, practice, Practice, practice. If you aren't practicing, you should be practicing (Jeff)." Such a conception of what counts as mathematical competence, following of prescribed procedures is in contrast to the practices promoted by NCTM (2000, 2014; NRC, 2001) and findings from research studies (Cobb et al., 2009; O'Dwyer, Wang, & Shields, 2015; Rittle-Johnson & Star, 2007). Results from these reports and studies indicate that effective learning occurs when instruction is more participatory with students having opportunities to communicate their solutions and ideas to others, and also engage in metacognitive processes as they provide justification for their methods or procedures. In effect, the maxim that 'listening is not learning' best captures mentutees' understanding and valuation of their specifically mathematical obligations. By behaving like good students as they sat "still" and observed their teachers demonstrate procedures to use in solving particular problem types, mentutees were denied opportunities to develop conceptual roots needed for further mathematics study.

Despite the potential challenges mentutees would face in future studies as a result of their acquisition of procedural knowledge not all of them were bothered by a lack of conceptual knowledge. As noted by Solomon (2007), not all students have problems if they do not understand what is being learned. This assertion is apparent in the comments by Jeff and a number of mentutees. In this regard, the exercise of disciplinary agency was not a source of worry to them, rather, students are expected to be pre-emptive in exercising this obligation consistent with their general classroom obligations of listening to teacher demonstrate procedures to be practiced later by them. However, as Boaler (2000b) argues, there is an interactional engagement between the identities learners form as mathematics students and the instructional approach. For mentutees who did not identify with the pedagogy and classroom norms being promoted in their mathematics classroom, there were instances where some high school students developed oppositional identities to their obligation of exercising disciplinary agency (Cobb et al., 2009; Robinson, 2014).

Research Question 2: How are normative identities as doers of mathematics constructed and negotiated within selected P2N communities?

As indicated in Chapter 3, P2N is a cascading mentoring and tutoring program comprising 8th and 11th graders. Tutoring sessions were held on Mondays for 11th graders and Saturdays for 8th graders. However, since the focus of this study is the 11th graders (mentutees), the analysis of tutoring norms focuses on what happens during the Monday sessions in the four sampled communities. Since tutoring sessions had a general format that all communities followed, a brief outline of what happens on Mondays is described.

On a typical Monday, tutoring started at 5:30pm. The first phase of activities involves mentutees doing a ‘warm up’ which is prepared by a project staff covering a specific benchmark skill from the 11th grade Minnesota (MN) standards. The purpose of the warm up was to serve as a review of what students have learned in their schools and usually has five items related to the target benchmark. Although it was conceived as a warm up, it was observed that for some mentutees it was the first time they were learning the concept being reviewed while for others there was no conceptual understanding when it was taught in their schools. When mentutees completed the warm up, their solution strategies are reviewed with their mentutor and/or the entire community members. After the review of the mentutees’ work, more practice examples from the ACT study guide were completed. Unlike the warm up which was more individualistic, the practice problems could be done individually or collectively after which there is generally a whole group discussion on the correctness of their procedures and solutions. This phase usually took about 40 minutes.

The second phase involved mentutees working on any homework they might have for that day. Since not all mentutees in a given community attended the same school, this phase tended to be more individualistic. During this phase, mentutees worked on their homework and requested for assistance as and when needed. In the absence of homework, mentutees were required to continue working on the benchmark skills covered during the warm up phase. The second phase lasted about 45 minutes, on average and mostly individualized in nature unless mentutees attending the same school were members of the community and chose to work together.

The third phase of tutoring was an 8^{th} grade benchmark review. Since 11^{th} graders were responsible for tutoring and mentoring 8^{th} graders on Saturdays specific benchmark(s) to be learned by the 8^{th} graders were previewed by the project director. The rationale behind the benchmark preview was to help 11^{th} graders gain a better understanding of these concepts. The preview phase was used to stress the concepts and skills 8^{th} graders were to learn during the tutoring session, the nature of challenges that students at that grade tended to face, and how to resolve such challenges. Interestingly, the preview session was found to benefit the 11^{th} graders in terms of revisiting what they learned in middle school thereby helping them fill in some gaps in their understanding.

In documenting the normative tutoring practices in each community for the purposes of comparison with what happens in schools, the first phase of tutoring was selected. This was because during this phase all community members were involved in the same activity with the mentutor facilitating their learning which is similar to what happens in schools where a teacher introduces a topic to the whole class and then facilitates the learning of students so that instructional objectives for the lesson are obtained. In line with the framework by Cobb et al. the nature of tutoring practices in the selected communities were analyzed in terms of the general tutoring obligations and specifically mathematically obligations. Similar to the approach used by Cobb et al. (2009), in documenting mentutees' specifically mathematical obligations in each community the focus was on "standards for mathematical argumentation" and normative ways of reasoning with written symbols (p.51). It must be noted that although four communities were selected, three of them had quite similar tutoring practices and were therefore treated as one community with their variations in style highlighted. This means that two unique cases are presented with each case highlighting different general community obligations and specifically mathematical obligations.

General Community Obligations

The Tyson Community. The mentutor, Dorothy, was in her second year of service as a mentor/ tutor in P2N. She was a mechanical engineering major. Her aim as a mentutor was "to help students discover how they learn math" and enable them to avoid the tendency to "just memorize problems" because they had no idea what to do. These ideals of enabling mentutees understand the mathematical concepts they were learning were evident in how authority was distributed in the Tyson community.

In this community, authority was distributed mostly to mentutees although during the first three weeks where most of the mentutees deferred to Dorothy, to determine the legitimacy of their strategies and answers for specific tasks. However, this changed from the mid-to-latter stages of the tutoring program. Mentutees could be observed sharing ideas and discussing their solutions with their mentutor making occasional comments when mentutees' reasoning was deemed to be "wrong." Instead of Dorothy telling community members what they did wrong or whether they got a particular task correct, mentutees learned during the first three weeks of tutoring that they should be prepared to explain their reasoning. As a result, not only were mentutees responsible for determining their own approaches to solving mathematical tasks, they were also expected to explain their reasoning. Over the course of the tutoring session, mentutees could be observed, after they had individually solved the tasks on the warm up, engaged in discussions about how they solved the questions and why they approached them in particular ways. This conclusion is evident from an analysis of mentutees general tutoring obligations which are:

1. Doing individual work
2. Understanding the demands of the task before formulating an approach
3. Explaining and justifying the approach used

The first obligation was evident at the first phase of tutoring where each member had a copy of the warm up. They were then given about 15 minutes to solve the tasks after which there was a group discussion of strategies. Discussions only started when community members had completed the warm up. In this regard, mentutees initiated their own strategies. They determined how to solve a given task based upon their own understanding rather than the mentutor modeling a particular way to solve a task which would become the ‘standard’ approach. In fulfilling this obligation, mentutees could be observed asking for copies of the warm up when they arrived before their mentutor or being reminded by other community members to grab copies of the warm up.

The second obligation of understanding the demands of the task before formulating an approach was evident during the discussion of warm up solutions. In fulfilling this expectation, mentutees were typically asked; “what was the question asking you to do? or “what do you know about this question?” These questions were posed to mentutees when they sought help from their mentutor. It was used as a means of helping mentutees take ownership over the learning process through an identification of the concept(s) embedded in a task. Once mentutees are able to make sense of a task and identify the embedded concepts being tested, they are more likely to formulate a strategy to solve the problem(s). On the contrary, inability on the part of mentutees to understand demands of tasks is likely to lead to them resorting to guess work or simply skipping such tasks.

To illustrate how students fulfilled this obligation of understanding the demands of a problem before formulating an approach, here is a dialogue that took place between Dorothy (mentutor) and Amira (mentutee). The problem being solved was: When x = 3 and y = 5, by how much does the value of $3x^2 - 2y$ exceed the value of $2x^2 - 3y$? Amira had finished solving the task and asked Dorothy to check if her answer was correct. Dorothy asked her to read the question after which she asked her "what is the question asking you to do or what do you know about this concept?' This led to both Dorothy and Amira identifying the parts of the task, which were, the values of $3x^2 - 2y$ and $2x^2 - 3y$ respectively. After helping her breakdown the question into its constitutive parts, Amira was then told to "try to answer the question" to which she agreed. As such, this obligation of understanding the question in order to formulate a solution was fulfilled.

Instead of telling community members what to do, Dorothy asked them to "read the question" and find out what they were solving for - such as identifying the givens and the unknown(s). Mentutees in the Tyson community were also expected to explain what they knew about the concepts being tested and how that knowledge could help them answer a given task. Through this process of asking mentutees to engage in a task analysis Dorothy enabled her mentutees to exercise conceptual agency by making sense of a task on their own instead of being told what to do. The obligation that mentutees understood a question before answering is evident in the following interaction between Dorothy and Amira. Amira is frustrated that she got the question wrong after an error was detected which led Dorothy to comment:

This is not me at all, it's all you. You know these things, you know how to do these things but you have to read what the question is about. If you keep reading the wrong question, you'll keep getting the wrong answers. Even if it says chapter 6 review, read the question because you never know what is in there.

In this episode Dorothy not only affirms mentutees' obligation to understand the demands of the question, she also gives a reason why it is important for mentutees to exercise this obligation which was to identify and understand the mathematics concepts embedded in a mathematical task before choosing a procedure or formulating a method to solve the task. Mentutees were therefore cautioned against following cues such as the chapter a question might be taken from in deciding how the task should be solved which is in contrast to what Mei, for instance did prior to P2N. She indicated that she relied on the chapter an item was taken from in the textbook or the particular topic being treated (since questions were based on sections they were treating at a particular time) to guide her choice of solution strategy and not an analysis of the problem type. Additionally, from this excerpt, whether a mentutee got a question correct or wrong is not up the mentutor. That responsibility rather rested squarely with the mentutees based upon their level of understanding the task demands.

The third obligation, explaining and justifying the approach used, occurred when mentutees had finished solving assigned tasks on the warm up and also during discussions about the practice items taken from the ACT study guide. An indication that authority was more widely distributed in this community were instances where the mentutor could not clearly explain a concept to a mentutee during to a communication gap or that she believed “they should hear it from a different person.” During such moments community members could be observed using either slang English or Somali language to explain the concept to the person while the mentutor looked on. Through this process of explaining to others their reasoning about specific tasks the mentutees exercised conceptual agency where they first of all formulated their own solution strategies and also explained their reasoning to each other. For instance, in another session on geometry, Amira was having difficulty solving a problem and had asked Dorothy for help after an initial attempt. The first question Amira was asked was, “what is the question asking for (the first obligation of understanding the problem)?" Amira drew a rectangle to illustrate what she thought about the problem which led to Dorothy asking her: “What do you know about a rectangle?" And what are the properties of a rectangle?” By posing open-ended questions, opportunity was created for Dorothy and Amira to have a discussion about angles formed in a rectangle, symbols used to indicate perpendicular angles and parallel sides. These questions enabled Amira to articulate her understanding of the underlying concepts being tested. In instances where her reasoning sounded incoherent she was told to avoid “guessing.” As a result, Dorothy made it clear the importance of reasoning through tasks and providing mathematically plausible explanations about tasks instead of engaging in try and error. The need for mentutees to explain and justify solutions is also evident from Dorothy’s interaction with Khadija who had finished solving a task and showed it to her. Dorothy's first question to her was "so how did you get that?” With the posing of this question, Khadija explained how she solved the task and her reasoning process.

As an obligation, it should be something that community members see to its enforcement with violators being reminded of them (Cobb, et al., 2009). This was the case with the third obligation as mentutees later picked up on this. A couple of weeks into the tutoring program, the Tyson community had come to understand their general community obligations and participated in its enforcement. Not only did they formulate their own strategies for solving a particular task, they also communicated their reasoning to each other in ways that made sense to them using various language resources, analogies, or drawings.

Although, most of the initial open-ended questions were asked by Dorothy (mentutor), with time it became a community practice that the mentutees took up. For example when Khadija offered help to Amira she could be observed asking her a series of questions similar to what Dorothy did when going over their work with them. In another example, Nafiso who had joined the community mid-way asked Amira to help her solve a task. Amira asked her to explain why she performed a particular step. Nafiso proceeded to explain her reasoning for using a particular strategy. Through this process of seeking to understand the reasoning behind a solution, mentutees exercised conceptual agency as they were in some cases able to identify what they did wrong and self-correct without being told explicitly told where they went wrong.

Cobb et al., (2001) note that reasoning with mathematics symbols involves being able to "articulate their task interpretations (as cited in Cobb et al., 2009)." Mentutees came to learn that it was not enough to produce an answer, they should be prepared to explain their reasoning as well. This obligation was evident from observations of interactions among mentutees as they were heard repeatedly asking each other to explain how they solved a particular task. In this regard, the need for mentutees to explain and justify how they solved a problem became a normative community practice. In all the discussions, Dorothy and other mentutees rarely commented on the correctness of solutions, however, through asking clarifying questions and using open-ended questions, the mentutee being helped could identify what they did wrong and engaged in self-correction.

In summary, the general obligations of each mentutee solving the tasks individually and then being prepared to explain their reasoning to others enabled mentutees to exercise conceptual agency. Authority was more widely distributed to mentutees as they initiated solution strategies based upon their understanding of given tasks and explained how and why they solved it in a particular way. Dorothy rarely showed them how to solve a task, rather, the strategies originated from the mentutees which then served as a springboard for engaging in mathematical argumentation and reasoning.

Specifically Mathematical Obligation

In line with their general community obligation of explaining and justifying approaches mentutees learned that it was not enough to produce an answer to a question. The norm for mathematical argumentation involved articulating an understanding of the task demands and how that understanding informed the solution strategy. Mentutees were required to make meaning of mathematical symbols and terminologies embedded in given tasks. Comments such as “you have to read the question” or “what do you know about the question” served as evidence of this obligation. Additionally, mentutees were expected to explain and justify their approach to others. Particular ways of reasoning with mathematical symbols were explained using drawings or analogies.

In the Tyson community, mathematical symbols were not mere marks to be operated upon. These symbols had meanings and therefore, had to be understood in order to successfully operate on them. Discussions about mentutees' understanding of the task demand, what the term 'difference' meant, and the symbols for indicating perpendicular and parallel sides all served as evidence of the need for mentutees to make meaning of terms and symbols used in mathematics in order to be gain conceptual understanding and for them to exercise conceptual agency.

Mathematical competence in the Tyson group therefore involved mentutees being able to make meaning of mathematical tasks on their own and also providing an explanation and justification for their solution strategy. These strategies were not prescribed by their mentutor but by the mentutees and they were expected to provide their mathematical reasoning when asked to do so. It was not the mentor who determined that a solution was incorrect or correct, it was a joint effort where both mentor and mentutee or in some cases the entire community discussed approaches.

In summary, Dorothy's goal for the Tyson community was to enable them to gain mathematical understanding instead of just resorting to memorization. Authority was mostly distributed to mentutees when they learnt in ways that connected with their learning style through the use of visual representations, or analogies. In some instances, mentutees engaged in code-switching between the English language and Somali language to express their reasoning clearly to other mentutees (all mentutees in this community were Somalis). Therefore, language became a visible resource to aide them in explaining their mathematical reasoning (Adler, 1998; Setati & Adler, 2000). Mentutees fulfilled their general community and specifically mathematical obligations of seeking to understand a given task before attempting a strategy to solve it as well as being prepared to explain and justify their reasoning to other members. Also, by repeatedly asking mentutees to seek to understand the question and to explain their reasoning, these obligations became community norms that mentutees helped enforcing it. The evidence for this conclusion is from the following response from Dorothy about how these obligations became normative overtime:

> I always ask in the process of correction 'what were you thinking, how did you come up with this method of solving it?' So over the several weeks once we get done with the warm up problems they start talking about it and I just listen in and come in to correct when they are not doing it right. They started it and it continued.

As such, while these general and specifically mathematical obligations were initiated by the mentutor, the mentutees with time came to view them as normative community expectations and helped in its enforcement.

The Daly Group

General Tutoring Obligation

As noted earlier, the Daly community had similar general and specifically mathematics obligations as the Tyson community. As such, in discussing the normative practices in this community, I highlight the difference(s) between these two communities. One such difference is that in the Daly community the mentutor (Fred) had a goal of enabling his mentutees to learn various strategies that can be used in solving the same problem which was evident in the general community obligations. As a result, unlike the Tyson community where it was the student who got a question correct who usually explained their reasoning process for the rest of the community members to listen and ask any clarifying questions where necessary this was not the case in the Daly community.

In the Daly community different solution strategies were shared. Typical comments in this group were, “this is another way to do this” or “there are multiple ways of doing it" to reinforce the notion that even if a mentutee had a preferred way of solving task, learning other strategies was helpful. Mentutees therefore, took turns in explaining their reasoning to the same task while others listened and asked questions to enable them to understand such strategies.

Specifically Mathematical Obligations

In the Daly community, what counted as acceptable ways to do mathematics was not just mentutees’ ability to solve tasks correctly similar to what happened in the Tyson community. What differed was the normative ways of engaging in mathematical argumentation. It was not sufficient for mentutees to know a single way to solve a task. Mentutees learned that there are multiple ways to reason about mathematical tasks which could all be valid leading to a correct answer. Therefore, there was no one way of solving mathematics problems but multiple ways which could all be correct provided sound mathematical reasoning was provided to justify them.

In order for community members to learn multiple ways of solving the same task, all community members, including the mentutor solved each task individually. After this, there was a group sharing of approaches used and why. The approach used by the mentutor was offered only when it differed from the various approaches demonstrated by mentutees. As a result of the general tutoring obligations of mentutees solving tasks individually and being prepared to listen to how others solved the same task, mentutees came to expect that there could be multiple strategies in solving the same problem and contributed in fulfilling this obligation. Although all mentutees shared their approaches and reasoning behind them, they took turns in leading the discussion for a particular item. In this instance, they were to discuss their approaches to item six which was, “Which one of the following expressions has an even integer value for all integers ‘a’ and ‘c’? The following options were provided: A) $8a+2ac$; B) $3a+3c$; C) $2a+c$; D) $a+c$; and E) $ac+a^2$. The following excerpt involves one of several instances where mentutees helped in enforcing these obligations.

Richard: Josh, your turn, number 6.

Mentutor: Alright Josh, give us the reason why you said 'A' (it was a multiple choice question).

Josh: I know that if you multiply something by an odd number it is not necessarily going to give you an even number. (As he explains his reasoning Richard cuts in)

Richard: But if you multiply an even number by even you'll get an even. I did not think about that. Yeah, that is great, that's a great one too of how you did it.

In this excerpt, not only did Richard help in enforcing the community norm that all members should share their approaches and reasoning, he also fulfilled the community’s general obligation of seeking to understand how others solved the same task. There were two instances where mentutees disagreed with their mentutor’s approach. One such instance involved an inverse trigonometric function. The mentutor commented as follows: "we were having a little dispute over this, what do you think the inverse of secant is, Josh?" In this and other instances, the mentutor did not exercise any form of disciplinary agency as the arbiter of what counts as the “correct answer.” Rather, he asked other community members to explain their work with the belief that their explanation(s) can clarify the disagreement. The process of explaining their approaches also required that mentutees used the appropriate terminology and various representations to convey their reasoning. For example, when the mentutor deemed an explanation given by Richard to be unclear, he asked him to “explain better.”

Reasoning with mathematical symbols involved the use of various representations in communicating mathematical ideas which most often involved a visual representation. Initially, the community members engaged in mostly verbal communication until the mentutor, unable to comprehend a mentutee’s reasoning, introduced a whiteboard to pictorially illustrate how he understood the task with the explanation that he was “a visual learner.” With time, mentutees would be observed using the whiteboard to make various illustrations including diagrams and graphs to explain their reasoning to other community members. With the use of pictorial representations, mentutees explained their understanding of particular symbols being manipulated and found ways to communicate their reasoning about such symbols in ways that could be understood by other members. Additionally, mentutees not only concerned themselves with learning various ways to manipulate symbols, they sometimes learned to make connections to other concepts.

Not only did mentutees solve the immediate task, in some instances, extensions were made relating the immediate task to other related concepts. As such, the mentutor, while meeting the demands of the program organizers also extended what was to be learned that day so that mentutees could make connections to other related concepts. The following excerpt illustrates an instance where the mentutor made extensions to the given task. The item required mentutees to find the area of a circle. After each mentutee had explained how they solved the problem, the mentutor asked "any other options you guys could think of to solve that?" He then introduced the idea of radians as another way that angles could be measured. He posed the question, "how will you find the radians answer?" With no one offering an answer, the mentutor explained how to calculate the area in terms of radians saying: "in terms of radians, the circle has a circumference of 2π, and it's still $\frac{1}{12}th$ of that circle so it could be 2π /12 or π /6, leaving the final answer in terms of π. In this case, the mentutor extended the question to other angle measures such as radians although the initial question asked mentutees to calculate the angle measure in terms of degrees.

