BELIEFS ABOUT EFFECTIVE INSTRUCTIONAL PRACTICES AMONG MIDDLE GRADES TEACHERS OF MATHEMATICS

by

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ABSTRACT

This study explores beliefs about effective mathematics instruction among middle grades teachers of mathematics. Using prior syntheses of research on instructional practices linked to students' mathematics achievement, the conceptual framework draws on features and strategies associated with Explicit Attention to Concepts (EAC) and Student Opportunities to Struggle (SOS). Data sources include mathematics teachers' self-reported priorities, comfort, and frequency of implementing EAC and SOS strategies, as well as the participants' teaching context and school demographics. Participants include 98 full-time Grades 6-8 mathematics teachers from 22 districts, and 34 schools in southwest and central Idaho. Findings include positive correlations among EAC and SOS beliefs, comfort, and frequency of implementation, as well as differences across school settings, years of experience, and number of distinct mathematics courses taught.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
EAC	Explicit Attention to Concepts
ELL	English Language Learner
ISAT	Idaho Standard Achievement Test
NAEP	National Assessment of Educational Progress
SOS	Student Opportunities to Struggle
ROOT	Researching Order of Teaching

CHAPTER 1: INTRODUCTION

Do you remember your first day of middle school? Were you scared, excited, indifferent? Many students have social and academic difficulties as they transition from elementary to middle school. They often find themselves among the younger group of students again, in a larger school, with multiple teachers instead of one, and entering the physical, social, and emotional development of adolescence. One noticeable change is how students perform academically. Math achievement in particular often declines dramatically when students reach the middle grades (NAEP, 2020). This decline can change the way students view themselves in relation to mathematics, and put them on a track for lower achievement through the rest of their schooling (West & Schwerdt, 2012).

There are many factors that contribute to academic struggles in the middle grades (defined as U.S. Grades 6-8 in this study) that educators may not be able to change. However, middle grades mathematics teachers play a pivotal role in their students' learning, and they can become more effective by using teaching strategies likely to boost student achievement (Williams, Haertel, Kirst et al., 2011). Best practices in education are always changing, and teachers can strive to keep up by learning the teaching methods that emerge from research into effective mathematics instruction. In particular, middle grades teachers can build on students' elementary mathematics understanding to help students develop flexible ways to use numbers, symbols and words to read and write their world with mathematics (Gutstein, 2006). Furthermore, if a teacher learns about an effective instructional practice, understands it, thinks it will benefit their students, and believes they are able to use it with their students, then the teacher may have more of a chance to implement it for improving students' mathematics achievement.

The purpose of this study is to learn more about middle grades mathematics teachers' self-reported teaching context, and their beliefs about instructional practices with robust research evidence for improving student mathematics achievement. Though it's been documented that teachers' beliefs about teaching methods can directly affect their students' learning (Stipek et al., 2001), this study aims to explore how teaching context and beliefs about effective instruction may be interrelated. In the context of the research setting and sample, the study addresses three questions

Q1. What are the teaching contexts of Grades 6-8 mathematics teachers?

Q2. How is teaching context related to the Grades 6-8 mathematics teachers' beliefs about effective instruction?

Q3. How are Grades 6-8 mathematics teachers' teaching contexts and beliefs about effective instruction related to the teachers' levels of comfort and frequency of implementing effective instruction?

CHAPTER 2: LITERATURE REVIEW

The research questions address relationships among teachers' instructional context and their beliefs about effective instruction in middle grades mathematics. To address those questions, it is helpful to consider related mathematics education research.

Effective Instruction in the Middle Grades

Researchers have found a number of special issues affecting teaching and learning in middle grades (AMLE, 2013). As students transition into middle school, becoming the youngest grade in a school negatively affects performance, and teachers may not have the tools necessary to deal with the academic and social emotional challenges associated with this grade level for many students (West & Schwerdt, 2012). As a result, experts recommend focusing on higher-order thinking and hands-on learning in order to improve both students' achievement and their ability to relate school to their everyday life, especially (Heller, Calderon, & Medrich, 2003, p. 3):

- Setting high academic expectations and creating a supportive climate of encouragement and extra time and help for students who need it;
- Engaging students in challenging, hands-on assignments that require them to practice new skills, that incorporate their interests, and that relate to life outside the school;

- Providing families with information about school and their student's progress, and encouraging discussions between parents and students about educational and career goals;
- Grouping students to help them connect what they are learning across the curriculum and linking them to a caring adult within the school;
- Coordinating curriculum, sharing data among schools that send and receive students, and preparing students for success in high school; and
- Assigning highly qualified teachers to every classroom.

The Role of Teaching in Middle Grades Mathematics

When the challenge of effectively teaching in the middle grades combines with the fact that mathematics has historically been a tough subject for students at every age, teaching middle grades mathematics can be doubly challenging. Unsurprisingly, large-scale assessments tend to show significant declines in the mathematics achievement of students between Grades 4 (40% of students), and Grade 8 (34% of students) (NAEP, 2017). In the research setting, Idaho’s standardized test (ISAT) scores show a steady decline in student achievement starting in Grade 6. At the same time, going back to 2014, ISAT scores show more students moving from proficient scores down to basic and below basic proficiency in Grade 6 and beyond. Researchers have found several factors that influence this decline in middle grades mathematics achievement, including school and community culture, lack of support for students’ varied learning trajectories, adolescent development (especially development of executive functioning), and poor alignment of curriculum, standards, and instructional methods (Pinter, 2016).