In summary, the general tutoring obligations enabled mentutees in the Daly group to exercise conceptual agency as authority was more widely distributed in this group than in the Tyson group.

Young Community

General and Specifically Mathematical Obligations

As indicated earlier, the general and specifically mathematical obligations in the community were similar to those of Tyson and Daly communities. Mentutees were expected to individually solve tasks and have a discussion about their reasoning. These obligations came about partly because the mentutor wanted them to share ideas as a way of leveraging relational resources available and also because of her own mathematics competence. Since she was a non-mathematics major (chemistry major), she made it known to her community members that she could not provide help on every mathematics concepts. As a result, mentutees were encouraged to share ideas and support each other especially in moments where she (the mentutor) could not offer the needed support. This situation also meant that the mentutees, when they needed support, had to explain their reasoning to their mentutor in ways that she could understood in order for her to assess the soundness of their mathematical argument.

General Tutoring Obligations

The Graves Community

In this community, the mentutor described her role as being there to “jump in and help them (referring to mentutees) figure out how to do it” when mentutees faced a roadblock. This objective of rescuing mentutees from challenging tasks or discomforting situations ensured that authority was more widely distributed to the mentutor with mentutees exercising disciplinary agency. Although mentutees were expected to solve tasks individually, explanations for their work, the how and why of their approach was most often provided by the mentutor. This led to a situation where the mentutor had to sanction whether an answer is correct and why instead of allowing the mentutees to explain how they solved a task and have a discussion about why they solved it in a particular way as pertained in the other three communities. Mentutees were therefore, exercised disciplinary agency by asking their mentutor and other community members’ specific steps to enable them solve a task.

The following were the general community obligations which served as evidence for the assertion that authority was distributed primarily to the mentutor and that mentutees exercised disciplinary agency:

1) Doing individual work

2) Asking mentutor or other mentutee for help with specific steps in order to solve a given task, and

3) Listening to mentutor explain how and why to perform specific steps and also answering closed ended questions when asked.

The first obligation was evident during the first phase of tutoring. Mentutees were required to obtain a copy of the warm up and solve individually. Mentutors' responsibility was to facilitate the learning of concepts after mentutees' have had time to work on all questions. As such, mentutees were obliged to engage in individual work at this phase.

The second obligation was apparent during the first phase of doing warm ups. In this community, unlike the other communities, the mentutor tended to be involved right from the moment mentutees start working on the problems. As part of monitoring her community members' work, there was a tendency on her part to "jump in" in when mentutees were stuck on a problem. This was different from the other communities where the mentutors tended to have all community members finish solving the tasks individually before engaging in any form of discussion. In instances, where mentutees needed help with a specific task, the process involved an interaction about the mentutee's work and collaboratively finding a solution to the task. Due to the tendency of the mentutor to “jump in” and ask guiding or leading questions to help mentutees when stuck at a particular stage, this normative practice of asking for help with a specific step in order to solve a given task became constituted. The second obligation therefore led to the third obligation, mentutees listening to the mentutor explain how to solve a problem.

As noted earlier, it is not just enough to ask mentutees to talk about how a problem was solved since this can lead to the stating of steps for solving a given task. Rather, mentutees should be provided opportunities to communicate their mathematical understanding which will reveal their level of understanding. The practice of allowing mentutees to articulate their mathematical understanding was rarely the case in the Graves community. When mentutees asked questions related to what they should do at a particular step, in most cases, the mentutor told them what to do or simply took a scratch sheet and demonstrated how to solve the task while the mentutee looked on. Questions asked by mentutees were to ask for help at a particular step or to receive affirmation that they were on the right track.

Another indication that authority was distributed mostly to the mentutor was evident in mentutees always asking her for confirmation as to whether they were on the right track or what the next step should be. Mentutees requested specific help to enable them to complete tasks while the mentutor provides such ‘guidance’ by telling them what to do. Mentutees then watched the mentutor perform the specific task or write it down.

In the few cases where Mary (mentutor) was observed asking open-ended questions involving ‘why’ she ended up answering the question without allowing mentutees time to think and formulate an answer. Through this process, the third obligation of listening to mentutor explain how and why to perform specific steps became evident. It was when the mentutor had given such approval did mentutees feel confident enough to solve tasks on their own. In one such instance, Albert asks Mary what he was supposed to do and then proceeded to explain his reasoning. After doing so, Mary commented: “Okay, good, let's think about this. What are we supposed to do?” She began explaining how to solve the problem but stopped midstream and suggested that both, that is, Mary and Albert, solve the task individually because it appeared that Albert was on the right track. Even in this instance that Albert was asked to work on the task alone, he continued to fulfill the general obligation of asking men tutor for help with specific steps. After commenting that “I don't like these kinds of problems” he was told by Mary to slow down and take time to understand the question since "his ideas have been great so far."

In summary, the nature of interaction in the Graves community ensured that authority was mostly distributed to the mentutor. Questions posed by the mentutor, most often, required one word answers or served as offering mentutees opportunities to affirm their agreement with whatever strategy the mentutor employed. Open-ended questions and extensions to tasks which were occasionally done were performed by the mentee rather than eliciting mentutees’ thinking and challenging any possible misunderstandings. In some cases where mentutees were asked to explain their reasoning, the mentutor ended up providing the justification for them thereby reasoning for them instead them articulating their understanding. The mentutees, in line with their general community obligations, exercised disciplinary agency by performing calculational steps (Cobb et al.,

2009) in the sense that they asked for what to do at specific steps and were told what to do or watched the mentutor doing so.

Specifically Mathematically Obligations

Consistent with their general community obligations, in the Graves community, norms for mathematical argument involved specifying specific steps taken to produce particular answers. This was consistent with the mentutor's response to a question about how she expects her mentutees to do mathematics. Her response was that:

> I ask questions by steps like what's your first step? I think that gets them thinking. When they are by themselves…okay I need to look at what I am given and I need to figure out what I am being asked and I need to just do my first step and then just ask yourself what's next. Yeah, I think that models how you should do math.

The following excerpt is illustrative of the general tutoring norms prevalent in the Graves community. Mentutees were to calculate the third angle of a right triangle with two of its lengths given involving the use of the Pythagoras Theorem and trigonometric ratios to solve the task. Albert was stuck and had asked for help:

Mary: So what is the question asking you to find?

Albert: Find sin θ.

Mary: So is it going to be the same theta? Yes, it will be (she informs Albert that the unknown angle can be named 'x' instead of theta on an examination).

Albert: So is this going to be x?

Mary: Yes. You don't have to find that because actually they want you to find theta.

Albert: So I find sine of this (referring to sin θ)?

Mary: Yes.

Albert: So is it going to be sin θ =3/x

Mary: Good. Then you find what θ actually is.

In this excerpt, Albert (mentutee) fulfills the normative ways of engaging in mathematical argument by asking for help with specific steps with the mentutor 'supplying' the necessary steps to be followed. Albert, therefore contributed to the constitution of the norm of asking for specific steps in order to obtain an answer thereby exercising disciplinary agency. He could not write anything without receiving some form of affirmation from his mentutor. Also, what counted as a mathematically correct approach depended upon whether the mentutor agreed with a particular step with mentutees never too sure of what to do. Another indication of mentutees in the Graves community exercising disciplinary agency was apparent in group discussions.

Discussions about what it takes to be mathematically competent involved asking mentutees to "memorize" theorems, rules of operations, or identities deemed necessary in solving a particular task. Mentutees were also expected to take note of particular problem types and make use of cues to help them identify procedures for solving particular problem types. This assertion is evident from the following excerpt which involves an interaction between Kylie and Mary. Kylie had asked for help from her mentutor and was asked to "write SOHCAHTOA on top" of her paper which she complied.

Mary: So I don't think these numbers (points at some numbers) are at the correct place. So according to SOHCAHTOA, what will tangent be? (No response from Kylie so she pulls a sheet, draws a right triangle and labels the sides 'a', b', and 'c').

Mary: So SOHCAHTOA (writes out what it means), sin $\theta = opposite/hypotenuse$,

$\cos\theta = adjacent/hypotenuse$, and $\tan\theta = opposite/adjacent$. After Mary had finished writing down the various basic trigonometry ratios she asked Kylie to identify the opposite, adjacent, and hypotenuse sides to a referenced angle. The discussion ended with Mary commenting: "so for these kinds of problems the easiest way to remember these relationships is SOHCAHTOA. Drill that into your brain, SOHCAHTOA, SOHCAHTOA."

In this excerpt, despite the mentutor making connections to other functional notations and graphical representations to explain the relationship between a reference angle and length of a side opposite to it, she ended by cautioning her mentutees to memorize these trigonometric identities so that they could solve them in future. As a result, doing well in mathematics depended on mentutees ability to memorize. Also, in this excerpt and similarly related instances, theorems or conventions for performing certain operations were invoked without any explanation why they work.

Reasoning with mathematical symbols in the Graves community amounted to learning how to operate on these symbols with little or no explanation as to why. These symbols were treated as meaningless marks to be operated so that the right answer is obtained. By asking mentutees to drill certain theorems and conventions "into their brain" the mentutees exercised disciplinary agency by relying on what their mentutor said or what was written in the ACT study guide without making meaning on their own as to why these things work which they complied with. The following excerpt illustrates how mentutees became complicit in the enactment of these ways of reasoning with mathematical symbols by focusing on what the final answer is rather than why the answer makes mathematical sense.

Albert: So I don't know how to do this (points at a problem)?

Mary: So for this one you have to remember a formula. (She pulled out a sheet and wrote $\sin^2 \alpha + \cos^2 \alpha = 1$).

Albert: So all these will be up to 1?

Mary: Yup, yup.

In this excerpt, there was no attempt by Albert to understand why the stated trigonometric identity equals one. All that he was interested in was that it amount to one and proceeded to use it to solve the given task.

In summary, there was an alignment between mentutees general community obligations and their specifically mathematical obligations. By having mentutor having most authority to determine particular ways of solving tasks, mentutees relied upon her to demonstrate how a task should be solved while they asked questions related to particular steps. The end result was that mentutees could not initiate solutions on their own when confronted with tasks they did not have a ‘ready-made’ approach to use in solving. They therefore exercised their general and specifically mathematical obligation of relying on their mentutor to determine the legitimacy of their solution or to tell them what to do thereby exercising disciplinary agency.

Cross-case Analysis of Normative Tutoring Obligations

At the heart of the reform efforts, standards-based instruction practices, are the opportunities provided for students to initiate their own solutions and communicate their ideas with each other (NCTM). For instance, Rittle-Johnson and Star (2007) conducted a study where they compared two groups of students, an experimental and control group, on the effects of comparing solution methods on their conceptual and procedural knowledge. Not only did the experimental group make significant gains in procedural knowledge and flexibility and conceptual knowledge, the authors also identified three benefits of allowing students to compare solutions. These gains are: 1) offers students with the possibility to differentiate important problem features (what Dorothy was stressing to mentutees); 2) enables students to consider multiple methods in general (which occurred through community members sharing their ideas, e.g. Daly community), and 3) it may better prepare students to learn from a summary lesson presented to all students (whole community discussions that reinforce what individual mentutees shared).

From the analysis of normative tutoring obligations, three of the communities namely, Tyson, Daly, and Young had very similar general and specifically mathematical obligations. Mentutors in these communities had a more participatory tutoring practice. Not only did mentutors in these communities expect their mentutees to initiate their own approaches to solve given tasks mentutees were also expected to justify their approaches to either the mentutor or other mentutees. As a result of their general tutoring obligations of: 1) doing individual work; 2) understanding the demands of task before formulating a task; and 3) explaining and justifying approach mentutees in these three communities exercised conceptual agency, developing conceptual understanding necessary for belief in their own efficacy. When mentutees needed assistance from their mentutor they were expected to have tried solving it on their own and explaining what they did to him or her.

As such, mentutees were more involved in constructing their own knowledge and articulating their reasoning.

For these three communities, their specifically mathematical obligations - norms for engaging in mathematical argument and reasoning with mathematical symbols- involved not only knowing how a task was solved but also why. In the Daly community especially, mentutees shared the various strategies, if applicable, used in solving the same task. This enabled community members to learn multiple ways by which the same task could be solved instead of the general perception that there is only one way to solve a task.

In the Tyson and Daly communities in particular, the symbols community members reasoned with had meanings which they had to understand. What counted as a correct answer, in most cases, was not sanctioned by mentutors in these three communities. Over the cause of the observing these communities, community members could be seen sharing approaches and engaging in self-corrections during the whole group discussion without being told by their mentutor where they went wrong.

The Graves community, on the other hand, had a less participatory tutoring practice with more authority distributed to the mentutor. Although they were expected to do individual work, their other general obligations of asking mentutor for help with specific steps and listening to mentutor explain how and why a particular step works meant that mentutees in the Graves community exercised disciplinary agency. This was because unlike the other communities where mentutees discussed their approaches with each other, those in the Graves community rarely shared their mathematical reasoning.

Most of the interactions occurred between mentutor and a mentutee who needed help. During such interactions the questions posed by the mentutor, in most cases, were answered by her with mentutees answering closed-ended questions. Justification for why a particular answer or approach worked were provided by the mentutor with the mentutees fulfilling their general obligation of listening to her and in some cases writing down what was being communicated or watching the mentutor demonstrate what to do.

Merely allowing mentutees to initiate their own approaches to solving tasks is not enough for them to be adequately involved in the learning process, they must explain how and why their procedures work (Cobb et al., 2009; Hammerness et al., 2005; NCTM, 2014; NRC, 2001). Tutoring becomes more participatory when community members are able to articulate their own mathematical reasoning and providing justification for what they did as happened in the other communities. It is through this process of engaging in public mathematical discourse that faulty reasoning can be challenged and replaced with more robust explanations and understandings. Due to mentutees in the Graves group fulfilling their general obligation of exercising disciplinary agency, they mostly relied on their mentutor to tell them what to do when stuck at a particular step or asked for confirmation as to the correctness of a particular step before proceeding with their work.

In summary, three communities, Tyson, Daly, and Young had authority more widely distributed to community members which was not the case in the Graves group. In the more participatory communities, mentutees exercised conceptual agency by taking control over their learning through solving tasks on their own and providing an explanation and justification for how and why they solved a tasked in a particular way in line with reform efforts as espoused by the NCTM and the NRC. In order for community members to share their ideas it was important that each mentutee had an individual responsibility to solve given mathematical tasks and not be dependent on the mentutor, for instance. By eliciting students' thinking (Lesh & Doerr, 2003), opportunities were created to deepen mentutees' conceptual understanding through the process of explain their answers. In the Daly group for instance, there were instances where a mentutee disagreed with the mentutor which led to other community members explaining their work with the expectation that it would be "a tie breaker."

Also, mentutees in the communities that promoted more participatory tutoring practices talked about a need to understand the task before formulating a solution strategy and also being prepared to share one's work. In the Graves community, on the contrary, tutoring practice was less participatory. Mentutees came to expect their mentutor to sanction an approach as being correct before they could proceed with an approach. In instances where mentutees were stuck on a task, they asked for what they should do at a specific step which led to the mentutor invariably telling them a formula to use or what the specific step should be, a more calculational approach. Although the mentutor asked good probing questions, she mostly ended up answering these questions herself. Mentutees therefore, exercised disciplinary agency by relying on their mentutor to determine the correctness of their answers. Also, the mathematical symbols they operated on, in most instances, had no meanings attached to them except that by manipulating them in a particular way, the 'correct' answer was produced. For instance, theorems and certain mathematical identities were invoked without any explanation as to why they work except that they were needed to solve a given task. Mentutees were, in such instances told to “memorize” such theorems or identities so that they are handy when they encounter similar problem types.

Research Question 3: How does a mentutor’s use of identity resources influence the formation of specific mathematical learning and identity trajectories of mentutees?

In order to answer research question three, both mentutees and mentutors responded to interview prompts related to the messages shared about how mathematics should be learned and what it might take to be successful in mathematics. They also responded to prompts regarding the usefulness of various material resources such as ACT study guide and TI Nspire graphing calculator that were made to each participant, and the importance of having learning communities (relational resources afforded in such communities). Findings for each of the practice-linked identity resources namely: material, ideational, and relational resources are presented and discussed.

Access or lack of access to particular identity resources can lead to different notions of belonging in a mathematics community. For example, in a mathematics class students who have access to academic network, requisite learning materials, and constantly receive affirmations for their effort are more likely to succeed compared to those who have none of these resources. Therefore, highlighting connections within the context of learning in terms of community members’ exposure to certain mathematical artifacts (material resources) and the ideas community members take away with them makes it possible for a connections to be made between learning and identity (Nasir & Cooks, 2009). Furthermore, such an analysis makes it possible to examine how various practice-linked identity resources were made available to mentutees and how they appropriated such resources in the learning and identity formation process.

Material Resources

In a review by Palardy (2015), the author noted that the scarcity of classroom resources such as books and equipment in minority schools have effect on students' learning. The importance of curricular resources such as textbooks and instructional technology are highlighted by the NCTM (2014) under what it termed as "essential elements of excellent mathematics program (p.59)." In the learning of mathematics, access to the requisite teaching and learning materials is vital in supporting students learning in terms of increased opportunities for learners to engage in research, review of content taught, and clarification of unclear concepts.

As noted earlier in Chapter 3, each 11th grader received a free TI Nspire calculator which has graphing capabilities. This graphing calculator was also allowed on the ACT test that all students are required to take in the state of Minnesota thereby making it a valuable tool since use of calculator has been found to lead to differentials in students' achievement on tests. In a meta-analysis of effects of calculators on students' achievement and attitudes levels in precollege mathematics, Ellington (2003) reported that when calculators were included in testing and instruction, students experienced improvement in operational skills and also had a better attitude towards mathematics compared to their non-calculator counterparts. In another study, McCulloch (2011) reported that when students enrolled in a high school calculus class were allowed to use graphing calculators it helped them gain productive affective pathways for engaging in problem solving activities as long as they had developed the necessary capabilities relative to the mathematical task at hand.

Furthermore, each mentutee had a copy of an ACT study book with the intention that when students access to a study guide that learners use during P2N meetings and hopefully outside of P2N would lead to regular interaction with mathematics. Especially for students who have no interest in learning mathematics a lack access to learning materials, such as a study guide, can prove detrimental to their success in mathematics since it reduces their opportunities to learn. However, a student who has access to a textbook or a mathematics learning resource can engage in further studies outside of school thereby increasing their level of understanding.

Irrespective of reservations about standardized testing, high school students see it as a rite of passage. Doing well on standardized tests such as the ACT confers certain privileges such as scholarships and caliber of college a student is admitted into. Doing well on such tests, therefore requires access to study guides and learning support thereby leveling the playing ground with high SES students who tend to have lots of these resources. When mentutees were asked how beneficial they found the ACT study book, all of them reported that they found it to be particularly useful to them. Some reasons cited by mentutees were that these material resources enabled them to study more mathematics at their own time, served as a reference material when they had forgotten a concept, and also offered them opportunities to prepare for the ACT test.' Amina comments about the importance of the ACT study guide: "all the things they gave us I think that helped me because as a junior I will be taking the ACT." Not only does access to the ACT study guide help in mentutees mathematics learning and preparation towards writing the state mandated ACT, for some it meant saving money.

The importance of having the ACT study book is stressed by Guang who noted that: “I am not in any ACT preparatory program so that really helped. We were able to get the whole book not just math sections so I am able to work in all the other sections.” In this excerpt, Guang highlights the importance of attending ACT preparatory programs in order to do well on the test, an issue that Li took up in the following:

> A lot of juniors like me don’t get the opportunity to get a free ACT book and the help I get from P2N some people have to pay for those kinds of things. I feel it’s really helpful to know that I got these things for free.

His comments and that of Guang highlight the importance of supplemental programs such as P2N in bridging the resource gap in urban schools. Such comments also highlight how access to certain material resources can affect students’ self-efficacy and sense of achievement.

Mentutees’ comments portrayed the stark reality that doing well in mathematics sometimes boils down to access to learning opportunities and support systems. The denial or a lack of access to learning resources can lead to differentials in achievement scores. The following comment by Amira sums up how students valued this resource as helping them be better prepared in their mathematics and develop confidence in themselves in contrast with colleagues in their schools: “it’s really, really important. When I’m home sometimes I go over concepts. At school, they don’t have those ACT books.” As a result, while some mentutees like Albert and Mei saw this resource as enabling them to hone their skills on how to write the ACT examination, others saw it as a textbook that offered them opportunities to engage in more mathematics learning while at home. They saw this material resource as invaluable in their mathematics learning and success in mathematics. By having access to this material resource, mentutees saw themselves as better positioned to succeed (confidence) while expressing concern for their school mates who did not have the “privilege” of being in a program such as P2N that could help them bridge the resource gap. In effect, access to a material resource such as an ACT study guide increased mentutees confidence because they saw that they had the kind of access to learning opportunities that students from high SES background have.