Despite all the issues affecting students' mathematics achievement in the middle grades, teachers play an important role. Research suggests that overall variation in student achievement may be explained up to 30% by teacher factors, second only to student factors - which account for about 50% of academic variation - and exceeding all other remaining identified factors combined (Hattie, 2003). Supporting students to reach a proficiency level in mathematics includes helping students to acquire and integrate multiple competencies, including conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Kilpatrick, Swafford, & Findell, 2001). A skilled teacher can support students to meet those challenges. When teachers use effective instructional practices that point students to concepts, they help them develop practices that go beyond memorizing, recall, and skill application. This allows students to develop different ways of reasoning through problems more effectively. Other instructional practices that allow students time to struggle and independently make sense of material can build sense-making skills, perseverance, and students' willingness to be challenged (Stipek et al., 2001).

Teacher Background and Experience

The ability of a teacher to improve students' mathematics achievement is often connected to their background and experience. Unsurprisingly, teachers with a certification in their subject tend to have higher student scores than those without that specialization (Darling-Hammond, 2000). Mathematics achievement has also been found to be greater among students whose teachers had a content major or minor in their subject as opposed to those who majored or minored in education, as well as among students with teachers who had five or more years of experience teaching mathematics (Greenberg et al., 2004). Monk (1994) also found a positive association between the number of undergraduate mathematics courses in a teacher's background and increased student achievement in mathematics. The specifics of a teachers' preparation can matter, too. Specific mathematics methods courses may have greater effects on student performance than other education classes (Darling-Hammond, 2000), and the positive effects of more teacher education coursework may be greater than broad undergraduate mathematics coursework (Monk, 1994). Though these patterns may change as researchers continue to investigate teacher education, it's reasonable to presume students with teachers who are taught up-to-date instructional practices and teaching methods may be better equipped to support students' achievement.

Teacher Beliefs

Beyond the ways in which teachers have been prepared for the classroom, what teachers believe about teaching and learning can affect their ability to support student learning. Teachers' beliefs about how students learn mathematics can impact their students' learning and achievement, especially when changes in beliefs can be translated to changes in classroom practices (Stipek et al., 2001). For instance, student anxiety about academic performance can be reduced when teachers focus more on effort, learning, and understanding, rather than right and wrong answers and speed. This creates an environment where students feel free to take risks, which in turn helps students learn concepts, supporting achievement.

Explicit Attention to Concepts and Student Opportunities to Struggle

As mathematics education has shifted to emphasizing students' conceptual understanding alongside procedural fluency, researchers have investigated teaching methods that are most likely to accompany students' development of conceptual knowledge. From synthesis of studies on effective instruction, Explicit Attention to Concepts (EAC) and Student Opportunities to Struggle (SOS) have emerged as common themes (Hiebert & Grouws, 2007). EAC is a cluster of instructional practices that focuses on surfacing concepts during instruction, emphasizing connections and making concepts explicit and public among students. SOS puts a focus on students being able to make sense of a problem, apply sustained mental effort, and engage with important mathematics.

Stein and colleagues (2017) observed that EAC and SOS practices combine to effectively explain relationships between instructional methods and student math achievement across a range of contexts and teaching systems. EAC in particular was found to be quite useful as it appeared across a variety of studies that used different research designs, were situated in different approaches to teaching (e.g., teacher- versus student-centered), and varied in terms of how concepts were developed (e.g., through discourse versus through specially designed materials).

Hiebert and Grouws' (2007) research on EAC led them to claim that students acquire conceptual understanding of mathematics best when teaching attends explicitly to mathematical concepts, based around the simple idea that "students learn what they have the best opportunity to learn" (p. 385). Across research into effective instruction, they came to the conclusion that when teaching attends explicitly and directly to the important conceptual issues, students are more likely to develop important conceptual understandings.

Research on SOS has shown that when teachers provide students with the opportunity to struggle to develop their own ideas before being directly taught the concepts, students can improve their problem solving skills (Schwartz et al., 2011). Stein (2007) warned that having too much struggle or not enough struggle for students can make SOS unproductive. Warschauer (2014) created a framework for productive struggle in middle school mathematics classrooms. This framework classifies different student struggles and how teachers should respond. When students need help getting started, working out a process, making sense of ideas, or addressing misconceptions and errors, there are specific recommended responses from teachers. For instance, teachers may find it helpful to give directed guidance (e.g. suggesting strategies, relating to simpler problems), probing guidance (e.g. offer ideas based on student thinking, ask for reasoning), or provide affordances (e.g. build on student thinking, ask for detailed explanations).

One interesting perspective on SOS ideas was outlined by Reiser (2002), who suggested scaffolding should be used for structure and supporting the process of student struggle, not just to lead students to completing a task. This shifts the purpose of a teacher's intervention from helping students to solve problems, to aiding students to become engaged as problem solvers. In particular, Reiser emphasized problematizing, which asks students to explain the conceptual importance of components and to make student thinking public. The emphasis on public discourse blends into EAC practices, which also underscores the idea that EAC and SOS instructional practices often go together.