Another material resource that mentutees found helpful was the TI Nspire graphing calculator. Mentutees noted that this resource helped them in their mathematics and science classes and also at home when doing homework. Not only did the graphing calculator enable mentutees to engage in routine computations, its various functions enabled them to move across various representational modes such as tabular, graphical (pictorial), and symbolic (equations of functions). While mentutees commented that they had access to calculators at school, these calculators were school property and therefore not accessible to them all the time. In P2N, the graphing calculators were theirs to keep and use at any time.

Li comments about how access to his own calculator facilitates his mathematics learning: “In school we use the school’s calculator. Having this graphing calculator I can take home makes it easier for me to do math problems.” Daniel supports Li’s comment about access to calculators in learning mathematics commenting: “the calculator has really helped me a lot because I don't have one at home and it's better than the one at my school. There's a lot of things you can do with it." Indeed, the TI Nspire calculator can help students do many mathematical computations and support students' mathematical learning. However, the potential benefits of possessing a graphing calculator such as improved achievement scores (Aimee, 2003) and improvement in productive affective pathways such as feelings of frustration (McCulloch, 2011) only arise when the owner uses it in performing mathematical tasks.

The specific role the graphing calculator played in supporting mentutees' mathematics learning and identity formation is taken up by Mei. On how useful the calculator has been to her, she commented: "if you plug in an equation into the graphing calculator, you can actually analyze it for intersections. You can analyze it for maximum, minimum, and you can see the actual table." Her comment, which was shared by some of mentutees, indicate that these students did not consider the tool as important for performing only procedural computation but also having the capability to help them engage in conceptual understanding through moving across multiple representations. As such, the calculator enabled them to reason about mathematical symbols by analyzing certain features of a given function.

The importance of students moving across multiple representations has been stressed in the mathematics education literature. It is argued that when students are allowed to learn the same concept in various modes such as pictorial, verbal, tabular, concrete, and symbolic representations, they are more likely to make the necessary abstractions than learning the same concept in a single representation (e.g. Cramer &

Wyberg, 2009; Lesh & Doerr, 2003). However, while all mentutees found the calculator to be useful in learning mathematics, one mentutee feared a dependence on graphing calculators could deprive students the ability to perform mathematical tasks independent of such devices. Richard offered the following critique:

> You don't really need the material to help you because people have been doing math without calculators for years. It helps you but at the same time it also sets you back because if you rely on the calculator all the time, you are not going to know how to do it by hand. If you don't have a calculator, you are going to sit there and be like how do I do this?

Richard's comment brings to the fore some of the tensions associated with technology usage in learning mathematics such as whether it impedes learning or facilitates it. While Richard offers a more cautionary view about the place of calculators in students' mathematical learning, his view does not capture how technology plays a crucial role in the work of mathematicians such as running simulations and analyzing trends in data. Graphing calculators are not only for performing computations: they can be used to analyze functions, move through multiple representations which all can enhance the mathematics learning experience. In order to dispel any negative attitudes towards mathematics, it may be important for graphing calculator usage to be tied to the learning of mathematical tasks so that their applications are obvious to all students. This will require that mentutors use the graphing calculator as a pedagogical tool. From observations made and mentutors comments, this was not often the case.

Mentutors were observed, in most cases, using the graphing calculator as a calculational tool to perform routine operations or crosscheck their answers. This was the case even when the specific content provided opportunities for mentors and mentutees to move across various representations since most of the content covered at P2N during the time of data collection involved trigonometry and geometry. Despite all P2N participants having received extensive training (six hours) on how to the use the graphing calculator, the calculator was not used as intended, a device that can enable high school students to move across various representations and not merely a calculational devise. Mentutors were observed to rarely use the calculator to illustrate concepts or reinforce symbolic representations which could have offered mentutees with extended opportunities to think differently about mathematical symbols.

In summary, eight of the mentutees found these material resources to be important in their mathematics learning. The following comments by Mei sums up mentutees' valuation of the importance of having curricular resources such as an ACT study guide and a graphing calculator in relation to their mathematical identities. They were responding to how important it was to have access to these two specific material resources:

Mei: I have some friends they don't have any ACT practice books and the ACT is coming up pretty soon. So I feel kind of nervous for them because they have never been exposed to the actual learning of what's in the ACT test and also like the calculator stuff we are using right now. I think it's really a privilege.

Khadija: Right now I'm discovering that you don't always have to depend on the teacher. Even if you have the worst teacher in the world, students can always find a way to learn by utilizing other sources, using their text books, finding tutors, and using a lot of online sources. Who knows maybe few centuries from now we won't even need teachers.

While the belief by Khadija that teachers may be replaceable in the foreseeable future may be farfetched, it highlights the importance of material resources in shaping students' mathematical identities.

Relational Resources

Relational resources have to do with a feeling of belonging in a community. It deals with networks community members form and how such networks can facilitate individuals' socialization process. Such networks, specifically, academic networks can help students overcome challenges they might be facing in a particular classroom or outside of school leading to academic success or the assumption of various identities and knowledge production. For instance, Varelas, Martin, and Kane (2013) argue that as individuals become more (or less) core members of an academic community, for example, a mathematics classroom and their engagement in cultural activities experience changes, there is a resultant change in their identity and knowledge due to the new position and status. A feeling of being connected to other students, therefore, has the potential to increase a student's sense of belonging in their assigned P2N community and the larger mathematics community (Nasir & Cooks, 2009). This is because a network of academic resources, specifically relational resources, allow for exchange of ideas and confidence as one begins to see himself or herself as a legitimate member of the learning community through the provision of both academic and emotional support.

The P2N structure supports the development of relations in a number of ways. First of all, each participant is assigned to a community comprising 10 members; a mentutor (undergraduate), three 11th graders, and six 8th graders. Unlike schools were desks are mostly arranged individually to emphasis individualism, in P2N chairs are arranged around a common table (s) to promote collaboration. Additionally, all the 15 communities meet in the same room thereby increasing the likelihood of participants bonding with each other and developing further academic networks. Furthermore, in assigning participants to communities, attempts were made at ensuring that students from the same school were not in the same community. This was to ensure that mentutees had opportunities to increase their learning through their interaction over mathematical tasks as individuals share potentially different strategies learned from their respective schools. This was expected to lead to rich mathematical discourse as students learn various ways of reasoning about the same mathematical task from various perspectives present in a community. Last but not least, mentutors and mentutees attended regular trainings to facilitate community bonding. A lack of relation with other community members, it was believed could affect learning opportunities a mentutee had.

All the 12 mentutees commented about the importance of cordially relating with their mentutors. Developing and maintaining cordial relations was not only a must, it also held the key to fruitful learning opportunities. For instance, Daniel commented on the importance of relating well with mentutors: “I don’t think you should be here if you have problems with your undergraduate because they have authority over you. Also, you will think they're wrong when explaining something to you." Daniel's comment might be related to the negative effect a breakdown in relation can have on mentutees' learning opportunities and not necessarily punitive measures.

In furtherance to Daniel's comment, Amina offered an example of how a breakdown in relation between her and previous mathematics teachers provided detrimental to her mathematics learning. She had earlier commented that due to a lack of connection with the pedagogy adopted by her teachers she had lost interest in classroom activities and was falling behind academically. However, a show of concern, what she termed as "these little things" by her teachers could have reverted the downward slide but that was not the case which fueled an 'I don't care attitude' towards mathematical tasks and her sense of achievement. This assertion is apparent from the following comment by Amina: "I would be like whatever, I could fail this test I don't really care and that's what I usually did." Support for the importance of relational resource is provided by Richard who had also developed an oppositional identity to a procedural instruction in grade 8.

Students are aware that it is important to seek help from others when needed. However, doing so requires an existing relationship. In the case of students who develop an opposition to procedural instruction, it tends to affect their relation with their mathematics teachers. Not only do they dislike mathematics, they also struggle to relate with their teachers especially if the teacher concerned does not reach out to them. The following comment by Richard illustrates the assertion that a lack of relational resource can negatively affect students learning. He acknowledged that “it was the duty of students to ask for help” but he never did that because he felt the teacher was “stuck up.” In effect, whether in school or out-of-school, mentutees highlighted the importance of connecting with teachers or mentutors.

While some mentutees, like Amina and Richard, played a key role in being isolated from their mathematics classroom community, others also commented about institutional factors such as large class sizes in their schools which made it difficult for teachers to make the necessary one-to-one connection. For these mentutees, they argued that due to the teacher-student ratio, it was the obligation of students to make those vital connections. However, in P2N, although the small community size, one undergraduate to three 11^{th} graders was a factor in developing positive academic networks, both mentutees and mentutors’ comments to interview questions regarding their sense of belonging in their various communities suggest a more conscious effort on the part of the undergraduates to building strong communities. Mentutors encouraged mentutees to bond with each other in addition to the general P2N community building training programs.

Regarding her sense of belonging in her community, Young, Anise made the following observation: “you are never going to feel like an outcast. Even if you are shy or can’t handle being around people, they [mentutors] are going to push you to your breaking point. You are here because of math.” In her comment, she highlights the fact that it was not necessarily her obligation to develop connections with her mentutor, the mentutors made it a reality by pushing people to their “breaking point” so that no one felt “like an outcast.” This, she noted, was not the case in her current mathematics class where she is sidelined because her teacher focused on students perceived to need more attention. In her P2N community, it is no longer her obligation to connect with her mentutor. The mentutor makes sure community members feel at ease around with each other.

The importance of relational resources goes beyond connecting with teachers or undergraduates. It also has to do with forming connections with other mentutees with the aim of supporting each other's mathematical learning. For some of the mentutees who did not have relatives to support their studies at home, connections formed with other mentutors and other P2N participants were crucial to their sense of belonging. Amira, in the Tyson community, argued for the importance of having this resource: "this is a good opportunity for *people like me* [emphasis added]. If you don't understand math it will help you; anything that you really, really don't get from school you can ask here and they will like answer you."

While relational resources at P2N offered help to mentutees like Amira who did have academic networks at home to support their mathematics learning, for Guang, such a resource went beyond offering support in the learning of mathematics concepts or receiving homework support. As noted earlier about concerns regarding low numbers of minorities in STEM fields (e.g. NCTM, 2014; PCAST, 2010), the presence of undergraduate and graduate students pursuing various STEM programs in a large urban university could serve as a source of encouragement for some high school students. In the case of Guang, this was precisely the case as she noted that:

> The undergrads, the Project Director, and the grad students are really inspiring in math. I feel like kids don't really do well in math because they think it's hard. I know a lot of people hate math, and this just inspires me to do a lot more math and to love math more.

Guang's comment also highlights how mentoring can help break down some of the stereotypes and myths about who can do mathematics since majority of the mentutors were females with three out of four of the project staff being females too.

The following comment by Amina sums up how important relational resource was to mentutees in terms of their sense of belonging and their attitude towards the study of mathematics. It involved an incident that occurred during one of the tutoring sessions where she was having a "bad day" and did not feel motivated enough to learn. She narrates the incident as follows:

> I was having a really bad day. My mentutor noticed right then that I wasn't like my usual self so she said 'hey what's wrong?' When I started working on my math there was a question I didn't get at all and I didn't want to ask anybody and so I was sitting there. She looked at me again and she said 'do you need help?' and I just ignored her question.

While in her school she had adopted a dismissive attitude towards mathematical tasks and distances herself from happenings in her class that was not the case with her mentutor. She continues the narrative by recounting her mentutor's persistence in connecting with her to find out what was happening:

> She came over and sat next to me and said ‘hey are you okay?’ and then I was like yeah I am just having a rough day. She then told me ‘is there anything you need help with?’ That’s when I said ‘oh you know this question’ and when she started to help me everything that was on my mind was forgotten. When she was done helping me she was like ‘it’s going to be okay. Whatever it is just forget about it and you will get through it.’

Her surprise at the amount of effort her mentutor put in to reach out to her despite her initial rude behavior led her to comment: “that was such an incredible thing, you know, my mentor noticing that I wasn’t acting the way I usually do. I think I will never forget something like that.” Amina’s comment also indicate that building relational resources in mathematics is an ongoing process. Students may enter a classroom or learning group with some issues weighing on their mind. Dealing with such emotional challenges or any other issue burdening students that threaten to disrupt their learning requires that teachers are sensitive to learners’ moods and behavior changes so that the right intervention can be provided.

The need to keep working on making connections with mentutees is stressed by Fred, a mentutor who noted that a mentutor should not give up on mentutees on when they have an off day. Rather, such periods called for building on relationships formed commenting that off days: “doesn’t mean you ignore them even if they are not doing math. You still engage them, if you can’t work on their math skills, work on the relationship you have with that student.” All the mentutors noted that making connections with their mentutees was not all smooth sailing, it required continuously working on it until everyone was comfortable around each other.

In summary, both mentutors stressed the importance of having relational resources in the learning of mathematics. For some of the mentutees, relational resources such as those provided at P2N helped offset some of the institutional challenges they face in their schools such as large teacher-student ratio, unavailability of relatives at home to support their learning, among others. In the case of the undergraduates, access to relational resources can help in playing an advocacy role and offering emotional support. For instance, Mary, a mentutor, noted that it was the relational resources she had at home that enabled her to enroll in advanced mathematics classes although she did not think she had the ability to pursue those classes. As such, relational resources can help individuals gain access to certain resources or serve as a source of encouragement through challenging tasks. Moreover, there was no discernible difference in how the mentutors related to each mentutee in their community. Rather, some of the mentutees tended to have more questions about college life and admission requirements leading to more conversation time with their mentutors compared to others who rarely asked such questions. However, an indication that lack of relational resource can have a negative effect on students' sense of belonging, irrespective of the learning space is evident from Kylie's lack of connection with any particular community. While 11 of the mentutees noted that they received a lot of help from their mentutors and other community members due to the connections formed, Kylie did not receive extensive support. This is because she did not form strong relations with her assigned community members because she kept changing her community, a statement which was confirmed by her mentutor, Mary. As a result of a lack of strong connections formed, she only showed up for homework support and missed out on the ideas that community members shared which are vital in developing a sense of belonging.

Ideational Resource

We teach who we are and the things we value. In this regard, those who teach bring in their own personal and professional lived experiences to bear in the decisions they make and the ideas they communicate in their learning environments. (Akyeampong & Stephens, 2002; Hammerness et al., 2005; Henriksen & Mishra, 2011; Nieto, 2003). This also means that the decisions those who teach or tutor make such as who to provide more individualized support are all influenced by their moral judgments. For instance, a mentutor's learning preference can influence tutoring practices enacted in his community. As such, irrespective of mentutors receiving a common training prior to and during their involvement in P2N, their values, preferences, and experiences are likely to influence the normative identities constituted in a community. This was the case with all the mentutors.

Mentutors drew on their own mathematics learning experiences and learning style preferences in enacting particular tutoring styles. Irrespective of ethnicity, all mentutors had high expectations for their mentutees and encouraged them to persist when dealing with challenging mathematical tasks. Three ideational resources that mentutors used often were: 'importance of persistence in learning mathematics', 'belief in own mathematics competence,' and 'asking questions is not a bad thing.'

Students' images about who a mathematics person is a person who learns mathematics effortlessly and do not break any sweat performing mathematical tasks. Struggling in learning mathematics, therefore is taken as evidence that an individual lacks the necessary competence to do mathematics. For those from stereotyped minority groups such as African Americans, struggling in mathematics can only affirm the notion that they do not belong in the mathematics community. For this reason, a deficit-oriented perspective to analyzing mathematics achievement scores sends negative signals about who can belong in a mathematics community and their sense of identity (Martin, 2012). It is for this reason that documenting the ideas mentutors shared with their community members was vital since ideas have the potential to shape students' mathematical identities.

Mentutors drew on their own challenges learning mathematics and successes in encouraging mentutees to be resilient and not to give up easily when confronted with a mathematical task they could not readily solve. This meant that instead of mentutees thinking that mathematical tasks should be solved within a few seconds otherwise it was beyond their capability, they were encouraged to persist by keeping on trying and to view any mistakes made as opportunities for learning. Failure to solve a task, therefore, was not an indication of a lack of mathematical competence, rather, it could serve as a springboard to engage in conversations as to why an approach did not work and help mentutees to develop a new approach that hopefully works.

The need for mentutees to accept this ideational resource was apparent in the following excerpt from Dorothy, mentutor in the Tyson community. She was talking about a mentutee in her community who gave up easily on tasks she could not solve readily and the idea she communicated to her: ‘try your best, you can do this. I know you can do it, you just have to try’. Not only does Dorothy encourage the mentutee to persist, she more importantly affirms her belief in the mentutee’s mathematics capability and adds that “there is no harm in making mistakes.” Dorothy’s comments highlight various ideational resources she made available to her mentutee which were: ‘the need for self-belief’; ‘there is no harm in trying and making mistakes,’ and also having ‘belief in mentutee’s mathematics competence.’ Not only did mentutors communicate the need for persistence in order for mentutees to succeed in mathematics but they also demonstrated it during tutoring sessions through their efforts to solve mathematical tasks they could not immediately solve.

When those who teach, whether in-school or out-of-school, make their own struggles public it can go a long way in boosting students’ confidence. Such public display of thinking process and challenges when dealing with a ‘novel’ problem has the potential of helping students do away with identities of marginalization (Solomon, 2007) occasioned by seeing teachers or other students walk to the board to solve tasks effortlessly. In various communities, both mentutors and mentutees, were observed regularly grappling with mathematical tasks together as they discussed particular problem types during whole group discussions or one-to-one tutoring help.

This observation occurred when mentutees asked their mentutors for assistance. In instances where a mentutor could not do perform the task because it had been a long while since they learned a particular mathematical concept, they would comment that they should all think through the given task thereby offering insight into their thinking processes and their challenges. The importance for mentutees to observe others persist on mathematical tasks through a public display of thought processes is evident from the following remarks by Anise who had a “theory where someone is born smart and were always going to excel at every single subject without struggle.” However, this perception was shattered after observing events unfold in her community: “I saw 8th, 11th, and 12th graders struggle and I assumed they were math persons. I was like wow I can be a math person and struggle at the same time, it’s alright.” Anise’s discovery that everyone struggles enabled her to “feel comfortable” leading to a sense of belonging unlike previously when she had described herself as an outcast.

The importance of this ideational resource that mentutors made available to their mentutees is evident from 11th graders’ reaction to challenging tasks. There was a noticeable shift in reliance on mentutors to self-reliance after week four. Most of the mentutees reported being more willing to at least try challenging tasks before seeking help. Li commented about how his attitude towards challenging tasks changed due to conversations he had with his undergraduate, Belinda: “it forced me to go through the problem and not just like skipping it.” In contrast to his pre-P2N reaction to challenging tasks where he did not even try, he noted that while you may “stress over it, it can be something that you learn to love.”

The idea that irrespective of the stress involved through persistence, an individual can find mathematical tasks enjoyable is taken up by Anise. She commented that: “I was like ‘oh my god I have to do this because I am taught here that you have to do the work and not give up." Not only did she accept the challenge she argued that to "solve a problem is the best feeling on earth" which is in sharp contrast to her previous comment that before joining P2N she usually skipped challenging mathematics task so that it did not "weigh her down."

Not only did the mentutees report becoming more reliant on their own mathematics competence, a productive disposition (NRC, 2001), the mentutors noted changes in most 11th graders' attitude towards mathematical tasks. The mentutors noted that unlike at the beginning of the tutoring program where mentutees will not even attempt a challenging task and would wait for them to help them solve it, in the course of the program, such practice became rare.

In effect, the mentutees realized that everyone struggles and the most important thing is to not give up (Yeager & Dweck, 2012). With the acceptance that 'struggling is not a bad thing' which was not only communicated but also demonstrated by various P2N participants, mentutees developed 'belief in their own mathematics competence.' The P2N slogan that *"Math is hard…So is life. We accept the challenge!"* took on a practical meaning in the lives of mentutees. Succeeding in mathematics is all about a willingness to persist and not some innate ability as most of them previously assumed.

For students who are not doing well in mathematics, there is a corresponding decline in confidence in their own mathematical competence leading to dependence on others who they deem to be more capable. On the other hand, doing well engenders self-confidence and a belief in students' own self-efficacy. Unfortunately, instead of underachieving students receiving encouragement and being held to high expectations, the tendency has been to dumb down content and enrolling them in low level mathematics under the guise that they will be misplaced in higher-level mathematics classes (Loveless, 2008). In P2N, another ideational resource that mentutors made use of was having high expectations for mentutees through expression of their belief in their community members' mathematical competence.

This idea was communicated to mentutees when they faced challenging tasks and felt like giving up and sometimes involved mentutors sharing their own struggles with mathematics and how they were in a position to serve as mathematics tutors. When mentutors were asked what they usually did when their mentutees felt like giving up, Belinda commented that she tells them that she: "was just like them, now I'm teaching you.' I would back them up with positive reinforcements and make sure that they believe in themselves." By referencing her own challenges with mathematics at both high school and in college, she does not only express her belief in her mentutees' mathematics competence but reminds them that it is within them to succeed. Li, who was in Belinda's community, reiterates what Belinda said by recounting that his mentutor told him on occasions when he felt like he did not belong in the mathematics community. He commented: "I shouldn't put myself down because nobody is really bad at anything. They just don't try or lose the will to be good and try their hardest." The importance of this ideational resource, believing in mentutees is evident from Khadija's comment about what her mentutor, Dorothy does during times that she felt like giving up. During such moments, she noted that her mentutor was always encouraging and telling her "not to give up really easily." Khadija continued with how important this ideational resource as follows: “I guess that encouragement is sometimes very much needed because sometimes it feels like the problem is in my own mind.”

In this regard, this idea that the mentutees had the capability to succeed in mathematics enabled them to have a self-belief that they can succeed in mathematics irrespective of the challenges. Knowing that they had undergraduates who backed them up and encouraged them to give off their best was helpful for mentutees who did not believe they could do mathematics and succeed. The need for self-belief becomes more apparent when one considers the harmful effects institutional categories can have on students, especially at the high school where such categorizations like AP versus regular math are more pronounced and label students into capable-incapable binary. Such institutional categories in the form of the type of mathematics class a student is enrolled can lead to students forming ideas about their competence in mathematics (Horn, 2008).

Mentutees in P2N had different mathematics backgrounds, those in ‘regular’ and AP mathematics classes. As a result, mentutees were assigned communities with the intention of leveraging these varied backgrounds in mathematics. A third ideational resource, being confident to ask questions, helped mentutors to overcome any feelings of intimidation. In mathematics classrooms, if a student is always the only one asking questions, it can create stereotypes about his or her competence in mathematics. For instance, eight mentutees’ commented that a math person was someone who either: “learned things very quickly,” “knew everything.” and never asked for help.” As such, students who regularly asked questions deemed themselves as lacking the requisite mathematics competences. Such a situation created a situation where one mentutee found her classroom threatening to her since her classmates frowned on her asking questions.

The idea that asking questions is not an indication of a lack of mathematics competence helped mentutees to feel at ease in asking questions and also to seek help when needed. Asking questions can help in gaining better understanding and also help the person to whom the question is posed to provide justification. As such, asking questions can help both the questioner and the individual to whom the question is posed. The need for mentutees to feel comfortable in asking questions and not to feel that asking questions means a person is ‘dumb’ was modeled by Belinda. When asked what does in situations where she was unable to help a mentutee solve a mathematical task, she commented that she asked other people with the reason that she wanted her mentutees “to see that I still need help so they have to be comfortable asking for help.” The idea that asking questions is not an indication that you are not good in mathematics is affirmed by Mary, a mentutor in the Graves community. She noted that she urged her mentutees to ask questions because everyone has a “hard time with whatever math” they are enrolled in. The way out in any challenging moment is for students seek for help and to ask questions.

The idea that asking questions or seeking for help is not a bad thing is taken up by most of the mentutees. Mei, a mentutee in Belinda’s community, commented that what she had learned from her mentutor was that: “you don’t have to know everything in math. If you don’t understand something it’s okay to reach out to other people.” For students who feel intimidated by students they deem to be better than them, the idea that no one knows everything and therefore asking questions is not a bad thing helped them shed away any feelings of inferiority.

The need for mentutees to feel comfortable in seeking for help irrespective of one's mathematics background is taken up by Li, also in Belinda's community. He notes that he felt "intimidated by people taking higher level math classes." However, through the ideas his mentutor shared with him, he no considered persons enrolled in higher-level mathematics courses as valuable learning resources that could help him learn mathematics.

In summary, the following comment from Richard, indicates the pervasiveness of this idea and how mentutees took up this resource. He noted that: "personally I hate asking for help but ever since being part of the program I've been able to get past that and actually ask questions when I don't understand or ask for help. The idea that asking for help is a good thing is not an indication that mentutees became reliant on other mentutees, rather, students attempted such tasks "without help" to see if it could be solved. However, when stuck, they knew that there was no shame in asking for help by drawing on their extensive academic networks formed at P2N.

Reflection on Identity Resources

The material resources at P2N provided some of the mentutees with opportunities to learn more mathematics than when they had no such access. They therefore, felt more confident that they could succeed in mathematics compared to their friends who had no such resources. Also, the graphing calculator enabled them to visualize functions and move across various representations thereby helping them to make better abstractions.

These material resources, therefore, highlight the importance of learning resources in enabling students to feel better prepared and more confident in themselves.

In terms of relational resources, unlike their schools were mentutees noted that they had to rely on only their mathematics teacher for support, in most cases, in P2N the structure enabled them to have more than one person to talk to about mathematics. For those who had no one at home to help them with their mathematics work the relational resources provided was especially useful in leveraging resources to support their learning.

Furthermore, the three ideational resources helped mentutees change their mindset concerning what it takes to do well in mathematics thereby making them have a sense of belonging. Rather than mentutees thinking that to be good in mathematics the individual should be able to do mathematics tasks effortlessly and not ask for help, they learned that everyone experiences some struggles. Instead of seeing struggles in mathematics as sign of inadequacy, mentutees learned that what matters is persistence so that mathematics can be viewed as the “best feelings on earth (Anise).”

Overall, all mentutors provided their mentutees with ideational resources related to resiliency, self-confidence, and an I- can- do- attitude that were helpful in changing mentutees’ images about who a mathematics person is and their sense of belonging.

Research Question 4 What is the nature of mentutees’ personal identities in mathematics prior to and after participating in P2N and how did specific identity resources help mediate these emerging identities?

Since research question one addressed mentutees’ general classroom obligations and their specifically mathematical obligations, students’ understanding and valuation of normative identities as doers of mathematics in their respective P2N communities are now presented. This is then followed by a contrast between 11th graders' pre-and-post-P2N personal mathematical identities to determine any influence P2N normative ways of doing mathematics might have had on the 12 mentutees in the focal communities. The results are presented and discussed under the following headings: mentutees' understanding and valuation of their general and specifically mathematical obligations: mentutees' reaction to challenging mathematical tasks; and assessment of their mathematical competence. The results presented focus on the 12 mentutees in the four sampled communities.

Mentutees' Post-P2N Understanding and Valuation of their General and Specifically Mathematical Obligations

Mentutees' understanding of their general and specifically mathematical obligations in their various P2N communities were consistent with observations made regarding normative ways of doing mathematics in the four communities. Mentutees in the Tyson, Daly, and Young communities understood their general community obligations to include: initiating their own approaches to solving given problems and explaining their reasoning to others either when receiving individual support or during group sharing. Through such interactions, mentutees exercised disciplinary agency with authority for learning being more widely distributed to all community members. This assertion is evident from mentutees' responses to items related to their understanding and valuation of how their mentutors expected them to engage in mathematical tasks in their respective communities.

In the Tyson community, when mentutees were asked what they thought their mentutor, Dorothy, expected them to do when performing mathematical tasks, their responses were pretty consistent: a need for understanding a task demand, identifying what is known and then formulating a task. The following mentutees' responses are evidence of their understanding and valuation of their specifically mathematical obligation which were consistent with their general community obligations.

Amira: First, try it yourself, whatever you know about it. Then if you don't know, undergrad will help or other people.

Khadija: She expects me to take it one step at a time versus combining all the steps at once. To read and think thoroughly before I actually do the problem and try to see if there are any properties that I could use.

In the Daly community, a common theme from their responses was a need to communicate one's understanding clearly to others. This meant that mentutees did not only know how to solve a given task but also why an approach worked which was evident in a comment during a whole community discussion. The mentutor, Fred, insisted on a 'better explanation' after a mentutee had given an explanation to how he solved a particular task. Daniel, for instance notes that his success in mathematics boiled down to "listening to undergrad explain things in many ways" thereby enabling him to "explain things better." He continued about the importance of communication as follows: "If you are able to explain things better then you can interpret. You can learn it differently also." Daniel's comment suggests that different modes of communication can be helpful in highlighting different ways of reasoning about the same problem which can lead.

Through the sharing of ideas about the same task, he was able to acquire multiple ways of performing a task. The importance of communication in mathematical meaning making was also highlighted by Richard. He commented: “the tutoring gives me a deeper understanding because I actually know how to teach it.” The following comment by Mei is typical of how mentutees in the Young community understood their general and specifically mathematical obligations: “she [referring to undergraduate] will be like ‘how did you do that, can you explain it to me’ since we got different answers.” As a result, verbalizing one’s reasoning process enabled them to make meaning of each other’s work and determine what an acceptable answer should be.

Eight out of nine mentutees in these three communities, Tyson, Daly, and Graves indicated that their primary specifically mathematical obligations involved understanding a given mathematical tasks, initiating their own approaches to solving a task, and having discussions about their reasoning. The process of explaining their work sometimes involved not only how but why they performed particular operations or solved tasks in a particular way. The following comment by Amina in the Tyson community sums up how mentutees understood their specifically mathematical obligations: “she wants me to understand what is happening, how I am solving my problems. She doesn’t want me to just put everything in my mind and try to memorize it.” From their understanding of their general community and specifically mathematical obligations, mentutees viewed mathematics as a subject that requires understanding and also articulate one’s thought clearly to others. Solving a task and getting a result was not sufficient.

In contrast, mentutees in the Graves community had authority mostly distributed to their mentutor. As a result, mentutees understood their community obligation to be that they should ask for help when stuck on a mathematical task and to listen and/or watch their mentutor demonstrate how to solve particular tasks. Also, mentutees' specifically mathematical obligation in this community involved learning specific steps to follow in order to obtain a desired answer. As a result of mentutees in the Graves community having more authority distributed to their mentutor which led to their exercising disciplinary agency, none of them reported any major changes in how mathematics should be learned and what it takes to be successful in its study. The following excerpt from Guang attests to this claim when she was asked: "how do you think your mentutor expect you to learn mathematics?" She commented: "I learned that repeatedly doing things actually makes you better at it the concepts. As you keep repeating and repeating you realize what you are doing and how it all comes together." In this regard, Guang joined P2N with the idea that through repeated practice, a student can be successful and had the same understanding of what it meant to do mathematics after P2N. However, repeated practice of a concept is not likely to lead to the development of conceptual understanding (Star, 2005).

The lack of changes in mentutees understanding and valuation of their specifically mathematical obligation was evident from Albert's comment on whether there has been any changes in how he learned mathematics: "well other than learning different steps I would say not really big change." In effect, irrespective of the learning environment that a student finds himself in, if authority is mostly distributed to the instructor or teacher it is likely to lead to learners exercising disciplinary agency. The negative effect of having authority distributed mostly to the mentutor – in the case of the Graves community- is that students do not have a better appreciation of what mathematics is and what it takes to be successful. A good understanding of what counts as mathematical competence comprises students making connections across concepts, looking for patterns, and comprehension and flexible use of concepts (NCTM, 2014; NRC, 2001; Star, 2005).

Reflections on Mentutees' Pre-and-Post- P2N Understanding and Valuation of their General and Specifically Mathematical Obligations

From mentutees responses, their two learning environments, school and P2N communities, offered them different understandings of what it meant to do mathematics. When mentutees were asked on the SRME survey what a new student in their respective mathematics classrooms should expect only one student mentioned that she should expect to see his teacher and students interacting. The remaining 11 were pretty consistent in their responses across the seven different schools participants attended and indicated that students' involvement during classroom discussions was restrictive in nature with distribution of authority from their point of view and mostly distributed to their teachers.

Eight of the mentutees' written responses indicated that they understood their general and specifically mathematical obligations to be: paying attention during phases of instruction were teachers lectured and demonstrated procedures for solving particular problems and behaving like model students – attentive, note book ready to take notes, and doing all assigned practice problems and homework since the items on these practice worksheets were similar to those on tests.

Additionally, what counted as mathematically correct response depended on whether a teacher said so. Mentutees' understood their obligation when reasoning with mathematical symbols to be that of following teacher prescribed steps. Mentutees indicated how they understood their obligations using phrases such as: "my teacher is making us," "I do it her way" or "I have to see her do it." As such, mentutees specifically mathematical obligations were obligations to their teacher; that is, doing what the teacher expects - obligation-to-others and not obligations-to-oneself (Cobb et al. 2009). In obligation-to-others, mentutees engaged in mathematical activities because they were required to, for instance, this is how my teacher solved it so it must be right.

However, in three of the P2N communities, eight out of nine of the mentutees perceived their general community obligations to be initiating their own approaches in order to solve a mathematical task and explaining solutions to other community members in line with their general community obligations. As Li noted, their mentutors "made sure they did their work." In this regard, mentutees were more involved in the learning process. They had to initiate their own methods and not be dependent on their mentutors to tell them how to solve particular tasks, they had to do "their work." The role of mentutors who engaged in more participatory pedagogy involved facilitating mathematical discourse among their community members which they learned during their training sessions. Also, these eight did not have to "see" their mentutor solve a task always. They took initiative to solve given mathematical tasks and also helped enforce community norms of sharing solutions. In the Graves community, the normative identities as doers of mathematics were quite similar to what prevailed in mentutees' high schools, which is, mentutor demonstrating steps to follow. See Table 9 for mentutees' P2N specifically mathematical obligations.

Table 9

P2N mentutees' understanding of their specifically mathematical obligation

Specifically mathematical obligation	*Number of Mentutees*	*Excerpt*
Being able to understand concepts	8	I got to learn math in a different way and that is what helped me a lot. *I just needed to understand the concepts.*
Being able to communicate mathematical ideas to others	4	At first I felt like I understood this stuff. I can do it myself but *I wasn't really good at explaining how to do any of that at all.* After P2N, I learned tips and tricks and that really helped me into being able to help others more.
Being able to answer a question in multiple ways	4	*I learned a lot of different ways to do things*. The more you know how to do one thing the better because you can show other people how to do it in multiple ways too. *If they don't understand one way you always have the backup.*

Table 9 Continued

Specifically mathematical obligation	*Number of Mentutees*	*Excerpt*
Making connections among concepts	3	I see that a lot of like the big *complicated math problems just look really big and complicated because they require a lot of different concepts in them* and that if you look at it as one big math problem you are not really going to see that because it looks all intricate. But *if you actually break it down and see all those small little math problems and you can take it piece by piece and work on it that helps.*
Memorization	2	They (undergrads) help us using analogies to *memorize* certain equations or certain ways of solving a problem.

Mentutees' Pre-and-Post-Reaction to Challenging Mathematical Tasks

Mathematics classrooms serve as spaces were messages about the nature of the subject are communicated (Bishop, 2012; Boaler, 2002). Students' perception about the nature of mathematics is contingent on the normative ways of doing the mathematics that they experience. For instance, Brown and Rodd (2003) note that students' images about the nature of mathematics can vary from "a meaningless game which is fun to do, maths as a source of the processes of following through tedious details, maths as a practical subject/a beautiful subject, or … as a high status subject that is character and mind-developing" (cited in Solomon, 2007, p. 81). This situation seemed to be the case with the 12 mentutees studied.

Mentutees' Pre-P2N Images about the Nature of Mathematics

To determine mentutees' interest in mathematics they were asked, during the interview sessions, to rank the courses they were enrolled in from their most liked to least liked course. Out of the 12 mentutees, five of them ranked mathematics as their best school subject out of the seven courses registered. For those who ranked it as their most liked subject they mentioned that mathematics was "fun." Some of the reasons they gave for their ranking were: "multiple solutions," or relatively "easier to do."

The perception that mathematics is fun was evident from Albert's response with his reason being that it he could find "different solutions to problems." While it is heartwarming to hear mentutees talk about mathematics being fun and their most liked subject, their reasons for not liking other school subjects provided interesting insights. In the case of Albert, one of the reasons for ranking mathematics highly was partly due to the procedural nature of pedagogy. This assertion was evident in the explanation he provided for not liking his English class. He commented: "it is easier than reading because you just get to write numbers and you don't have to worry if you messed up one sentence or put the wrong period." While his comment that mathematics is "free in a way" could be partly explained as mathematical tasks offer multiple ways to solve them, at the same time, there are rules for determining the correctness for a mathematical argumentation. As such, mathematical symbols are not meaningless marks that are operated on without any structure (Boaler, 2008b; Dossey, 1992; Solomon, 2007). Unfortunately, the view that mathematical symbols are mere marks with no meanings attached was evident from Guang's reason for ranking mathematics as her most liked subject.

Concerning why she ranked mathematics very highly Guang commented: "What I like most is that homework is not so repetitive. It's working on multiple problems which are the same, *it's just that different numbers are plugged into it.*" [emphasis added]. Unfortunately, her dislike for repetitive homework is inconsistent with her previous comments concerning why she enjoyed mathematics. In an answer to why she enjoyed mathematics in her current mathematics class her response indicated that any perceived enjoyment of mathematics boiled down to her specifically mathematical classroom obligation of repeating teacher demonstrated procedures, which was, plugging in "different numbers." She noted that the homework items were similar to those demonstrated in class with the only variations being slight changes in numbers used in constructing the item. Her major concern was that once she has 'understood' the demonstrated procedures there is no need for the teacher to keep assigning more of the same things.

While five mentutees ranked mathematics as their most liked subject, another group of five ranked it as either fourth or fifth out of the seven courses registered. This group of mentutees did not find a procedural approach enjoyable. In addition, one mentioned that he enjoyed mathematics insofar as he remembered the rules to use, the rest did not find mathematics enjoyable. Mathematical concepts, it appears, were viewed by these mentutees as a laundry list to be memorized. This view is summed up by Kylie who noted: “I would be good at if we didn’t change the subject every week. We will learn factoring one week and then something else every week. It’s a lot for me.” From Kylie’s comment the tendency by her teacher to speed up lessons in order to complete curricular prevented her from understanding concepts being treated before new ones are introduced. It also highlights potentially lack of curricular coherence so that she is unable to make connections leading to memory overload (Chazan et al., 2013; Cobb & Jackson, 2013). Mentutees who did not like mathematics noted that it lack coherence, had little meaning attached, and they struggled to fit the pieces together. Evidence of the deleterious effect of procedural pedagogy as experienced by mentutees in their various mathematics classrooms was evident from their reactions to challenging mathematical tasks.

Mentutees’ Post-P2N Images about the Nature of Mathematics

How mathematics is taught influences how students view the subject, a meaningless subject or a subject which makes sense, enjoyable, and flexible in terms of ways of expressing concepts (Boaler, 2008). Additionally, various pedagogies portray different aspects of the subject (Dossey, 1992). For instance, a procedural pedagogy with a heavy emphasis on students learning procedures can lead to a perception that learning of mathematics involves learning rules of the game.

At the end of mentutees’ participation in P2N, most of them viewed mathematics as a subject that requires “understanding,” drawing on various concepts, and the use of “prior knowledge.” Also, the need for communicating one’s ideas to others in a clear and comprehensible manner were also highlighted. Additionally, mentutees noted that there were multiple ways to solve mathematical tasks.

The idea that there are multiple ways of solving mathematical tasks was apparent in response by Amina to the following question: "What have you gained from being in P2N that you were not getting from your advanced algebra teacher?" She commented that:

> Definitely different perspectives because it was just my advanced algebra teacher that was helping me. Not that I am complaining but I got different ideas and ways from other people to solve problems. If I did not like one way I could do it another way.

Amina's view is re-iterated by Daniel who noted that he had "learned a lot of different ways to do things. He explains why he values the multiple perspectives as follows: The more you know how to do one thing the better because you can show other people how to do it in multiple ways too. If they don't understand one way you always have the backup." From the comment by Daniel, multiple strategies has the potential to increase a student's level of understanding and possibly improve procedural fluency (Rittle-Johnson & Star, 2007).

With regards to mathematics being a subject where concepts are interrelated the following comment by Khadija who indicated that in solving a mathematical task, there is a need to identify the various concepts learned previously in order to successfully solve it. She commented as follows:

> The big complicated math problems just look really big and complicated because they require a lot of different concepts. If you look at it as one big math problem you are not really going to look intricate but if you actually break it down you can take it piece by piece and work on it.

In this excerpt, Khadija portrays mathematical concepts as connected and not stand-a-lone concepts. Doing well in it requires an ability to make connections within and across concepts and drawing on relevant concepts to solve given mathematical tasks.