Framework for Effective Instruction in the Research Setting

This research uses data from Researching Order of Teaching (ROOT), which is an NSF-funded research project designed to improve learning in grades 6-8 mathematics. The project addresses a need for mathematics achievement to increase in the middle grades by working to reinforce innovative and effective ways of teaching. Teachers work with colleagues and researchers to learn about modeling and problem-solving in grades 6-8 and to collaboratively develop and study effective instructional strategies and routines in their classrooms. Ultimately, ROOT's goals are to clearly describe effective ways to teach grades 6-8 modeling and problem solving, and to compare sequences of those instructional practices. ROOT takes place over four years, including three years of classroom "crossover" studies in which teachers compare two teaching routines by trying both instructional practices with two groups of their students. Research questions include qualitative and quantitative investigations of teacher beliefs and instructional practices that center around EAC and SOS practices, as well as how they affect student achievement. Each phase includes data gathered via video observations of EAC/SOS practices displayed by teachers, teacher belief surveys, teaching artifacts, and students' mathematics achievement. The ROOT project adopted the EAC and SOS theoretical framework by Hiebert and Grouws (2007), and staff have built a guide (Figure 1) to communicate these fundamental ideas for effective math instruction.

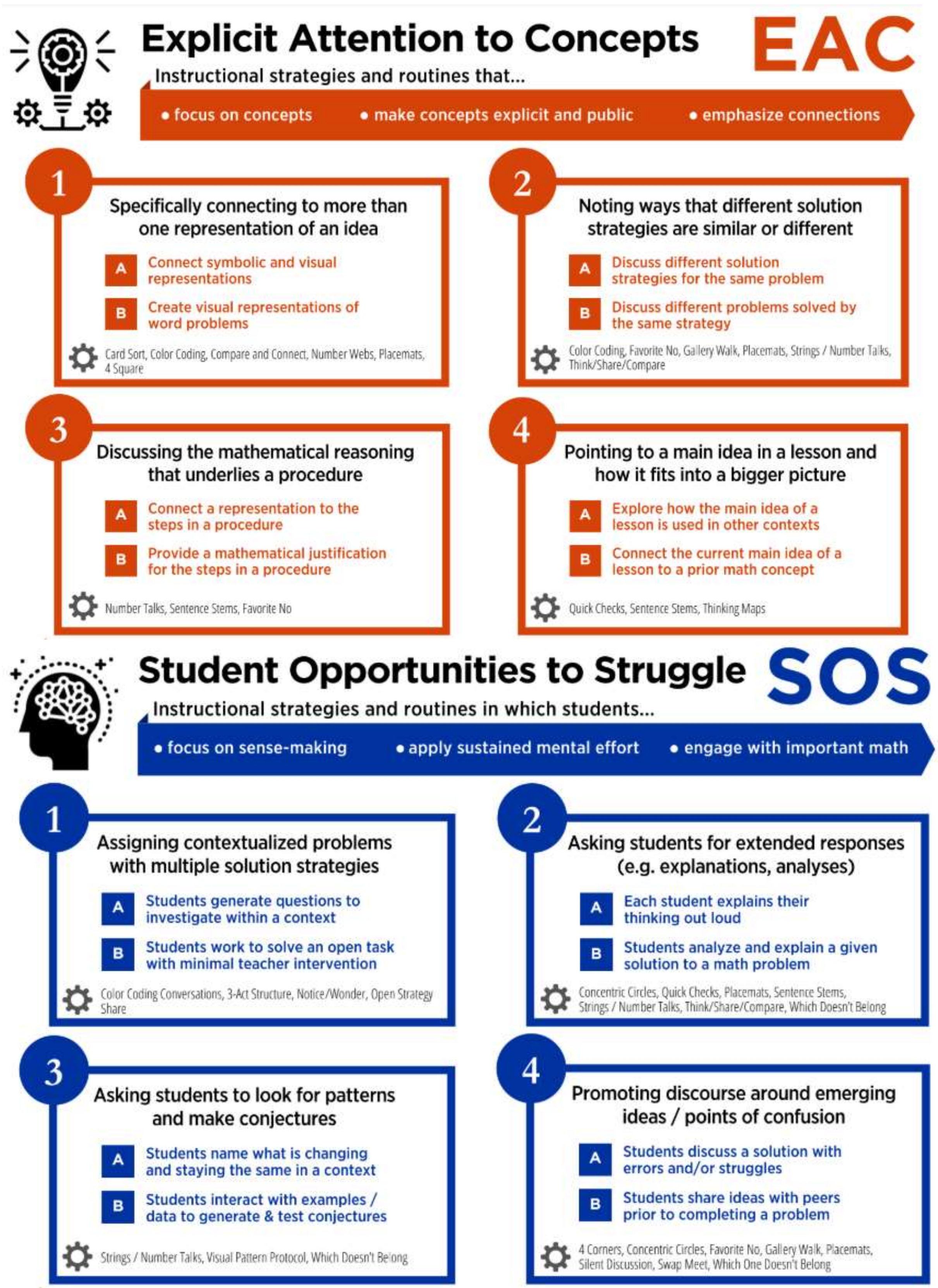

Figure 1. **EAC and SOS Instructional Guide in the ROOT project**

Relationships among Teaching Context, Beliefs, and Practices

In the prior sections of this literature review, I discussed a set of issues which have been separately identified by researchers as important factors for improving middle levels mathematics education. However, the factors are likely to be interrelated in complex ways. Nonetheless, we can use literature to inform the analysis of teachers' context, beliefs, and practices. For example, a teacher's years of experience may not necessarily be associated with where the teacher works, as years of experience appear to be evenly distributed across different community types such as rural and urban settings (NCES, 2012). On the other hand, Jackson, Gibbons, and Sharpe (2017) found that when teachers perceive their students to have academic deficiencies, they attribute it to their background such as family and community. In turn, teachers may use these assumptions to lower the cognitive demand of lessons, such as not allowing students to struggle or come up with answers or ideas of their own. In the following methods chapter, I outline some partial answers to the research questions in the form of hypotheses which are consistent with my review of the literature.