In summary, mentutees' responses indicated that their perception about the nature of mathematics changed for most of them. Mathematics was viewed as a subject that required an understanding of concepts and not memorization, making connections and not a long list of topics, and also clear communication of ideas to others.

Mentutees' Pre-P2N Reaction to Challenging Mathematics Tasks

The NRC (2001) defines mathematical competence in terms of five interrelated strands. According to the authors, being good in mathematics (being mathematically proficient) goes beyond procedural fluency - facility with carrying out procedures taught in a flexible, accurate, efficient, and appropriate manner. In addition, mentutees should acquire; a) conceptual understanding, that is a comprehension of mathematical concepts, its operations, and relations; b) strategic competence; c) adaptive reasoning which is a capacity for mentutees to engage in logical thought, reflect, explain, and justify answers; and d) procedural disposition- develop a habit of mind to see mathematics as sensible, useful, and worthwhile in addition to a belief in diligence and one's own efficacy.

In effect, being good in mathematics should lead to a belief in student's ability to solve non-routine mathematics problems without resorting to their mathematics teachers, textbooks or their written notes for answers. In this sense, we would expect mentutees to possess some of the characteristics outlined by the NRC when confronted with challenging mathematical tasks. However, mentutees' responses to an interview question regarding what they usually did when faced with a challenging task pre-P2N indicated a lack of strategic competence and productive dispositions (NRC, 2001).

Mentutees responses indicated that most of them hardly attempted such tasks. Typically, when faced with challenging mathematical tasks, they either consulted their written notes, asked their teachers or friends for assistance, or googled Khan Academy for answers. This finding was consistent for students who either identified with, merely complied with, or resisted procedural pedagogy. It was also evident from the responses of mentutees who ranked mathematics as either their most liked or least liked subject.

Out of the five mentutees who ranked mathematics as their best subject, only Guang responded that she attempted the problem before looking for help when "stuck." When really stuck she would look online for help or ask her teacher for help. In the case of Amira, she noted that she would try to look at what the teacher did and if she still did not have a way to solve the task, she would ask the teacher. Albert's sums up how mentutees, despite ranking mathematics as their best subject and performed well in it lacked the requisite proficiencies to solve challenging mathematical tasks. He commented: "Whenever something is challenging for me honestly I usually type in answers relying on my calculator. I also look at my notes and when that doesn't work I just ask for help from somebody." In all the processes he goes enumerated, there was no mention of him trying to understand the task demands, what he knows about the problem, and then using what is known to formulate an appropriate solution.

While there is nothing wrong with mentutees or students in general seeking for help or consulting other material resources, the argument is that Alberts's reaction is illustrative of what dependency on teachers for procedures can hamper students' future learning. Again, mastery of teacher demonstrated procedures prevents students from developing roots in mathematics. For the mentutees who were either compliant or opposed their normative identities of repeated demonstrated procedures their reaction to challenging tasks were pretty consistent. All of them noted that they hardly wasted time on such tasks. Mei, in the compliant group commented: "I probably put a question mark, I don't know how to do this and will probably ask my peers or teachers how to do it." The resort to 'more competent others' is also taken up by Li. He commented: "I usually try to find *people who know how to do these kinds of problems*. There is no use of me trying to figure out if I know I can't solve it [emphasis added]." His comment that he found "people who know how to do these kinds of problems" reveals a belief that there are some people for whom certain kinds of mathematical tasks are best left for. There is an attempt at categorizing students into the more capable group of students and the less capable group. The more capable group of students are best positioned to deal with challenging mathematical tasks while the less capable deal with the routine problems that teacher demonstrated procedures apply neatly. Such a belief reveals images and stereotypes some students have related to who can do mathematics (Boaler, 2008; Cobb, Gresalfi,& Hodge, 2009; Ladson-Billings, 1997).

For Anise, her reaction to challenging mathematical tasks amounted to saving face in the form of preserving her grades. This was apparent from her response: “oh wow! I would skip it because it’s going to weigh me down and go to another one.” While mentutees in the second group would usually skip challenging tasks or resort to the use of persons deemed more capable than them, those in the third group tended to have a more dismissive attitude towards mathematics and mathematical activities.

Mentutees in the third group either postponed working on mathematical tasks or did not do them at all. Two of them, Richard and Amina had developed oppositional identities and less involved in classroom discourse. Richard for instance, usually postponed working on mathematical tasks noting: “I am like it will get done but I always ended up either falling asleep, eating or just having other stuff come up and forgetting about it.” In effect, performing mathematical tasks was not a priority and sometimes totally forgotten. Amina’s reaction was: “I would be like, ‘okay whatever.’ I could just fail this test, I don’t really care and that’s what I usually did.”

Just like Richard, Amina knew the negative effects of their actions yet persisted. Richard, for instance notes that when he started high school he “didn’t really get some of the stuff until 10th grade” because he isolated himself from classroom activities right from grade eight because her mathematics teacher was “stuck up.” The reactions of these two mentutees reflect what Kohl (1992) argued about learning being partly voluntary. In this regard, students exercise agency in choosing to learn or not learn depending upon several conditions such the nature of pedagogy being experienced. For mentutees in the third group, some of them were conscious of the negative effects of their decisions yet decided against exerting themselves in the learning of mathematics because they disliked the nature of mathematics instruction prevalent in their mathematics classrooms.

Mentutees' Post-P2N Reaction to Challenging Mathematical Tasks

Unlike their pre-P2N experience where most of them reported skipping challenging tasks or relied on persons deemed more capable than them, there was a noticeable shift post-P2N. All 12 mentutees noted increased level of understanding and confidence in their mathematical competence. These changes are attributable to the nature of tutoring practices mentutees received and/or the ideational resources made available to them. The ideational resources enabled mentutees to persist on mathematical tasks as they viewed any incorrect answers due to a mistake made as learning opportunities. The mentutees valued attempting problems knowing that their way of approaching a task served as a springboard for more productive mathematical discourse.

In contrast to what pertained in their schools where only Guang indicated that she tried a problem at least once before seeking help, the reverse was the case after mentutees' participation in P2N. Eleven mentutees indicated a change in their reaction towards challenging tasks. They attempted to solve challenging tasks fueled by the belief that they knew something about the task and that making a mistake is not a bad thing.

Mei commented about her change in attitude towards challenging tasks as follows: "I am more confident in my math. I feel like even if I don't know how to solve it at least I have to know something to be able to solve it." While Mei's change had to do with increasing understanding about the nature of mathematics and how various concepts maybe embedded in a problem/ task, the reason for Li's renewed confidence was slightly different.

Li's reaction to challenging tasks had more to do with a change in mindset. He had earlier indicated that he did not waste his time on challenging mathematical tasks preferring to consult fellow students who "dealt with such problems." However, after participating in P2N, his response to what he does when faced with a challenging mathematical task can be described as being cautiously optimistic. Despite indicating that he "wouldn't be the brainiac in math" he commented: "before I used to think oh the math on the ACT is very challenging for me. After going through this program I can tackle the test in various forms."

Unlike the other mentutees who talked about seeking to make sense of a given task and drawing on previous knowledge (which fits into their specifically mathematical obligations), three of the mentutees still held onto a more procedural view. However, the ideational resources made available to them enabled them to at least try any given mathematical task before seeking help.

Generally, mentutees could be described as developing a more productive disposition towards mathematics irrespective of their pre-P2N sense of affiliation with mathematical tasks. They no longer engaged in self-doubts regarding their mathematics competence. Instead, they were more prepared to at least try a given tasks before seeking help, an indication of a productive disposition towards mathematics. However, this was not the case for four of the mentutees. In summary, mentutees' reactions to challenging mathematics tasks indicate that any sense of achievement based on mastery of procedures or rote memorization of steps can be short-lived as it leads to a majority of students doubting their sense of mathematical competence.

Mentutees' Assessment of their Mathematics Competence

A less participatory pedagogy leads to a majority of students feeling incompetent and disinterested in pursuing the study of mathematics (Boaler, 2008; Cobb & Jackson, 2013; NCTM, 2014). This was evident in the case of the 12 mentutees who participated in P2N.

Mentutees' Pre- P2N Assessment of their Mathematics Competence

When mentutees were asked, during the interview, to assess their mathematics competence relative to other students in their respective classrooms prior to P2N, only three mentutees, Albert, Daniel, and Guang, rated themselves as being at the top or close to the top. However, only Albert and Daniel felt confident in their mathematics competencies and viewed themselves as mathematics persons. Reasons they cited for assessing their mathematics competence included: possessing a good memory, and the belief that mathematics is easy.

In the case of Guang, a female, although she liked mathematics, she did not feel confident in her mathematics competence. Her reason was she did not fully understand what was being taught; a not there "yet." She noted: "I don't know enough yet to call myself a math person." A possible reason for her lack of confidence could be inferred from her understanding of her specifically mathematical obligation: "In my math class, we worry more about finishing our homework. We don't really go deep into understanding the concepts." In effect, while mentutees could identify with a particular mathematical pedagogy, it is possible for some of them to develop identities of exclusion at the same time.

Nine mentutees, on the other hand, did not feel confident in their mathematics competences. While five of them had some form of affiliation with mathematical tasks, they were uncertain about their mathematical competence. The remaining four mentutees did not have any sense of affiliation with mathematical tasks and did not feel competent in mathematics. Comments such as "He doesn't talk about why math is important, why we do this (Amira)" or "in class we just move on we don't look back at the things we do (Li)" were some of their reasons for their lack of confidence in learning mathematics. The following excerpt illustrates why some mentutees developed *identities of uncertainties*.

Interviewer: Why did you rank math as fifth?

Li: Math of all has been a thing I struggle with. People ask me like 'are you good at math?' my best response is no. Because there are some times when I feel like I am good at some parts but not at other parts so I am always like between. I just really have a hard time because sometimes I feel like I understand for example the graphing and factoring all that stuff. And sometimes I will not get some other parts like trigonometry or like geometry those kind things. And I think *I feel like I just know the basics but not the deep stuff* [emphasis added].

In his rather elaborate response, Li highlights the importance of going beyond knowing the "basics" to knowing the "deep stuff." A lack of the deep stuff meant that he did not have the necessary mathematical proficiencies to call himself a mathematics person.

Mentutees' Post-P2N Assessment of their Mathematics Competence

All 12 mentutees in P2N reported having a sense of achievement in mathematics post-P2N. They noted gaining confidence in their mathematics capability as a result of gaining "deeper understanding" and seeing that they were not the only ones who struggled in mathematics. They noted a self-belief that suggested a departure from constant reliance on others (teachers and textbooks) for help to reliance on their own capabilities such that most of them were more likely to persist on tasks for a while before seeking for assistance. The following statement by Khadija that students do not "always have to depend on the teacher" was indicative of mentutees assessment of their own mathematical competence. In terms of achievement, all the 12 mentutees reported gains in their scores which ranged from B+ to solid A's. In some instances, mentutees who were averaging grades D or F's reported obtaining grades A/-A with those who were already doing well maintaining their good grades. As such, there was a sense of achievement for all mentutees whether they ranked themselves close to the top or below average in their respective classrooms.

In summary, mentutees' assessment of their mathematics competence prior to P2N indicated that some students developed a sense of affiliation with procedural identities yet developed identities of exclusion. This indicates that a sense of achievement in mathematics is not enough for some students to feel a sense of belonging and affiliation with mathematical tasks. As such, students can develop different identities and have different modes of belonging namely, identities of inclusion, uncertainty, or exclusion. It is therefore, possible for students who are successful in mathematics to remain at the periphery of the practices of mathematics instead of becoming core members of the community (Solomon, 2007). On the contrary, more participatory pedagogies result in more mentutees identifying with mathematical tasks and also have a sense of belonging and not just having a sense of achievement in mathematics. See Table 10 for students' sense of mathematics competence pre-P2N and post-P2N.

Table 10

Mentutees' sense of mathematics competence

Sense of Math Competence	*Pre-P2N*	*Post*
Sense of achievement	3	12
Uncertainty	5	-
Lack of Competence	4	-

CHAPTER 5

Summary, Conclusions, Implications

Since 1989 when the National Council of Teachers of Mathematics (NCTM) launched its standards-based movement in response to concerns about quality of mathematics education, there has been continuous efforts to improve educational outcomes for all students. These efforts are aimed at finding ways to improve the quality of mathematics teaching and learning so that a more diverse group of high school students can gain access to rigorous mathematics curriculum necessary for further education in STEM disciplines in college and future professions.

In order to enrich the mathematics learning experience for a lot more students and potentially increase the number of students enrolling into STEM disciplines, mathematics should no longer be considered as an elitist subject and therefore, the preserve of a select few, especially college-required mathematics courses. It also means that a lot more students should be able to excel in mathematics instead of the pockets of excellence being witnessed currently. It also calls for a shift in research based predominantly on gap-analysis – racial or gender disparities in mathematics achievement - to an understanding of classroom practices that might enable some students to succeed while others do not.

Recent studies in the mathematics education community, influenced by sociocultural theorists have shifted from a focus on the individual (purely psychological) to a social perspective (situated learning). This shift to classroom practices is fueled by a belief that a significant amount of students' learning depends on the nature of classroom interactions between learners and teachers (Ball & Forzani, 2011). Since Lev Vygotsky in the 1970s and Lave and Wenger (1991) highlighted the social nature of learning, a number of mathematics education researchers (e.g. Bishop, 2012; Boaler, 2000b; Cobb et al., 2009; Cobb et al., 2001) have carried out research investigating how the social norms promoted in a learning environment influences students' mathematical learning. These researchers contend that the learning of mathematics involves a form of socialization into mathematical practices and what it means to belong to the larger mathematics community. As such, the learning of mathematics by students involves a form of apprenticeship. In this regard, students in a mathematics classroom or any learning community for that matter do not only learn how to operate on mathematical symbols or some mathematical concept, they also learn how to participate in the classroom they find themselves and what it means to do mathematics. In effect, the learning of mathematics involves the formation of mathematics-related identities. The extent to which students either identify with, merely comply, or resist established sociomathematical norms, it is argued, influences their motivation, attitude, interest, and achievement in mathematics. In this regard, any attempt aimed at improving instructional practices and students' achievement in mathematics should begin at both the general and sociomathematical norms that learners have to identify with instead of adopting a deficit-oriented perspective in explaining students' underachievement in mathematics.

According to Cobb et al. (2009), accounting for what happens in a learning environment at identities formed by learners involves two constructs. The first construct, normative identities, focus on obligations which are not necessarily specific to the learning of mathematics, that is, general classroom obligations. The second type of obligation, specifically mathematical obligations, has to do with obligations that are unique to the study of mathematics in terms of what counts as competence in mathematics. The second construct, personal identities focuses on the extent to which students identify with their learning community obligations, are compliant, or resist engaging in learning activities constructed in a learning space. The assumption is that it is when norms have been established that individuals choose whether to identify with, merely cooperate, or resist participation in community practices.

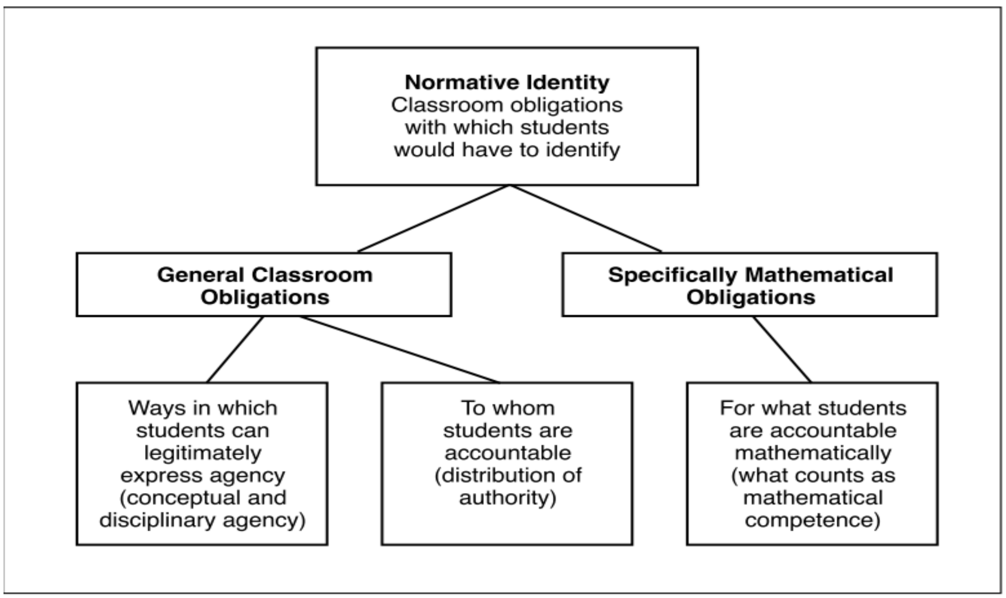


Figure 3. Normative identity as a doer of mathematics in a particular classroom (adopted from Cobb et al., 2009).

Of critical importance during this enculturation process into mathematical community and activities is students' access to practice-linked identity resources. These resources, also referred to as identity resources, in a mathematics classroom involves the extent to which students have access to teaching and learning resources (material resources), relational support whether in school or out-of-school (relational resources), and specific ideas about what it means to do mathematics and what it takes to be successful in mathematics (Nasir & Cooks, 2009). These resources are deemed as vital in helping community members learning about the cultural practices of a community. Taken together, documenting students' mathematical identities requires a focus on both the general and sociomathematical norms that learners have to identify with as suggested by Cobb et al. (2009) in addition to learners' access to certain resources (Nasir & Cooks, 2009).

In order to determine the influence an out-of-school learning environment known as Prepare2Nspire (P2N) had on high school students' mathematical identities, the framework by Cobb et al. (2009) was used in this study. This framework enabled the researcher to examine the normative and personal identities 11th graders' personal formed prior to and after participating in P2N. While the first framework was useful in mapping out the nature of instructional practices, the second framework by Nasir and Cooks (2009) was also used to make explicit, how access to certain practice-linked identity resources influenced identities students formed. Also, the combination of these two frameworks enabled me to overcome some of the methodological issues raised by Wood (2013) such as lack of sensitivity of macro-level frameworks in identifying micro-level changes in students' mathematical identities. By focusing on the identity resources made available to 11th graders in P2N, it was possible to examine how these resources mediated the personal identities learners formed in terms of perceptions about the nature of mathematics and affiliation with mathematical tasks, assessment of their mathematical competence, and their sense of belonging.

A major assumption that underpinned this study was that different pedagogies namely, participatory versus less participatory pedagogies, leads to different normative identities and personal identities. For students who have developed identities of marginalization, it is possible for them to experience a turnaround in their mathematical identities in learning environments which are transformational (Horn, 2008). It was hypothesized that the setup of P2N with its emphasis on communal learning and the provision of specific identity resources had the potential to be an identity transforming environment.

Summary

A mixed methods design involving a survey (quantitative method) and an embedded multiple case study design (qualitative method) was used to investigate the influence of P2N on 11th graders' mathematical identities. The sampling procedure involved a two-stage process. The first phase comprised 34 participants (all participants who responded to the two instruments initially administered). The second phase of sampling involved a purposeful sampling technique to select four communities. This sampling led to a total of 12 11th graders (mentutees) and four undergraduates (mentutors) who were nested in these communities.

Multiple instruments were used to collect data including a written survey (SRME), a Likert scale survey (MIS), and an interview guide. The four communities were also observed for a period of four months, January to April, 2015. The analysis of the data corpus allowed the researcher to discuss differences in mentutees' mathematical identities before and after participating in P2N based upon the normative identities 11th graders had to identify with in their assigned communities. The various data sources also made it possible to document the mechanisms by which students assumed particular identities. The following questions were used to guide this study:

1. What is the nature of the mathematics learning experiences of 11th graders prior to joining P2N?
2. How are normative identities as doers of mathematics constructed and negotiated within selected P2N communities?
3. How does mentutors' use of identity resources in P2N influence the formation of specific learning and identity trajectories?
4. What is the nature of mentutees' personal identities in mathematics prior to and after participating in P2N?

In answering the first research question, both quantitative and qualitative methods were used. The quantitative method (survey) was used to have a general idea of the 11th graders' mathematical identities related to factors such as: perceptions about the nature of mathematics and mathematicians, interest in mathematics activities, and teacher expectations and mathematics competence. Qualitative methods are used to gain an in-depth understanding of the mechanisms leading to the formation of specific mathematical identities by students.

The quantitative survey instrument was adapted from Aschbacher et al. (2009) and had five scales with a total of 37 items. The Cronbach reliability estimates for the five scales ranged from 0.50 to 0.82. In order to determine the direction of 11th graders' responses to statements regarding their mathematical identities, percentages of respondents who chose a particular response were calculated. Results obtained using the quantitative instrument indicate that the majority of 11th graders believed that mathematicians, through their work, make contributions to the world. However, the majority of students were found to be uninterested in pursuing mathematics-related careers, and held negative perceptions about how mathematicians work. Nearly a third of 11th graders did not believe that good mathematicians looked like them. Additionally, most of the 11th graders indicated having a teacher who made them not like mathematics. Overall, the results from the survey indicates that while majority of students believe that mathematicians play a role in everyday activities, quite a number of them did not identify themselves as mathematicians.