CHAPTER 3: METHODS

Sample

The participants in this study included 98 middle grades teachers from 22 districts, and 34 schools in southwest and central Idaho who volunteered to join the ROOT project. All the teachers worked full-time in public schools, many across multiple grades, including 49 who taught Grade 6, 44 who taught Grade 7, and 44 who taught Grade 8. Participants had a mean of 9.8 years (SD = 7.4, Range = 1 to 32) of teaching experience. A large majority (77%) self-identified as female (22% male, 1% non-identified). All had earned a bachelor's degree, including 57% for which this was their highest degree, 40% who held a master's degree, and 2% who held an Ed.S.

Data Sources

Prior to beginning their participation in the ROOT project, teachers completed an online Teaching Context survey (see Appendix for abridged survey). Items included questions about the courses they taught, school structure (e.g., 4 or 5 day instructional weeks), and their perceptions of external influences on their instruction, such as state or district assessments, standards, curriculum, future courses, and parental preferences. Other questions addressed the self-efficacy of teachers to teach modeling and problem solving, teachers' beliefs about math instruction, and how frequently they use EAC and SOS in their teaching practices. The survey ended with questions on each educators' demographics, including their gender, race/ethnicity, highest degree earned, type of teaching certification, and years of teaching experience. This survey data was augmented with public school demographic data from the state's accountability system, including rural status, percentage of low income students (i.e. federal eligibility for free/reduced lunch), and percentage of English Language Learners (ELLs).

For survey questions about teaching context, teachers indicated the degree to which they agreed with different influencers for what is taught in their math course (e.g. state content standards, state test results, students' special needs, parental preferences) on a 3-point ordinal scale (Little to No Influence, Moderate Influence, Strong Influence). The most common courses taught were Math 6, Math 7, Math 8, Accelerated Math 6, and Accelerated Math 7.

In addition, a composite EAC Beliefs scale was formed by averaging teachers' responses to 8 survey slider-based items regarding priorities in EAC-based statements about student achievement (e.g., "Students are more likely to succeed in math when they can (a) apply a particular method to solving similar math problems, vs (b) make connections among math topics.") Similarly, SOS Beliefs is a composite scale based on slider-based responses to 7 survey items about teachers' priorities in supporting student achievement through SOS (e.g., "Students learn more from math class when they can (a) watch a teacher solve a problem, try with their classmates, and then on their own vs (b) try to solve problem on their own, then with classmates, and then with help from the teacher.").

EAC Frequency is a composite scale based on teachers' self-reported estimates of how frequently their students engage in ten EAC-focused activities, such as "make connections between previous and new math topics", "make a visual representation of a math problem”, and “discuss the meaning behind a math procedure.” Similarly, SOS Frequency is a composite scale based on teachers’ self-reported estimates of how frequently their students engage in ten SOS-focused activities, such as “try problems on their own, then with classmates, and then with help from the teacher”, “solve tasks without immediately apparent solution strategies”, and “try a challenging problem before they learn and practice a procedure.”

Finally, during the first ROOT professional development meeting, teachers rated their level of comfort and frequency of implementing each of the eight strategies listed in the EAC/SOS guide. Specifically, Comfort-Frequency scores were formed by measuring teachers’ positioning of the eight EAC/SOS strategies on an *x*-*y* plane indicating their self-reported comfort with the respective strategies (*x* axis) and frequency in which they use the strategy in their teaching (*y* axis). The measurements are standardized to be between 0 and 1 (based on the limits of the *x*-*y* grid they created on paper).

Definitions of Variables

- *Teacher*, anonymized plant name to uniquely identify participants (e.g., “coneflower”)
- *Rural*, federal rural vs. non-rural classification (NCES, 2018-19) (dichotomous)
- *LowIncome*, percent of low-income students at the teacher’s school (SDE, 2018-19)
- *ELL*, percent of English Language Learners at the teacher’s school (SDE, 2018-19)
- *M6* / *M6A*, whether participant teaches regular / advanced Math 6 (dichotomous)
- *M7* / *M7A*, whether participant teaches regular / advanced Math 7 (dichotomous)

- *M8* / *M8A*, whether participant teaches regular / advanced Math 8 (dichotomous)
- *MAdv*, whether participant teaches any advanced course(s) (dichotomous)
- *MPreps*, number of different courses taught by participant (sum of M6 to M8A columns)
- *Experience*, number of years of teaching experience
- *Degree*, highest degree earned, collapsed to Bachelor's vs. Master's/EdS (dichotomous)
- *EAC_comf* / *SOS_comf*, mean comfort level for EAC / SOS strategies
- *EAC_beliefs* / *SOS_beliefs*, mean EAC / SOS forced response priority questions
- *EAC_freq* / *SOS_freq*, mean level frequency for EAC / SOS strategies
- *Inf_text_materials* / *Inf_state_tests* / *Inf_district_tests*, ordinal 3-point level of influence (low/medium/high) of textbook and materials / state assessments / district assessments on math instruction

Hypotheses

Based on the review of literature and data sources, the data analysis focused on eight hypotheses.

Q1. What are the teaching contexts of Grades 6-8 mathematics teachers?

H1.A. School context will be associated with experience and highest degree.

H1.B. Courses taught will be associated with preparation.