The results from the open-ended survey corroborates results from the quantitative survey. The nature of mathematics instruction experienced by mentutees were found to be mostly procedural, less participatory. Mentutees understood their general and specifically mathematical obligations to include: notes taking and listening and watching their teachers demonstrate procedures.

In a follow up interview with the 12 mentutees in the four focal communities, more light was shed on the nature of mathematics pedagogy experienced by students. Norms for mathematical argumentation – classroom discussions- and reasoning with mathematical symbols involved mentutees being able to reproduce teacher demonstrated steps. Fulfilling this obligation means that mentutees have to either memorize demonstrated procedures on engage in repeated practice. In general, most of the mentutees did not identify with a procedural pedagogy with two of them expressly indicating how they resisted the fulfillment of a disciplinary agency in their previous mathematics classrooms.

In summary, a less participatory pedagogy led to pockets of mentutees who believed that they were competent in doing mathematics. An inherent weakness in mentutees fulfilling their obligations of repeating teacher demonstrated procedures is apparent in their reaction to challenging mathematical tasks. None of the mentutees can be described as developing a productive disposition prior to P2N. This conclusion is based on the fact that they were unable to persevere on challenging tasks and tended to express responses indicating low confidence in their mathematical competence.

Although all mentutors received the same training regarding the tutoring practices desired at P2N such as enabling mentutees to do their own learning with mentutors only serving as facilitators, three of them namely; Dorothy, Fred, and Belinda in the Tyson, Daly, and Young communities respectively enacted practices similar to those advocated. Analyzes of observational video transcripts and interview transcripts reveals that mentutees in these communities had a better understanding about the nature of mathematics – a subject that requires understanding of concepts and ability to communicate thoughts to others clearly and were less likely to depend on their mentutor for assistance when faced with a challenging tasks. In contrast, mentutees in the Graves held views about the nature of mathematics and what counts as being mathematically competent similar to their pre-P2N perceptions.

Despite variations in tutoring styles, the provision of especially ideational resources in terms of images of who a math person is- a person who seeks to understand a given mathematical task and draws on various concepts learned to formulate an approach, persists on a mathematical task (and learns from mistakes made), among other ideational resources were particularly helpful in transforming some of the mentutees' mathematical identities. The sharing of ideas about what counts as mathematical competence was made possible through the various relations mentutees formed with other community members. In the case of the mentutees who lacked the necessary academic network at home, the relational resources at P2N enabled them to receive the needed learning support and mentoring. Additionally, the relational resources mentutees received led to the promotion of relational equity – valuing each community member's unique contributions. Each community member was seen as having something to share in the learning process leading to mutual respect and self-belief in their mathematical competence. Furthermore, the availability of material resources such as ACT study guide and graphing calculator that mentutees used to enhance their mathematical learning experiences highlighted how access to curricular resources could help bridge the gap between students from low socioeconomic status and those from high socioeconomic status.

At the end of their P2N experience, most of the mentutees, nine in all reported becoming more confident in their mathematics competence, developing a sense of affiliation with mathematical tasks – having deeper roots in mathematics instead of an instrumental learning, and having a sense of belonging in the mathematics community. The three mentutees who did not identify themselves as math persons were one mentutee from the Daly community and two from the Graves community.

In addition to the participatory pedagogy that most of the mentutees experienced, the provision of certain identity resources were crucial in turning around the mathematical identities of most mentutees from identities of uncertainty or exclusion to identities of inclusion. In summary, mentutees who prior to P2N could be described as having periphery learning and identity trajectory – not full members because they did not have strategic competence and productive dispositions to tackle challenging mathematical tasks-started developing an inbound learning and identity trajectory (Wenger, 1998).

Conclusions

Interactional Inclusion promotes students' mathematical understanding, and confidence

When mentutees are engaged in interactions, *interactive inclusion*, regarding the mathematical tasks being learned they are likely to have a sense of achievement due to increasing level of understanding of concepts. On the other hand, when mentutees are excluded from interactions, *interactive exclusion*, about mathematical tasks, they are less likely to understand concepts being taught leading to less confidence in their mathematical competence. This assertion holds true considering that both in school and in P2N, mentutees who were mostly excluded from extensive interactional engagements, were found to continuously rely on teachers or mentutors for help. Such students, based upon their general and specifically mathematical obligations did not develop a productive disposition necessary for them to initiate their own solutions when confronted with a task where they did not readily know an approach to use. In this regard, any attempts aimed at improving achievement scores for students and also increase number of students entering the STEM fields should focus on creating more participatory learning communities where students are more included in interactions over curricular activities. Such a learning community, as envisaged should: provide students multiple opportunities to articulate their thoughts using various representations that make sense to them, provide justifications for how and why they reasoned about mathematical tasks in particular ways, and where their reasoning is faulty learners' reasoning should be challenged through the use of counterexamples instead of being told what to do.

Less Participatory Pedagogy Creates False Sense of Belonging and Different Zones of Identification

A number of scholars have noted that mathematical identities are not fixed. Rather, individuals can have multiple possible selves (e.g. Markus & Nurius, 1986; Wood, 2013). In this regard, a student can have multiple identities with the same pedagogy. For instance, while a student may identity with a procedural pedagogy, the same student may not have a sense of belonging in the mathematics community. Also, the multiplicity of identities means that a student who with identity of exclusion at a particular point - *actual identity* - may project an identity of inclusion-*designated identity* (emphasis in original, Sfard & Prusak, 2005).

In this study, it was observed that a less participatory pedagogy creates typologies of learners' mathematical identities along a continuum of inclusive-exclusive identities, termed as *zones of identification*. A zone of identification represents students' sense of belonging based upon their affiliation with mathematical tasks, assessment of their mathematical competence, and sense of belonging. These zones are fluid with students capable of moving between zones. Mentutees' mathematical identities were classified into three zones, namely - *Zone of Inclusion*, *Zone of Uncertainty*, and *Zone of Exclusion*,

With regards to less participatory pedagogy, while some students could have a sense achievement based upon their identification (zone of inclusion) with procedural instruction, they may develop identities of marginalization (zone of exclusion). For example, while Guang identified with procedural pedagogy because she had a sense of achievement (zone of inclusion), she did not evaluate her mathematics competency positively and expressed identities of exclusion (zone of exclusion). This was also the case for students who had a sense of achievement but their reaction to challenging mathematical tasks indicated that they remained at the periphery of the mathematics community. See Table 11 for high school students' *Zones of Identification*.

Table 11

Inbound versus peripheral participation

	Pre-P2N	*Post-P2N*
Zones of Identification	Number of 11^{th} Graders	
Zone of Inclusion	2	9
Zone of Uncertainty	3	-
Zone of Exclusion	7	3

In summary, zones of identification provides a more fluid description of students' mathematical identities so that learners can identify with an aspect of a pedagogy and oppose other aspects based upon their assessment of their mathematical competence and notions of self as a mathematics person. In that regard, students who desire for a more conceptual understanding are more likely to develop a sense of learned helplessness and feel like outcasts in the mathematics learning community (Mair & Seligman, 1976; Waxman & Padron, 1995).

More participatory forms of pedagogy benefits all students, irrespective of gender

More participatory pedagogies leads to more students developing identities of inclusion, zone of inclusion, irrespective of gender or racial background (Solomon, 2007). Unlike pre-P2N where the majority of mentutees (10) developed identities of exclusion, this was not the case post-P2N. All mentutees reported having a sense of achievement in mathematics with many of them willing to pursue higher-level mathematics courses to reaffirm their new mathematical identities. The results of this study indicate that when all students, both males and females prefer teaching and learning pedagogy which promotes conceptual understanding in contrasts to other studies which seem to suggest that only females react negatively to procedural pedagogy (e.g. Boaler, 2002; Solomon, 2007). For instance, in this study, while two males (Albert and Daniel) identified with a procedural pedagogy and did not express any concerns about the lack of conceptual insofar as they were doing well, that was not the case for the other two males namely, Li and Richard. The latter group of male mentutees did not have a sense of belonging and developed identities of uncertainty or exclusion respectively.

Also, in terms of exercising disciplinary agency in order to succeed in mathematics, a number of females namely, Anise, Mei, and Guang) were happy to align with such agency as far as that enabled them to pass their tests. As such, both males and females developed a functional identity necessary to succeed in their respective classrooms. Additionally, Richard, a male and Amina, a female, were the only students who openly resisted fulfilling their disciplinary agency obligation.

Mathematical identities can be changed with the provision of the right identity resources

No one, at birth, dislikes mathematics. Individuals learn what to like and dislike based upon their learning community norms. It is the enculturation process which influences students' subject interests and ultimately motivation and persistence in pursuing a program of study. While the nature of mathematical pedagogy can create a divide, capable versus less capable, another factor that can mediate this divide is students' access to practice-linked identity resources such as learning materials, ideational resources and relational resources. For instance, mentutees' access to an ACT guide helped them to feel better prepared for their ACT test while they expressed concern for their friends who were not enrolled in a program such as P2N. Students' reference to curricular resources such as the ACT book and graphing calculator as a "privilege" only highlights how lack of access can exacerbate the achievement gap. Additionally, the relational and ideational resources mentutees had access helped them to gain a different understanding of what it means to be competent in mathematics leading to a turnaround in the mathematical identities of most of them (Horn, 2008).

Implications

Results from this study indicate that mentutees have different understandings of what it means to be competent doer of mathematics based upon the pedagogy experienced. While three mentutees assessed themselves to be good in mathematics their reaction to challenging tasks indicated that their sense of achievement could be described as superficial. The remaining nine mentutees did not have enough confidence in their mathematical competence due to reasons such as lack of conceptual understanding or lack of connection across concepts. Being mathematically competent requires acquisition of the five strands of mathematical proficiencies outlined by the NRC (2001) which was not the case for these mentutees. Additionally, most of the mentutees did not have any interest in mathematics and in performing mathematical tasks apart from fulfilling a school obligation that all high school graduate must take at least three mathematics classes. In effect, the mentutees could be described as being at the periphery of the practices of mathematics (Lave & Wenger, 1991; Wenger, 1998). Not only did they lack a better understanding of what the nature of mathematics is, they also were not engaged in the practices of mathematicians such as making sense of tasks, looking for patterns, devising a plan, and justifying why an approach works (Solomon, 2007). However, after being in P2N, most of the mentutees had a better appreciation of the nature of mathematics, that is, a subject that could be understood and had a relevance to future vocations. They also talked about a need to communicate what one is doing to others in ways that made sense to them using language, analogies, and pictorial representation. Additionally, while before P2N most of them felt like outsiders or outcasts in mathematics, this was not the case in P2N due to the nature of tutoring most of them experienced and the relational and ideational resources that were made available to them by their mentutors, in particular.

In light of the findings from this study, a number of instructional implications arise. First of all, efforts by mathematics educators and high school mathematics teachers aimed at counter-socializing minority students who have imbibed negative stereotypes about their sense of belonging in mathematics will require a change in pedagogy from a pedagogy of poverty (Haberman, 1991) to a more participatory pedagogy(Cobb & Jackson, 2013). It will also require creating more equitable relations among students so that no one feels intimidated leading to notions of being outcasts in a learning environment (Boaler, 2008a).

Secondly, it is important that specific messages that counteract negative images of the nature of mathematics, for example, mathematics as a subject one just does what he or she is told to do and that only nerds can do mathematics, are communicated by teachers. Students should be made to observe publicly, how teachers and other students grapple with mathematical tasks, their reasoning processes and justifications for their procedures. Achieving this will also require creating mathematics classrooms as learning communities were learners interact with and learn from each other thereby promoting relational equity.

Thirdly, students' success in mathematics does not depend on quality of instruction alone. It is also contingent on students having access to certain curricular resources such as teaching and learning materials (material resources), building of academic networks that leverage challenges some students face at home, and building mindsets that enable them to be resilient.

Recommendations for Further Research

To contribute to the literature on the effects of pedagogy on students' mathematical identities, the researcher investigated 11th graders personal identities formed in two different mathematical learning spaces; school and an out-of-school learning program, P2N. The use of two frameworks helped to make explicit connections between nature of pedagogy, images about the nature of mathematics, sense of achievement, and sense of belonging formed by students. However, to continue to continue to assess the influence of out-of-school programs in turning around hitherto marginalized students, a number of suggestions for further research are offered.

First to understand the effect of tutors/mentors background on tutoring practices, the researcher suggests that studies that investigate tutors' mathematics background and personal identities be conducted. For example, do tutors with identities of exclusion or inclusion have different effects on community members' mathematical identities? This is because it was observed that mentors/tutors own experience with mathematics and views about preferable learning styles influenced their tutoring practices. Such a study will also shed light on specific ways that the mathematics identities of those who teach can influence how they socialize students into the larger mathematics community.

Secondly, to investigate the influence of out-of-school programs on participants' emerging mathematical identities, it is suggested that longitudinal studies are conducted to delve deeper into issues such as persistence of participants post-participation in such programs. For instance, does changes in mathematical identities lead to changes in course taking behavior? Are participants' emerging mathematical identities robust enough to carry them through higher-level mathematics classes or there is a breakdown? This will help determine whether new mathematical identities are functional and robust in nature or not.

References

Adler, J. (1998). A language of teaching dilemmas : Unlocking the complex multilingual mathematics classroom. *For the Learning of Mathematics*, *18*(1), 24–33.

Adler, J., Ball, D., Krainer, K., Lin, F.-L., & Novotna, J. (2005). Reflections on an emerging field: Researching mathematics teacher education. *Educational Studies in Mathematics*, *60*(3), 359–381.

Akyeampong, K., & Stephens, D. (2002). Exploring the backgrounds and shaping of beginning student teachers in Ghana: Toward greater contextualisation of teacher education. *International Journal of Educational Development*, *22*(3-4), 261–274.

Anderson, J. R., Greeno, J. G., Reder, L. M., & Simon, H. a. (2000). Perspectives on Learning, Thinking, and Activity. *Educational Researcher*, *29*(4), 11–13.

Anfara, V. A., Brown, K. M., & Mangione, T. L. (2002). Qualitative analysis on stage: Making the research process more public. *Educational Researcher*, *31*(7), 28–38.

Aschbacher, P. R., Li, E., & Roth, E. J. (2009). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching*, *47*(5), 564-582.

Ball, L. D., & Forzani, F. M. (2011). Building a common core for learning to teach: And connecting professional learning to practice. *American Educator*, *35*(2), 17 – 39.

Bell, A. (1993). Principles for the design of teaching. *Educational Studies in Mathematics*, *24*(1), 5-34.

Bishop, J. P. (2012). " She's always been the smart one. I've always been the dumb one ": Identities in the mathematics classroom. *Journal for Research in Mathematics Education*, *43*(1), 34–74.

Boaler, J. (2008a). Promoting "relational equity" and high mathematics achievements through an innovative mixed ability approach. *British Educational Research Journal*, *34*(2), 167–194.

Boaler, J. (2008b). *What's math got to do with it? Helping children learn to love their most hated subject-and why it's important for America*. Hudson, New York: Viking Penguin Group.

Boaler, J. (2002a). The development of disciplinary relationships: Knowledge, practice and identity in mathematics classrooms. *For the Learning of Mathematics*, *22*(1), 42-47.

Boaler, J. (2002b). Paying the price for 'sugar and spice' - Shifting the analytical lens in equity research. *Mathematical Thinking and Learning*, *4*(2&3), 1–36.

Boaler, J. (2000). Mathematics from another world: Traditional communities and the alienation of learners. *Journal of Mathematical Behavior*, *18*(4), 379–397.

Boaler, J., & Sengupta-Irving, T. (2006). Nature, neglect and nuance: Changing accounts of sex, gender and mathematics. In C. Skelton., B. Francis., & L. Smulyan (Eds.), *The Sage Handbook of Gender and Education. Londres: Sage Publications*, (pp. 207–221).

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of railside school. *Teachers and Teaching: Theory and Practice*, *110*(3), 608–645.

Boaler, J., William, D., & Zevenbergen, R. (2000). The construction of identity in secondary mathematics education. In *Paper presented at the International Mathematics Education and Society Conference (2nd, Montechoro, Portugal, March 26-31, 2000).*
Britzman, D., Dippo, D., Searle, D., & Pitt, A. (1997). Toward an academic framework for thinking about teacher education. *Teaching Education*, *9*(1), 15–26.
Burch, P., Steinberg, M., & Donovan, J. (2007). Supplemental educational services and NCLB : Policy assumptions , market practices , emerging issues. *Educational Evalauation and Policy Analysis*, *29*(2), 115–133.
Burris, C. C., Heubert, J. P., & Levin, H. M. (2006). Accelerating mathematics achievement using heterogeneous grouping. *American Educational Research Journal*, *43*(1), 137–154.
Carraher, T. N., Carraher, D. W., & Schliemann, A. D. (1985). Mathematics in the streets and in schools. *British Journal of Developmental Psychology*, *3*(1), 21–29.
Chazan, D., Brantlinger, A., Clark, L. M. &, & Edwards, A. R. (2013). What Mathematics Education Might Learn from the Work of Well-Respected African American Mathematics Teachers in Urban Schools, *115*(February 2013), 1–40.
Cobb, P., Gresalfi, M., & Hodge, L. L. (2009). An interpretive scheme for analyzing the identities that students develop in mathematics classrooms. *Journal for Research in Mathematics Education*, *40*(1), 40–68.
Cobb, P., & Jackson, K. (2013). Lessons for mathematics education from the practices of African American mathematics teachers. *Teachers College Record*, *115*(February 2013), 1–14.
Cobb, P., Stephan, M., McClain, K., & Gravemeijer, K. (2001). Participating in Classroom Mathematical Practices. *Journal of the Learning Sciences*, *10*(1-2), 113–
Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. Madison, New York: Routledge.
Cole, M., & John-Steiner, V, Scribner, S., & Souberman, E. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, Massachusetts: Harvard University Press.
Covington Clarkson, L. M., Ntow, F. D., Tackie, N, A. (2014). Negotiating the opportunity gap with a peer tutoring framework. *International Journal of Science, Commerce and Humanities*, *2*(8), 98–111.
Cramer, K. (2003). Using a translation model for curriculum development and classroom instruction. In *Beyond constructivism: Models and modeling perspectives on mathematics teaching, learning, and problem solving. Mahwah, NJ: Erlbaum.* (pp. 449–463).
Cramer, K , A., Wyberg, T. (2009). Efficacy of different concrete models for teaching the part-whole construct of fractions. *Mathematical Thinking and Learning*, 226–257.
Cresswell, J., & Clark, V. P. (2007). *Designing and conducting mixed methods research*. Los Angeles, CA: Sage Publication.
Darling-Hammond, L. (2014). One piece of the whole: Teacher evaluation as part of a comprehensive system for teaching and learning. *American Educator*, 4–14.

Delpit, L. (1995). *Other people's children: Cultural conflict in the classroom*. New York: New Press.
Delpit, L. D. (1988). The silenced dialogue : Power and pedagogy in educating other people' s children. *Harvard Educational Review*, *58*(3), 280–298.
Dienes, Z. P. (1960). *Building up mathematics*. London: Hutchinson Educational Ltd.
Dienes, Z. P., & Golding, E. W. (1971). Approach to modern mathematics. New York: Herder and Herder.
Dossey, J. A. (1992). The nature of mathematics: Its role and its influence. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 39–48). New York: MacMillan.
Dweck, C. S. (2010). Even geniuses work hard. *Educational Leadership*, *68*(1), 16–20.
Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist*, *41*(10), 1040–1048.
Eccles, J. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist*, *44*(2), 78–89.
Economic Policy Institute. (2010). *Problems with the use of student test scores to evaluate teachers*. Retrieved from http://epi.3cdn.net/b9667271ee6c154195_t9m6iij8k.pdf
Eisenhart, M. A. (1988). The ethnographic research tradition and mathematics education research. *Journal for Research in Mathematics Education*, *19* (2), 99-114.
Ellington, A. J. (2003). A meta-analysis of the effects of calculators on students' achievement and attitude levels in precollege mathematics classes. *Journal for Research in Mathematics Education*, *34*(5), 433–463.
Engberg, M., & Wolniak, G. C. (2013). College student pathways to the STEM disciplines. *Teachers College Record*, *115*(January 2013), 1–27.
Freeman, M., DeMarrais, K., Preissle, J., Roulston, K., & St. Pierre, E. a. (2007). Standards of evidence in qualitative research: An incitement to discourse. *Educational Researcher*, *36*(1), 25–32.
Galligan, L. (2008). Using Valsiner. In M. Goos., R. Brown., & K. Makar (Eds.), *Proceedings of the 31st Annual Conference of the Mathematics Education Research Group of Australasia* (Vol. 1, pp. 101–108). Brisbane, Australia.
Gay, G., & Kirkland, K. (2012). Developing cultural critical consciousness and self-reflection in preservice teacher education. *Theory into Practice, 4*2(3), 181-187.
Goos, M. (2005). A sociocultural analysis of the development of pre-service and beginning teachers' pedagogical identities as users of technology. *Journal of Mathematics Teacher Education*, *8*(1), 35–59.
Greeno, J. G., & Collins, A. (2008). Commentary on the Final Report of the National Mathematics Advisory Panel. *Educational Researcher*, *37*(9), 618–623.
Gresalfi, M. S., & Cobb, P. (2011). Negotiating identities for mathematics teaching in the context of professional development. *Journal for Research in Mathematics Education*, *42*(3), 270–304.
Grootenboer, P., Smith, T., & Lowrie, T. (2006). Researching identity in mathematics education : The lay of the land. *Identities, Cultures and Learning Spaces*, 612–615.

Gutiérrez, R., & Dixon-Román, E. (2011). Chapter 2. Beyond gap gazing : How can thinking about education comprehensively help us (re)envision mathematics education? In B. Atweh, M. Graven, W. Secada, & P. Valero (Eds.), *Mapping Equity and Quality in Mathematics Education* (pp. 21–34). Dordrecht, The Netherlands: Springer.

Gutman, L. M. (2006). How student and parent goal orientations and classroom goal structures influence the math achievement of African Americans during the high school transition. *Contemporary Educational Psychology*, *31*(1), 44–63.

Freire, P. (1970). *Pedagogy of the oppressed*. New York: The Seabury Press.

Haberman, M. (1991). The pedagogy of the poverty versus good teaching. *Phi Delta Kappan*, *73*(4), 290–294.

Hammerness, K., Darling-Hammond, L., Bransford, J., Berliner, D., Cochran-Smith, M., McDonald, M., & Zeichner, K. (2005). How teachers learn and develop. In *Preparing teachers for a changing world: What teachers should learn and be able to do.* (pp. 358–389). San Francisco, CA:John Wiley.

Henriksen, D & Mishra, P. (2011). We teach who we are: Creativity and trans-disciplinary thinking in the practices of accomplished teachers. *Teachers College Record*, *117*(July), 1–46.

Holme, J. J. (2013). Exit strategies: How low-performing high schools respond to high school exit examination requirements. *Teachers College Record*, *115*(January 2013), 1–23.

Horn, I. S. (2008). Turnaround students in high school mathematics: Constructing identities of competence through mathematical worlds. *Mathematical Thinking and Learning*, *10*(3), 201–239.

Horn, I. S. (2007). Fast kids, slow kids, lazy Kids: Framing the mismatch problem in mathematics teachers' conversations. *Journal of the Learning Sciences*, *16*(1), 37–79.

Inzlicht, M., Aronson, J., Good, C., & McKay, L. (2006). A particular resiliency to threatening environments. *Journal of Experimental Social Psychology*, *42*(3), 323–336.

Inzlicht, M., & Good, C. (2006). How environments can threaten academic performance , self-knowledge , and sense of belonging. In S. Levin., & C. van Laar (Eds.), *Stigma and Group Inequality: Social Psychological Approaches*.Mahwah, NJ: Erlbaum.

Jaworski, B. (2006). Theory and practice in mathematics teaching development: Critical Iinquiry as a mode of learning in teaching. *Journal of Mathematics Teacher Education*, *9*(2), 187–211.

Jencks, C., & Phillips, M. (1998). The Black–White test score gap.Washington, DC: Brookings Institution Press.

Klopfenstein, K. (2005). Beyond test scores: The impact of black teacher role models on rigorous math taking. *Contemporary Economic Policy*, *23*(3), 416–428.

Kohl, H. (1992). I won't learn from you! Thoughts on the role of assent in learning. *Rethinking Schools*, *7*(1).

Ladson-Billings, G. (2006). From the achievement gap to the education debt: Understanding achievement in US schools. *Educational researcher*, *35*(7), 3-12.

Ladson-Billings, G. (1997). It doesn't add up: African American students ' mathematics achievement. *Journal for Research in Mathematics Education*, *28*(6), 697–708.
Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, *32*(3), 465–491.
Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.
Lesh, R., & Doerr, H. M. (2003). Foundations of a models and modeling perspective on mathematics teaching, learning, and problem solving. In R. A. Lesh., & H. M. Doerr (Eds.), *Beyond Constructivism: Models and Modeling Perspectives on Mathematics Problem Solving, Learning, and Teaching*. Mahwah, NJ: Elrbaum
Lichtenstein, S., & Fishhoff, B. (1977). Do those who know more also know more about how much they know? *Organizational Behavior and Human Performance*, *20*, 159–183.
Loveless, T. (2008). *The misplaced math student: Lost in eighth-grade algebra*. Special Report by the Brown Center on Education Policy.
Markus, H., & Nurius, P. (1986). Possible selves. *American Psychologist*, *41*(9), 954–969.
Martin, D. B. (2012). Learning Mathematics while Black. *Educational Foundations*, *26*, 47–66.
Martin, D. B. (2000). *Mathematics success and failure among African-American youth: The roles of sociohistorical context, community forces, school influence, and individual agency*. New Jersey: Lawrence Erlbaum Associates.
McCulloch, A. W. (2011). Affect and graphing calculator use. *The Journal of Mathematical Behavior*, *30*(2), 166–179.
McGrane, B. (2010). *All rise: The remarkable journey of Alan Page*. Chicago: Prologue Publishing Services, LLC.
Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd ed.). Thousand Oaks, CA: Sage Publications.
Moss-Racusin, C. A, Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. In S. Tilghman (Ed.), *Proceedings of the National Academy of Sciences of the United States of America*, *109*(41), 1–6.
Nasir, N. S., & Cooks, J. (2009). Becoming a Hurdler : How learning settings afford identities. *Anthropology & Education Quarterly*, *40*(1), 41–61.
National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. Reston, VA:Author.
National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA:Author
National Research Council (2001). *How people learn: Brain, mind, experience, and school*. J. KIlpatrick., J. Swafford., & B. Findell (Eds.), Mathematics Learning Study Committee. Washington, DC: National Academy Press.
National Research Council (2000). *How people learn: Brain, mind, experience, and school*. J. D. Bransford, A. L. Brown, & R. R. C. (Eds.), Committee on

Developments in the Science of Learning. Washington, DC: National Academy Press.
Nieto, S. (2003). *What keeps teachers going?*New York: Teachers College Press.
Noguera, P. A. (2014). Urban schools and the black male "Challenge." In H. R. Milner IV., & K. Lomotey (Eds.). *Handbook of Urban Education* (pp. 114-128). New York: Routledge.
Nomi, T., & Allensworth, E. M. (2012). Sorting and supporting: Why double-dose algebra led to better test scores but more course failures. *American Educational Research Journal*, *50*(4), 756–788.
Nunnally, J. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.
O'Dwyer, L. M., Wang, Y., & Shields, K. A. (2015). Teaching for conceptual understanding: A cross-national comparison of the relationship between teachers' instructional practices and student achievement in mathematics. *Large-Scale Assessments in Education*, *3*(1). 1-30.
Palardy, G. (2015). Classroom-based inequalities and achievement gaps in first grade : The role of classroom context and access to qualified and effective teachers. *Teachers College Record*, *117*(February), 1–48.
Patton, M. Q. (2002). *Qualitative interviewing. Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA.Sage Inc.
Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester (Ed.), *Second Handbook of Research on Mathematics Teaching and Learning* (pp. 257-315). Charlotte, NC: Information Age Publishing.
President's Council on Science and Technology. (2010). *Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future (Pre publication ed.).*
Rittle-Johnson, B., & Star, J. R. (2007). Does comparing solution methods facilitate conceptual and procedural knowledge? An experimental study on learning to solve equations. *Journal of Educational Psychology*, *99*(3), 561–574.
Robinson, R. J. (2014). *Examining the process of identification in the mathematics classroom and the role of students' academic communities. Unpublished dissertation submitted to the University of Tennessee*.
Schoenfeld, A. H. (2004). The math wars. *Educational Policy*, *18*(1), 253–286.
Setati, M., & Adler, J. (2000). Between languages and discourses: Language practices in primary multilingual mathematics classrooms in South Africa. *Educational Studies in Mathematics*, *43*, 243–269.
Sfard, A., & Prusak, A. (2005). Telling identities: In search of an analytic tool for investigating learning as a culturally shaped activity. *Educational Researcher*, *34*(4), 14–22.
Solomon, Y. J. (2007). Not belonging? What makes a functional learner identity in undergraduate mathematics? *Studies in Higher Education*, *32*(1), 79–96.
Star, J. R. (2005). Reconceptualizing procedural knowledge. *Journal for Research in Mathematics Education*, *107*(9), 404–411.

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and identity threat. *Advances in Experimental Social Psychology*, 34, 379–440.

Stentoft, D., & Valero, P. (2009). Identities-in-action. *Nordic Studies in Mathematics Education*, *14*(3), 55–77.

Stinson, D. W. (2013). Negotiating the "White male math myth": African American male students and success in school mathematics. *Journal for Research in Mathematics Education*, *44*(1), 69–99.

Varelas, M., Martin, D. B., & Kane, J. M. (2013). Content learning and identity construction: A framework to strengthen African American Students' mathematics and science learning in Urban Elementary Schools. *Human Development*, *55*(5-6), 319–339.

Wager, A. A. (2014). Noticing Children ' s Participation : Insights Into Teacher Positionality Toward Equitable Mathematics Pedagogy. *Journal for Research in Mathematics Education*, *45*(3), 312–350.

Walker, E. N. (2012). Cultivating mathematics identities in and out of school and in between. *Journal of Urban Mathematics Education*, *5*(1), 66–83.

Walker, E. N. (2006). Urban high school students' academic communities and their effects on mathematics success. *American Educational Research Journal*, *43*(1), 43–73.

Walker, L. H. M., & Syed, M. (2013). Integrating identities : Ethnic and academic identities among diverse college students. *Teachers College Record*, *115*(August 2013), 1–24.

Waxman, H. C & Padron, Y. N. (1995). Improving the quality of classroom instruction for students at risk of failure in urban schools. *Peabody Journal of Education*, *70*(2).

Weissglass, J. (2012). Listen first, then teach. *The Phi Delta Kappan*, *93*(6), 29–33.

Wenger, E.(1998). *Communities of practice: Learning, meaning, and identity*. New York: Cambridge University Press.

Wood, M. B. (2013). Mathematical micro-identities: Moment-to-moment positioning and learning in a fourth-grade classroom. *Journal for Research in Mathematics Education*, *44*(5), 775–808.

Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education*, *27*(4), 458–477.

Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist*, *47*(4), 302–314.

Yin, R. (2009). *Case study research: Design and methods* (4nd ed.). Thousand Oaks, CA: Sage Inc.

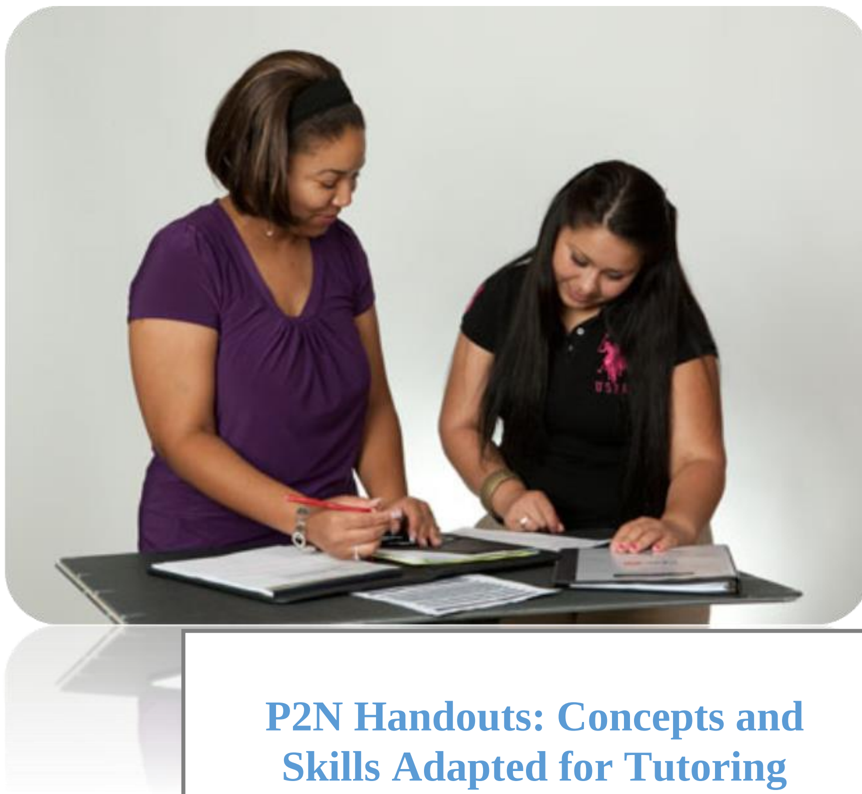
Walker, E. N. (2012). *Building mathematics learning communities: improving outcomes in urban high schools.* New York, NY, Teachers College Press.

Walshaw, M. (2004). Pre-service mathematics teaching in the context of schools: An exploration into the constitution of identity. *Journal of Mathematics Teacher*

Education, *7*(1), 63-86.

Appendix A

Prepare2Nspire Sample Training Material



P2N Handouts: Concepts and Skills Adapted for Tutoring

Guided Questions

The purpose of Guided Questions (GP) is to navigate subjects to new knowledge based on using existing information and resources. The method of GP is to use effective simple questioning to help facilitate cognitive association of information in order to find solutions, new ideals, and answers. There are two steps to GP: Essential Question and Open-ended questioning

Essential Question
The essential question is the primary statement that defines what needs to be resolved, concluded, or answered. It is usually associated to finding the ideal or value behind a given problem. It is very important to establish the essential question for the subject to know the foundation for the next part.
Example:
What needs to be solved?
Solve for X?
Complete the formula?
Add or subtract the following mixed numbers and simplify all fractions.
Word Problem Example:
Marcia needs to approve ¾ of the labels addressed by her staff. If the last batch was 950 labels, **how many does Marcia have to approve?** The essential question is the question in the problem, finding the exact number of labels to approve.

Open-ended Questioning (Apart of GQ)
This process is to generate appropriate questions based on the essential question; build upon what the knowledge base of the individual; and to best utilize the resources available. (notes, calculator, graph, database etc) The open-ended questioning has to extract information that cannot be necessarily answered with a yes or no.
Example: (using the word problem example above)
Essential Question: *How many labels does Marcia have to approve?*
Open-end Question:
What data/information do we have?
Explain or identify the denominator and numerator?
What is the whole number?
What do we know about finding a fraction of a whole number?
Which operation should we use?
Describe the method of the operation?

Conclusion: Guided Questions requires practice and is not easily adapted to every situation. To prepare, it’s good to make sure you find the essential question first. Next, developing or brainstorming the corresponding open-ended questions may take trial and error. Be patient and ready to retry new questions over and over until you see the subject gradually moving in the right direction. The open-ended questions should use what they know and the resources available. At the appropriate time, you will know when to infuse the right information and tools.

Learning styles

Think about the different ways you have been taught and how you learn best. In order to tutor most effectively, it is important to understand different learning styles and develop an awareness of your mentee's specific learning style. Here are some possibilities:

Visual Learner

- needs to see subject to understand it
- likes stories and descriptions
- uses mental pictures of events
- takes notes and is a list maker
- usually a quiet person
- usually become impatient when lengthy listening is required

Some teaching tips:
- use graphics, charts and diagrams
- provide written instructions

Auditory Learner

- needs to hear subject to understand it
- may have trouble reading or writing
- like to talk more than listen
- is easily distracted by sounds
- thinks in sounds

Some teaching tips:
- use tapes for reading and class notes
- have discussion or interviews

Kinesthetic Learner
- prefers hands-on learning
- has difficulty sitting still, fidgets
- remembers things that were done, not what was seen or heard
- learns better when physical activity is involved

Some teaching tips:
- make models, do lab work and role-playing

- take frequent breaks while studying
- use computers to aid in learning

Concepts of Healthy Engagement

The most important value to mentoring is nurturing and maintaining a healthy relationship that fosters support, care, and growth to an individual. Establishing a healthy relationship isn't difficult. However, there are 5 key concepts that research has proven to produce effective connections between adult and youth.

___ Name/Identity: Relationships start with knowing the individual and the first step is the name. The name is the door way to connecting your mentee's experience, culture, and character. It's important to remember the name of your mentee and become interested in who they are. It becomes the grounds to many healthy levels of communication and effective guidance.

___ Affirmation: Mentoring matches can be specific to a task, project, or generally be relationship focused. Research demonstrates that affirming skills, character development, or the completion of focused task fosters tighter bonds with mentees. Yet, affirmations are not just empty praises of nice words. To affirm the mentee, you must carefully observe the task, project, or character demonstrated. Once identified, evaluate with the mentee about their performance. Then lastly find the appropriate words to allow them to join you with their own kind words toward themselves. Affirmation allows you to guide the mentee toward their self-recognition of accomplishment and builds self-confidence.

___ Healthy Boundaries: To mentor is to know the appropriate function and space respected between mentee and the mentor. Mentors do not take the place of parents, siblings, guardian, or any familial bond. The mentor and agency has to place healthy and safety for the participants above all practice. Most importantly, both the mentor and mentee has to be made aware of what's expected out them during the match.

___ Relationship Building: Nurturing the connection requires commitment, dedication, professionalism, and time. Research indicates matches that had a high mentor commitment were more lasting and reported stronger bonds. Mentors who were dedicated to the connection during its challenging moments learned more about their mentees and produced better outcomes in the match. Research also indicates that mentees report more benefit with their mentors over time and they acknowledge higher levels of respect from their engagement.

___ Communication: Depending on the modality of the mentoring match, communication is a prominent factor to establishing a long lasting supportive relationship. Actively listening and engaging in health appropriate conversations helps mentees to feel understood. Several studies suggest that mentoring connections were well supportive and effective when mentees felt like they were listened too and engaged in their thinking from their mentors. Further, mentoring relationships become trustworthy when mentees believe that their mentors "understand me". Understanding is the outgrowth of empathy which arrives from careful intentional communication that over time strives to build a bridge into the mentees life.

Active Listening

Active listening is an attempt to truly understand the content and emotion of what the other person is saying. This skill requires mentors to notice verbal *and* non-verbal communication cues. The task is to focus, hear, respect, and communicate your desire to understand. This is not the time to be planning and/or delivering how “you” (mentor) feel.

Active listening is NOT: nagging, controlling, reminding, threatening, criticizing, advising, evaluating, probing, judging or ridiculing.

What skills are used?

1. Utilization of eye contact.
2. Body language including open and relaxed posture, forward lean, appropriate facial expressions, positive use of gestures, etc.
3. verbal cues such as "Um-hmmmm", "sure", "ah", "yes", etc.

What are the results of active listening?

1. Encourages honesty - helps people free themselves of troublesome feelings by expressing them openly.
2. Reduces fears - help people become less afraid of negative feelings.
3. Build respect and affection.
4. Increased acceptance - promotes a feeling of understanding.
5. The first step toward problem-solving - "negotiating from the heart".

When you actively listen, you cooperate in solving the problem and in preventing future problems.

Open ended question (Stand Alone Skill)

Intended to collect information by exploring feelings, attitudes and how the person views the situation. Open ended questions are extremely helpful when dealing with young people. Young, teenagers in particular, tend to answer questions with the least amount of words as possible. In order to maintain an active dialogue without interrogating, try to ask questions which cannot be answered with "yes", "no", "I don't know", or a grunt.

Examples:

"How do you see the situation?"
"What are your reasons for…?"
"Can you give me an example?"

"How does this affect you?"
"How did you decide that?"
"How do you feel about this?"
"What would you like to do about this?"
"What part did you play?"

Note: Using the question, "why did you do that?,” can invoke a defensive rather than a clarifying response.

Result:

Since open ended questions require a bit more time compared to close-ended questions, those which are answered by "yes ", "no", or a brief phrase, they give the person a chance to explain. Open ended questions yield significant information which can then be used to problem-solve.

Appendix B

Self-Reflection on Math Experiences (Adapted from Robinson, 2014)

Please take a moment to reflect on your mathematics learning experiences prior to joining P2N. This will help know how you felt about mathematics and the reasons for such experiences. Note that there are no right or wrong answers, your honest opinion is deeply appreciated.