H1.C. Influences will differ by courses taught and preparation.

Q2. How is teaching context related to the Grades 6-8 mathematics teachers' beliefs about effective instruction?

H2.A. School context will be associated with EAC/SOS beliefs.

H2.B. Experience will be associated with EAC/SOS beliefs.

H2.C. Number of different courses taught will be negatively associated with EAC/SOS

beliefs.

Q3. How are Grades 6-8 mathematics teachers' teaching contexts and beliefs about effective instruction related to the teachers' levels of comfort and frequency of implementing effective instruction?

H3.A. EAC/SOS beliefs, comfort, and frequency will be positively correlated.

H3.B. EAC/SOS frequency will be negatively associated with the number of different courses taught.

Data Analysis

To address the association between experience and school context (H1.A.), I analyzed *Experience* and *Degree* as indicators of experience, as well as *ELL*, *LowIncome*, and *Rural* as indicators of school context. I measured the statistical significance of these by completing a chi-squared test to assess *Rural* effects and a one-way ANOVA to assess *ELL* and *LowIncome* effects. I used cross tabulations to summarize the reported influences on instruction by math course and school type. To address the association between courses taught and teachers' preparation (H1.B.), I analyzed the variables *Experience*, *Degree*, *MPreps*, *MAdv*, and each grade level variable (*M6*, *M6A*, *M7*, *M7A*, *M8*, *M8A*). I used cross-tabulations and mosaic plots to assess joint distributions, and measured potential differences using chi-squared tests. To address whether influences within education will differ by the courses taught and preparation of teachers (H1.C.), I used cross-tabulations and mosaic plots to describe joint distributions of *Inf_text_materials*, *Inf_state_tests*, *Inf_district_tests* with each grade level variable. I assessed the statistical significance of potential differences by completing a chi-squared test for each influencer variable by grade level.

To address the association between school context and EAC and SOS beliefs (H2.A.), I analyzed *EAC_beliefs*, *SOS_beliefs*, *Rural*, *LowIncome*, and *ELL*. To measure effects of the school context variables on EAC and SOS beliefs, I followed a standardized MANOVA procedure, which began with conducting summary statistics by each school context variable. I checked assumptions for MANOVA, including adequate sample sizes, lack of univariate or multivariate outliers, univariate normality assumption, and multicollinearity. I also checked the linearity assumption, the homogeneity of covariances assumption, and the homogeneity of variance assumption. I then completed the computation followed by post-hoc tests for differences between school context groups and EAC and SOS beliefs. To address the association between experience and EAC and SOS beliefs (H2.B.), I analyzed the variables *EAC_beliefs*, *SOS_beliefs*, *Experience*, and *Degree* using the same MANOVA procedure. To address the hypothesized effect of more preps on teachers' EAC and SOS beliefs (H2.C.), I analyzed the variables *EAC_beliefs*, *SOS_beliefs*, *MPreps*, and *MAdv* using the same MANOVA procedure.

To address correlations among EAC and SOS beliefs, comfort, and frequency (H3.A.), I analyzed the variables *EAC_beliefs*, *SOS_beliefs*, *EAC_comf*, *SOS_comf*, *EAC_freq*, and *SOS_freq*. I inspected both individual and joint distributions of each variable to evaluate normality assumptions, and then computed a matrix of correlations (specifically Pearson product-moment correlation), testing each pairwise correlation for statistical significance. To address the association between the number of teaching preps and EAC and SOS frequency (H3.B.), I analyzed the variables teacher, *EAC_freq*, *SOS_freq*, and *MPreps* using the MANOVA procedure.

CHAPTER 4: RESULTS

In the following sections, I present statistical findings for each hypothesis.

H1.A. School context will be associated with experience and highest degree.

Hypothesis not supported. Teachers' professional background was similar across indicators of school context. Cross-tabulations indicated that non-rural teachers may be slightly more likely to have a graduate degree (Figure 2), but the differences were not statistically significant ($\chi^2(1, 90) = .82$, $p = .36$). Similarly, there were no significant associations between other school variables and teachers' highest degree, including percentage of Low Income students ($F(1, 93) = .36$, $p = .55$) and ELLs ($F(1, 91) = 2.01$, $p = .16$) (Figure 3 for an example).

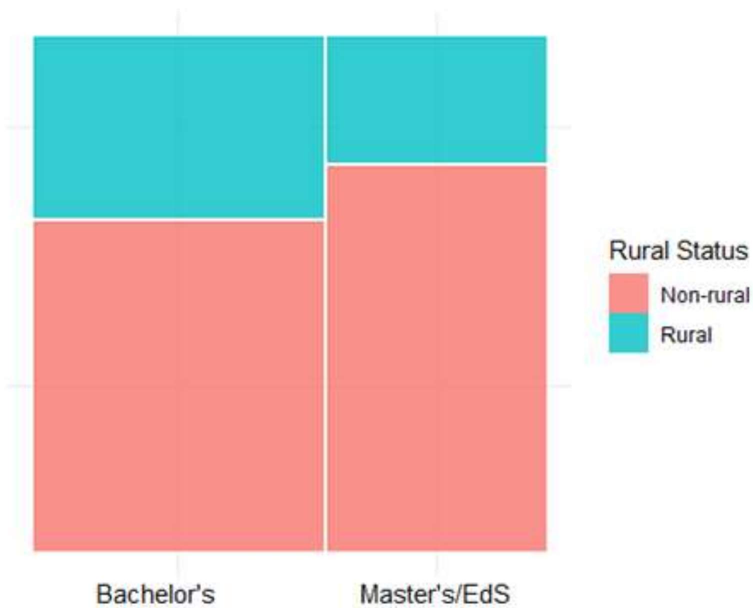

Figure 2. Joint distribution of teachers' rural status by highest degree.

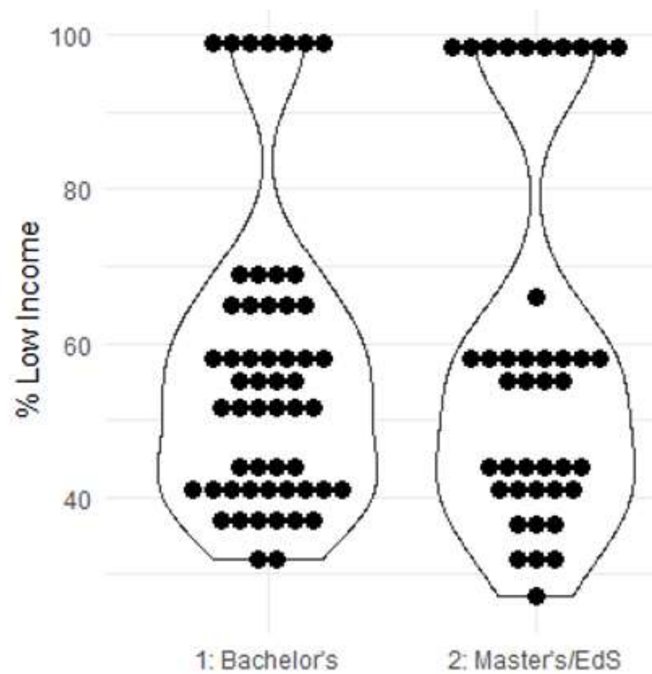

Figure 3. Distribution of percentage of low income students by participants' highest degree.

Teachers' years of experience was also not associated with school context. The observed correlations between experience and low income ($r(94) = .07$) and experience and ELL ($r(94) = .15$) were each not statistically significant. The statistical effects of experience and rural districts was also not statistically significant ($F(1, 94) = 1.66$, $p = .20$).

H1.B. Courses taught will be associated with preparation.

Hypothesis not supported. Participants who taught more than one type of mathematics course had similar degree distributions ($\chi^2(2, N= 94) = 1.97$, $p = .37$, Cramer's V = .14), and there was not an statistical effect of teaching experience ($F(2, 93) = .08$, $p = .92$). Cross-tabulations and mosaic plots for each type of mathematics course (regular and advanced) at each grade level were also very similar across the groups of teachers with bachelor's vs. master's/Ed.S. degrees, respectively. Additionally, participants who taught advanced courses had very similar degree distributions compared to those who didn't ($\chi^2(1, N= 94) = .04$, $p = .84$, Cramer's V = .02), and there was no observed effect of teaching experience ($F(1, 94) = .04$, $p = .83$).

H1.C. Influences will differ by courses taught and preparation.

Hypothesis partially supported. Participants who teach Advanced Math 7 reported lower influence of state math assessments on their instruction ($\chi^2(2, N= 90) = 12.7$, $p = .002$, Cramer's $V = .36$, see Figure 4). Participants who teach Advanced Math 8 teachers reported lower influence of curriculum on their instruction ($\chi^2(2, N= 90) = 2.83$, $p = .24$, Cramer's $V = .17$). However, there were no other statistical differences in teaching influences by courses taught, including the reported influence of district tests.

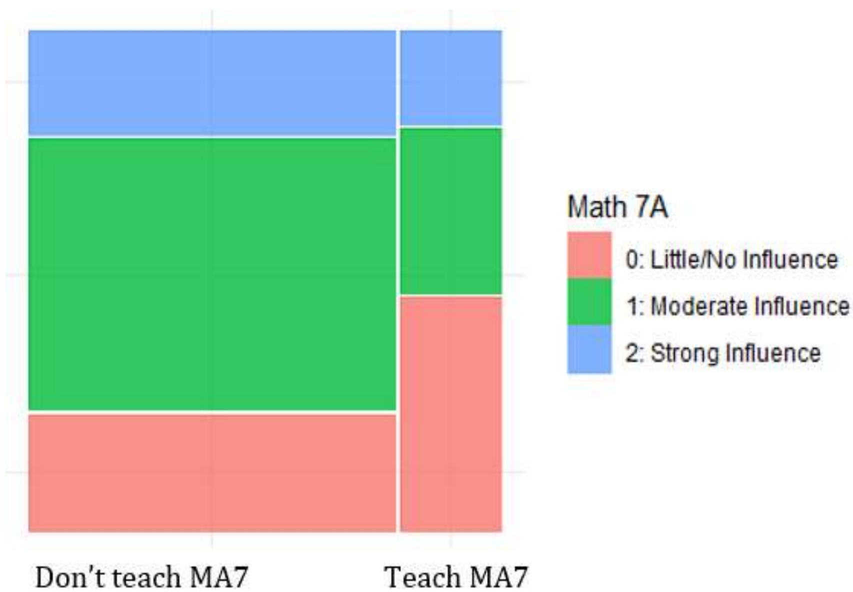

Figure 4. Joint distribution of influence of state math assessments by Advanced Math 7 teaching.