1. Imagine a new student has transferred to your class. You want to tell him or her about a **typical day** in your mathematics class. Describe in detail what s/he can expect, from the moment the person enters the classroom, to the moment the bell rings to signal the end of class (Robinson, 2014).

2. How does the nature of activities described in the **typical class** (think back to question 1) compare to other math classes you have taken in school (Robinson, 2014)?

3. What does it take to be successful in mathematics (Robinson, 2014)?

4. Will you describe yourself as a mathematics person? Please explain your response. (Boaler, Wiliam, & Zevenberg, 2000)

Appendix C

Interview Guide (Questions Adapted from Robinson, 2014)

INSTRUCTIONS

Greetings to you! My name is Forster Ntow. Thank you for accepting to be interviewed. This study is being conducted as a result of my desire to find ways to improve mathematics learning outcomes for all students and also ways to help mathematics teachers improve on their practice. In answering this question, there are no right or wrong answers. You ae therefore encouraged to freely answer all questions to the best of your knowledge. You were selected as a possible participant because you are currently enrolled in *Prepare2Nspire* and therefore, in a position to offer relevant information for this study. You will be recorded only if you agree.

Please note that participation in this study is purely voluntary in nature and your decision to participate or not will not have any effect on you as a member of *Prepare2Nspire.* At any point in time that you want to withdraw from this study, you are free to do so.

Any questions you may have regarding this study can be addressed to my advisor, Dr. Lesa M Covington Clarkson, in the STEM Education Center at the University of Minnesota.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researchers, you **are encouraged to** contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

Competence (mentutees)

It is possible for some students to be better in one subject than in another. Considering the classes you are taking at the moment, if you were to rank these classes based upon performance, which one will be first, second, etc.? Explain?

If you were to categorize students in your class in terms of top, middle, and bottom groups based upon those who are good in mathematics, where would you place yourself?

Prior to joining P2N, what did you normally do when you encountered a new mathematical problem that you couldn't solve immediately? [Boaler, 2002a]

Understanding of Community Obligations (mentutees)

On a typical tutoring session on Mondays, describe in detail what a new person **should expect** from the moment the person joins this community until tutoring ends. (Robinson, 2014).

Describe the nature of math instruction in a typical **math class** in your school? How does the nature of math instruction in the **typical class** compare to how your undergrad tutors you in math (Robinson, 2014)? Probes: [a) How does your teacher expect you to learn math? b) How does your undergrad expect you to do math? c) Do you have to do that? Why is it so? Say more; e.g. any differences, similarities, etc.

Based upon how your undergrad expects you to learn math what will you tell a new 11th grader joins your community (P2N) to do in order to be successful in **learning math**?

Valuation of Community Obligations

1. Would you recommend your P2N community to a **new mentutee** (i.e. another 11th grader) based upon what your undergrad **expects you** to do in order to learn math? Why or why not?

2. Has your being in your assigned P2N community (i.e. working with your undergrad) led to any change(s) in how you see yourself in terms of ability to do math? [General probes: Can you tell me more? Tell me an experience/story related to that; e.g. improvement in math scores, understanding of math concepts, confidence in your math abilities, etc.]

3. Would you describe yourself as a math person based your participation in this P2N community? Why or why not?

Appendix D

Identity or Practice-linked Resources

Material Resources (Mentutees)

1. What materials do you consider to be important to being successful in mathematics, e.g. textbooks, calculators, internet, study environment? Why?

2. How important is it for you to get access to these materials**?** Do you have a fair access to these resources? Can you say more?

3.Looking back to your mathematics experiences in your school, are there any materials that you have access to by joining P2N which have been helpful to your learning of mathematics that you did not have previously?

Relational Resources

1. How important is it for you to form relationships with other mentutees and mentutor in your community? Why or why not? [Follow up: Do you feel a part of your community? Why or why not?]

2. If you do not understand a mathematics concept or have challenge solving a task, who in your community, do you typically ask for help (i.e. undergrad or other 11th graders)? Why?

3. Looking back to your mathematics experiences in your school, is there any benefit from having a community of learners by joining P2N which have been helpful to your learning of mathematics that you did not have previously?

Ideational Resources

1. How important is it for you to be good in mathematics? Why?

2. Based on your school math experiences, would you consider yourself as a math person? [Follow up: Say more]

3. What ideas have been communicated to you by your undergrad concerning your ability to do mathematics? Follow up: How does these ideas about whether you can or cannot do math compare with the ideas communicated to you by your math teacher?

4. Do you feel that your undergrad considers you to be good in mathematics? [Follow up: To be a math person?] Describe a conversation that occurred between you and your undergrad that illustrates that your undergrad believes in your math abilities?

5. What have you learned regarding what you are required to do in order to succeed in mathematics from your undergrad?

Appendix E

Undergrads Interview Guide (Adapted from Robinson, 2014)

INSTRUCTIONS

Greetings to you! My name is Forster Ntow. Thank you for accepting to be interviewed. This study is being conducted as a result of my desire to find ways to improve mathematics learning outcomes for all students and also ways to help mathematics teachers improve on their practice. In answering this question, there are no right or wrong answers. You are therefore encouraged to freely answer all questions to the best of your knowledge. You were selected as a possible participant because you are currently enrolled in *Prepare2Nspire* and therefore, in a position to offer relevant information for this study. You will be recorded only if you agree.

Please note that participation in this study is purely voluntary in nature and your decision to participate or not will not have any effect on you as a member of *Prepare2Nspire.* At any point in time that you want to withdraw from this study, you are free to do so.

Any questions you may have regarding this study can be addressed to my advisor, Dr. Lesa M Covington Clarkson, in the STEM Education Center at the University of Minnesota.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researchers, you **are encouraged to** contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

Part I (Math Experiences)

1. Kindly describe your mathematics learning experience (e.g. Geometry, Calculus, etc.) at:

a.) the high school (Grade 11) and ii) at the university (if they took math classes at college);

b) What is/was your 'best' math class?

i) What makes it your best math class? [Follow up, e.g. nature of math learned/taught, teacher characteristics, etc.]

d) What is/was your 'worst' math class?

i) What made it your 'worst' math class? [Follow up, e.g. nature of math learned/taught, teacher characteristics, etc.]

2. a) what did you normally do when you encountered a new mathematical problem that you couldn't solve immediately? [Boaler, 2002a]

b) How do/did you feel when it is/was time for mathematics lesson?

3. Based upon your school math experiences:

a) What do you think is the nature of math?

b) Would you consider yourself as a math person (i.e. good in math)?

Part II (Knowledge about P2N and Reason for Joining)

1. What you think is the purpose of P2N?

2. What informed your decision to enroll in P2N? a) What were you hoping for personally?

b) What were your expectations for your 11th grader (mentutees)? [Follow up: How does own math experiences inform these expectation]

3. It is possible that your 11th graders have varying mathematical abilities. If you were to rank them after the first few weeks of them being in your community, who will be first, second, third, etc. based upon their math abilities? Explain.

Part III. Understanding of Community Obligations (mentutees)

1. On a typical tutoring session on Mondays, describe in detail what a new 11th grader **should expect** from the moment the person joins your community until tutoring ends. (Robinson, 2014).

2. Describe how you tutor your 11th graders on a typical **math tutoring session**? In which ways does how you tutor compare to how you were taught math (Robinson, 2014)? Say more; e.g. any differences, similarities, etc. Probes: [a) Is that how you expect the 11th graders to learn math? Why is it so?

Part IV. Valuation of Community Obligations

1. Do you see your 11th graders either accepting/rejecting your views about how math should be learned? Say more.

2. Do you see any changes in how your 11th graders;

a) Approach math tasks or learn math based upon their being in your community? Think back to when you started tutoring them and how they learned math.

b) In their view about their mathematical abilities **(**Tell me a story related to that; e.g. improvement in math scores, understanding of math concepts, confidence in your math abilities, etc.)

Part V. Identity or Practice-linked Resources

Material Resources (Mentutees)

1. What kinds of resources do you make available to or make use in order to help your 11^{th} graders learn math; e.g. textbooks, calculators, internet, study environment? Why?

2) Who has access to these resources in your community? [Follow up: Do they all have equal access to them?]

Ideational Resources

1. How important do you think math is to your 1th graders? Say more?

2. What do you tell your 11^{th} graders when they are faced with a challenging math problem? [Follow up: Describe a conversation that occurred between you and your 11^{th} grader that illustrates what you typically say in such situations?]

3. What do you normally tell them regarding;

a) Nature of mathematics?

b) What it takes to be good in math? [Follow up: How math should be learned in order to be successful, who can/cannot do math?]

Appendix F

Mathematics Identity Survey (Adapted from Aschbacher, Li, & Roth, 2009)

Circle where appropriate

Grade: 11 Name_______________________________________

You are kindly requested to complete the following statements to the best of your abilities. There are no right or wrong answers and your honest responses are very much appreciated.

A. For each of the following statements, select **Strongly Agree = SA, Agree somewhat = A, Disagree somewhat = D, or Strongly Disagree = SD**

STATEMENT	Strongly Agree	Agree somewhat	Disagree somewhat	Strongly Disagree
Math is interesting to me	SA	A	D	SD
I see myself as a math person	SA	A	D	SD
Mathematicians have a chance to make a difference in the world	SA	A	D	SD
Mathematicians spend most of their time working by themselves	SA	A	D	SD
Mathematicians spend most of their time working indoors	SA	A	D	SD
Good mathematicians don't look like me	SA	A	D	SD
The media (television, movies, etc.) make math seem fun to learn	SA	A	D	SD

B. What is your **BEST GUESS** as to how you are doing in **All** of your classes so far this year? Circle only One.

Mostly A's	Mostly B's and C's
Mostly A's and B's	Mostly C's
Mostly B's	Mostly below C's
A mix A's, B's, and C's	

C. What is your **BEST GUESS** as to how you are doing in **All** of your math classes so far this year? Circle only One.

A B C Below C I am not taking Math this year

D. How many math classes are you enrolled in this year?

None One More than one

If you are enrolled in a math class, please list all classes

____

E. For your math class this year, how **often** do you (tick where appropriate)

Statement	**Always**	**Most of the time**	**Sometimes**	**Never**	**N.A**
Do the homework for this class					
Do work for extra credit					
Participate in class discussions					
Ask questions in class					
Make up work when you miss class					

Feel bored in class

F. For your math class this year, how much do you **agree** or **disagree** with the following statement

STATEMENT	**Strongly Agree**	**Agree somewhat**	**Disagree somewhat**	**Strongly Disagree**
My teacher thinks I could be good in mathematics	SA	A	D	SD
I enjoy learning math this year	SA	A	D	SD
My teacher cares if I think math is interesting	SA	A	D	SD
You need to have special abilities in math to well in this class	SA	A	D	SD
It is important to me that my math teacher believes in me	SA	A	D	SD
My math teacher has high expectations for me	SA	A	D	SD
In this math class, I am learning how math applies to real life	SA	A	D	SD
Doing well in this math class is important for my future career goals	SA	A	D	SD
My math teacher seems to enjoy teaching the subject	SA	A	D	SD
In this math class, we talk about what everyday mathematicians do	SA	A	D	SD
My current math teacher makes math	SA	A	D	SD

exciting to learn				
I had a math teacher who made me **not** like math	SA	A	D	SD

G. By the time you graduate from **high school**, what's your **BEST GUESS** as to how many semesters of the following you would have completed?

S/N	Statement	None	1-2	3-4	5-6	7-8	≥9	I don't know
1	**Science** in high school							
2	**Math** in high school							

By the time you graduate from **College**, what's your **BEST GUESS** as to how many semesters of the following you would have completed?

S/N	Statement	None	1-2	3-4	5-6	7-8	≥9	I don't know
1	**Science** in college							
2	**Math** in college							

H. How interested would you be in having a job where you would do the following activities? (Tick where appropriate)

S/N	Statement	Very interested	Fairly interested	A little interested	Not interested
1	Design, invent, or develop new products or tools				
2	Spend a lot of time and energy on a problem until you solve it				
3	Discover new things that help the environment or people's health				
4	Teach other students math at middle or high school				
5	Analyze data to draw conclusions				

I. How much do you **agree** or **disagree** with the following statement about **your math experiences in your school so far?**

Statement	Strongly Agree	Agree somewhat	Disagree somewhat	Strongly Disagree
During class, I like to share my ideas with other friends	SA	A	D	SD
I like classes that are easy for me more than classes that challenge me	SA	A	D	SD
When an assignment turns out to be harder than I expected, I usually don't complete it	SA	A	D	SD

If I'm in a class that is not right for me, I can get switched to another one	SA	A	D	SD
I feel comfortable asking my math teacher to explain ideas that are unclear	SA	A	D	SD
I am free to take any math class I want	SA	A	D	SD
I like it when my classmates critique my work	SA	A	D	SD

Appendix G

Sample Warm Up Worksheets

Name: Community Name: Date:

Combinations (pages 197 to 199)

1. At the school cafeteria, students can choose from 3 different salads, 5 different main dishes, and 2 different desserts. If Isabel chooses one salad, one main dish, and one dessert for lunch, how many different lunches could she choose?

2. At the school cafeteria, 2 boys and 4 girls are forming a lunch line. If the boys mush stand in the first and last places in line, how many different lines can be formed?

3. Elias has to select one shirt, one pair of pants, and one pair of shoes. If he selects at random from his 8 shirts, 4 pairs of pants, and 3 pairs of shoes, and all his shirts, pants, and shoes are different colors, what is the likelihood that he will select his red shirt, black pants, and brown shoes?

4. In the word HAWKS, how many ways is it possible to rearrange the letters if none repeat and the letter W must go last?

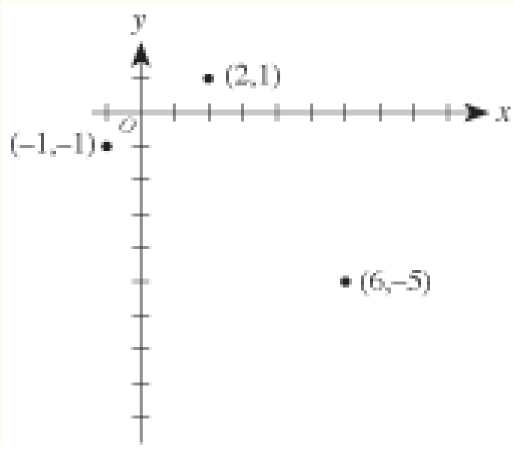
Name: **Community Name:** **Date:**

Mixed Review

1. When $x = 3$ and $y = 5$, by how much does the value of $3x^2 - 2y$ exceed the value of $2x^2 - 3y$?

2. The length, in inches, of a box is 3 inches less than twice its width, in inches. What is the length, l inches, in terms of the width, w inches, of the box?

3. In the standard (x, y) coordinate plane below, 3 of the vertices of a rectangle are shown. What is the 4th vertex of the rectangle?



Name: Community Name: Date:

March 2 Check Point: Circles, Ellipses, and Parabolas; and Trigonometry

1. If the equation $x^2 = 9 - y^2$ were graphed in the standard (x, y) coordinate plane, the graph would represent what kind of geometric figures?

2. What is the center point and radius of circle O, represented by the equation $(x - 4)^2 + (y + 5)^2 = 16$?

3. Given a right triangle ABC with hypotenuse AB = 10, AC = 3, and let angle A be θ, find cos θ.

4. If the secant of angle θ is 1/2, then the cosine of angle θ is….

5. Write the equation of the line that is parallel to $y = (2/3)x + 2$

6. What is the slope of the line parallel to the line $2x + 3y = 5$?

Appendix H

Excerpts of Codes

Normative Identity (School)		Survey (MIS)	Interview/Observation
General Classroom Obligation	Phase 1	**If we had homework that night**, **we give the teacher the homework** questions, and she goes through it, and answers the questions we had	
	Phase 2	**Every day you will receive a warm up** on the board from the teacher. After about 10 minutes, teacher will help and clarify questions as a group	**For my school** it is more notes.
	Phase 3		**When the bell rings**

		When **teaching begins** we will learn a lot in a short time. It is usually dense material **Then we have notes** **Then comes examples**. For the rest of the class, we practice the curriculum. **Then we work** on a few problems related to that topic	**the teacher starts the lesson**. Usually when **we finish the notes,** we would get like 10 to 20 minutes to work on **practice problems in the book**
Type of Agency	Disciplinary agency (*relying on established*	We learn by section and topic, so based on a problem, I would be like okay	**If you had an equation like this you would solve it this way**

	procedures or methods to solve tasks)	**since we are learning this section, e.g. quadratics, I will look at the problem and I will be like okay how is this problem related to quadratics and know what I am supposed to solve for**	I probably try to **look at my notes** and when that doesn't work I just like ask for help from a peer or somebody
	Conceptual Agency *(giving students opportunities to choose their own methods/procedures, how and why something works)*	It is vital to **understand** the basics. Math is also reliant on the **ability to make connections and discover patterns**	It would always be notes, notes, and more notes but this algebra 2 teacher it's like you take notes but **you understand the material that she is teaching**. She gives us **little activities** in

			between the notes that makes us understand it.
	Distribution of Authority (*mostly to teacher or other sources)*	**She'll (the teacher) will point out** tricky questions **All you have to do** is listen and take notes	I usually try to find people that know how you do these kinds of problems because **there is no use me trying to figure it out if I don't know the basics**. I will try my way to solve it. Then I will call her and ask if this is the way to do it and if she says no then I will do it the way she did it.
	Specifically Mathematical Obligation (*What counts*	Practice, practice, Practice, practice. **If you aren't practicing, you**	I enjoy math. **I can think quickly** in math. I learn it easily. **I rarely get confused**.

	as mathematical competence)	**should be practicing.**	Well my teacher is having us **memorize the trig identities** …it's an all or nothing test so we have to memorize them and know how to prove them. I **am fortunate to catch on to math concepts pretty fast**, and **my memory is pretty good**. **I also genuinely love learning math and applying it**
General Tutoring Obligations (P2N)	Type of Agency Disciplinary		

	Conceptual		This is not me at all, it's all you. You know these things, you know how to do these things but you have to read what the question is about. If you keep reading the wrong the question, you'll keep getting the wrong answers. **Even if it says chapter 6 review, read the question because you never know what is in there.** She wants me to **understand what is happening and what is going on and how I**

			am solving my problems. **She doesn't want me to just put everything in my mind and try to memorize it.**
	Distribution of Authority		During this program and other things **I have gained different ways to solve problems.** I have gained more solutions. When I first came to P2N I would explain things in a really confusing way, I will make lots of mistakes when I was explained things and now it's like I'm more careful. **If you are able to**

			explain things better then you can interpret. You can learn it differently also.
Identity Resources (P2N)	Material Resources (curricular resources necessary for success, e.g. ACT study guide and calculator)		If I read over a problem and I don't know how to solve it, **the ACT book tells you, it's this answer because of these reasons** so I think that helps me build up my skills. You can graph on the calculator. If you plug in an equation into the graphing, **you can actually analyze it for intersections, you can analyze it for**

			maximum, minimums, and can see the actual table I have some friends they don't have any ACT practice book and the ACT is coming up pretty soon. I feel nervous for them because they have never been exposed to the actual learning of what's on **the ACT test. Also, the calculator we are using right now I think it's really a privilege.**
	Relational resources (*networks*		It's been really important having a group there to help

	mentutors form to support their learning)		you. **I can help the girl sitting right next to me when she doesn't understand her math and she can help me or he can help me**. The undergrads, Dr XXX, and the grad students **they are really inspiring**. I feel like kids don't really do well in math because they think it's hard; a lot of people hate math. **This just inspires me to do a lot more math and to love math more**
	Ideational Resource *(ideas about*		Before P2N I would say that I will not take a calculus class or

	what math is and what it takes to be successful in it)		those like really hard classes. **After P2N, I can see that everybody can do math**. You just need to **make sure you ask questions or trying hard**. Try to figure it out so that we can als**o learn from our mistakes.** Whenever someone would give up on a problem, she will be like '**no you can do this'** and she would make us more determined to do the problem

Personal Identities	Turnaround in Identities		**Definitely yes! I do see myself as a math person**. I just needed to understand the concepts… I never liked math and it was so hard for me to see myself doing something like that. Before P2N I used to be like ugh I hate math. After algebra 2, I am not going to take pre-calculus because for our school pre-calculus is an option. **But in P2N I was people challenging themselves so I am going to challenge myself too. Next year I'm taking pre-**

	No turnaround		**calculus.** Math isn't really that complicated. I am not going to let math break me down just because things are complicated you know. I just push myself towards higher math courses. **I am not a math person.** I get it that I need math for college and all that but in the future I am not going to have a job that has to do with math. I will probably follow my mom's footsteps and run a YWCA or something.