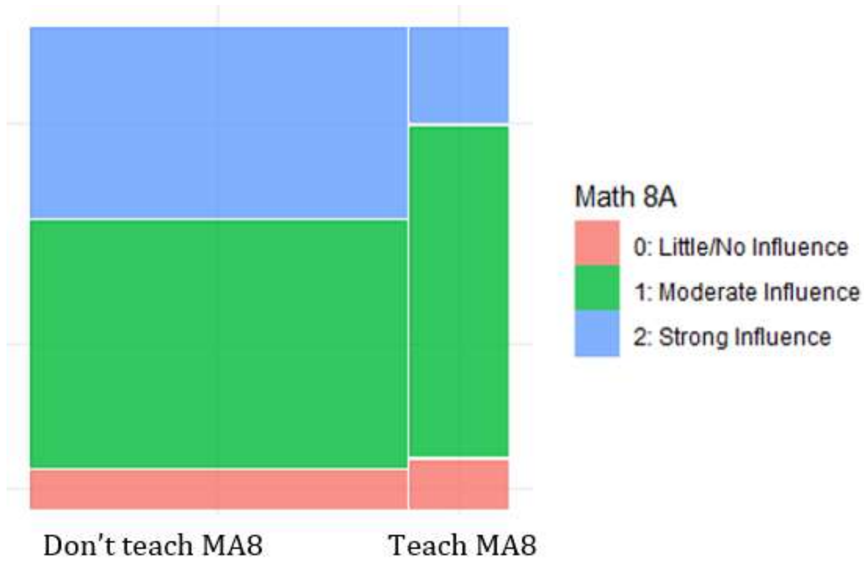

Figure 5. Joint distribution of influence of curriculum by Advanced Math 8 teaching.

H2.A. School context will be associated with EAC/SOS beliefs.

Hypothesis supported. As indicated by Figure 6, rural teachers reported lower EAC and SOS beliefs than non-rural teachers. Following a significant MANOVA global effect ($F(1, 90) = 5.10$, $p = .008$), post-hoc one-way ANOVA tests indicated small effects of rural status on both EAC beliefs ($F(1, 90) = 6.91$, $p < .01$, $\eta^2 = .05$) and SOS beliefs ($F(1, 90) = 8.90$, $p = .004$, $\eta^2 = .05$). The mean difference between EAC beliefs for rural and non-rural teachers was -0.36. The mean difference between SOS beliefs for rural and non-rural teachers was -0.54. There was not a significant effect of percentage of low income students on teachers' EAC beliefs ($F(1, 90) = .13$, $p = .72$, $\eta^2 = .001$) or SOS beliefs ($F(1, 90) = 4.03$, $p = .05$, $\eta^2 = .002$). Similarly, there was not a significant effect of percentage of ELLs on teachers' EAC beliefs ($F(1, 90) = 0.50$, $p = .48$, $\eta^2 = .005$) or SOS beliefs $F(1, 90) = 1.03$, $p = .31$, $\eta^2 = .01$).

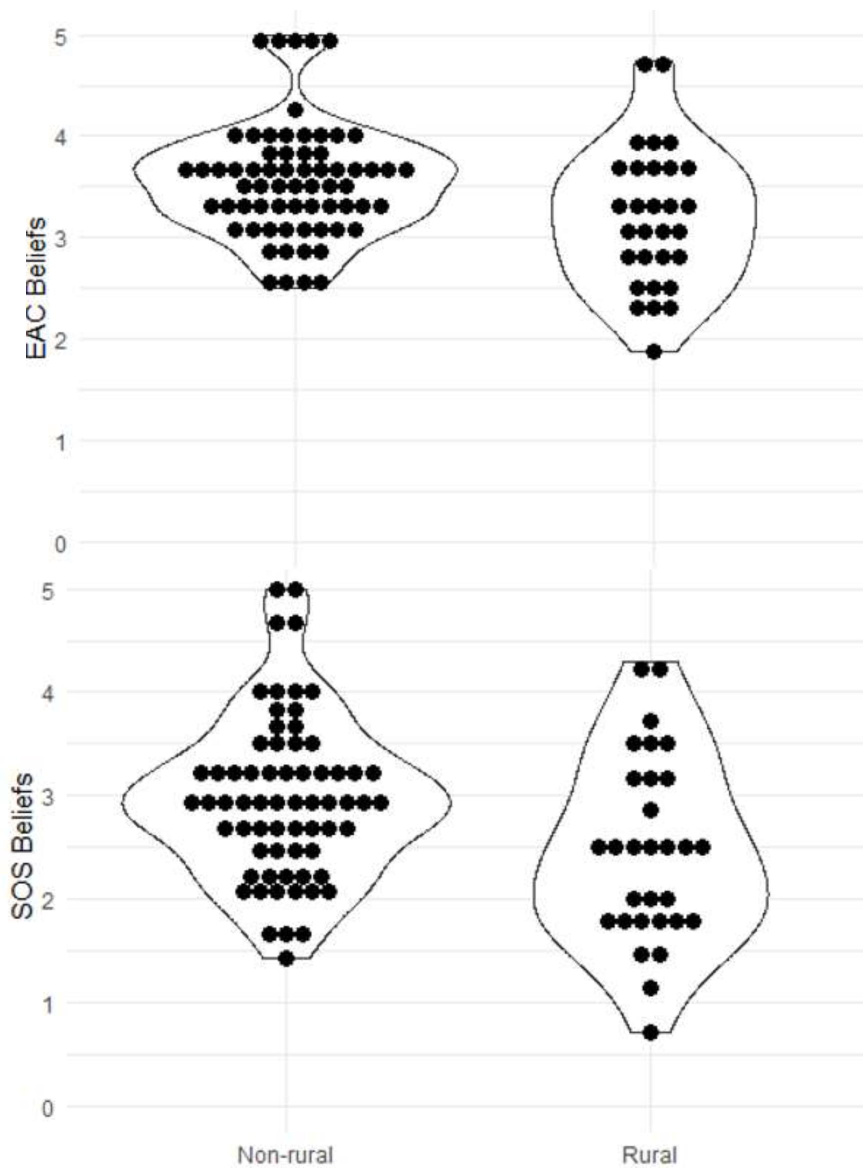

Figure 6. **EAC and SOS Beliefs by Rural Status.**

H2.B. Experience will be associated with EAC/SOS beliefs.

Hypothesis supported. As indicated by Figure 7, teachers with a graduate degree reported higher EAC and SOS beliefs. Following a significant global effect of highest degree via MANOVA ($F(1, 90) = 5.16$, $p = .008$), post-hoc one-way ANOVA tests indicated small effects of highest degree on both EAC beliefs ($F(1, 90) = 9.52$, $p < .003$, $\eta^2 = .08$) and SOS beliefs ($F(1, 90) = 6.50$, $p = .01$, $\eta^2 = .06$). The mean differences in

EAC beliefs between Bachelor's and Master's/EdS teachers was 0.39. The mean differences in SOS beliefs between Bachelor's and Master's/EdS teachers was 0.44. There was not a significant effect of years of teaching experience on either EAC beliefs (F(1, 90) = .88, p= .35, η^2 =.009) or SOS beliefs (F(1, 90) = .65, p = .42, η^2 =.007).

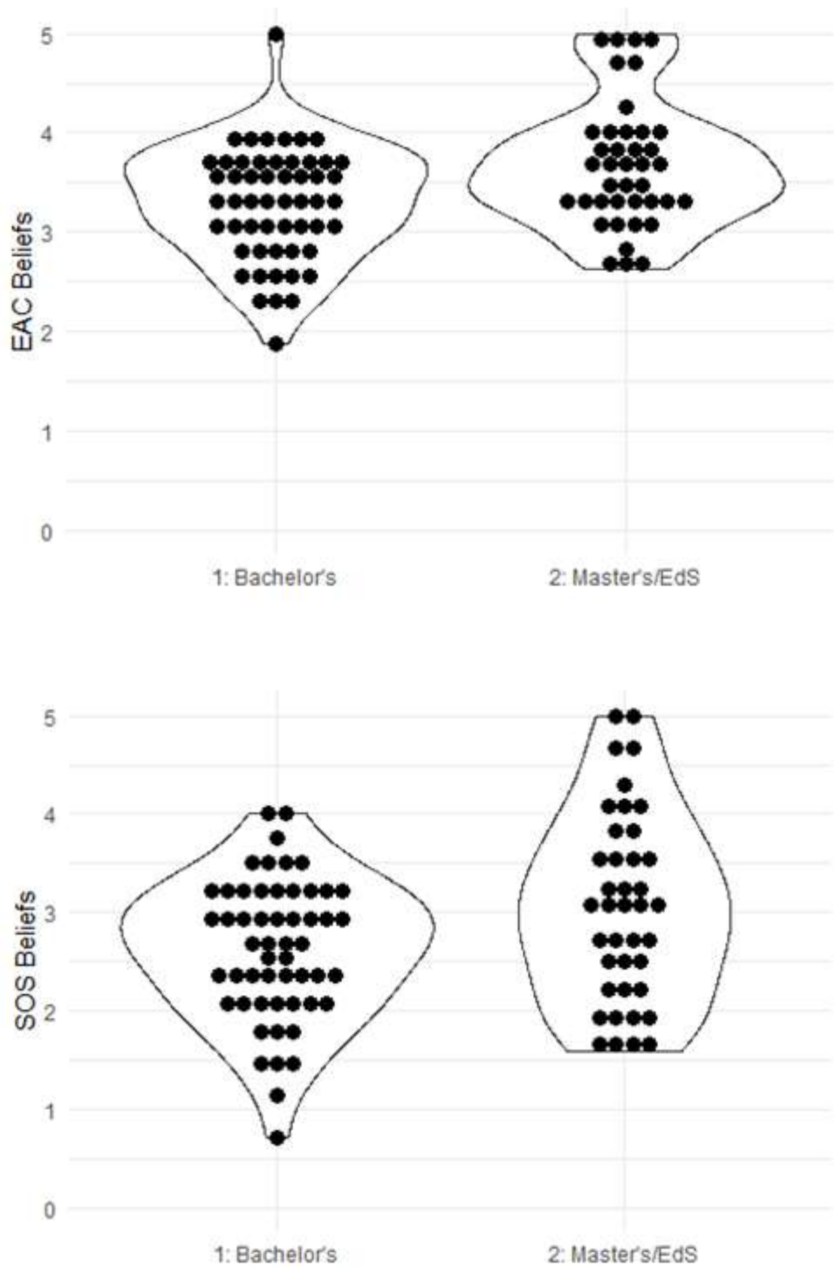

Figure 7. EAC and SOS Beliefs by Highest Degree Earned.

H2.C. Number of different courses taught will be negatively associated with EAC/SOS beliefs.

Hypothesis partially supported. As indicated by Figure 8, participants who teach more than one type of mathematics course reported lower SOS beliefs. Following a significant global effect of teaching more than one type of mathematics course via MANOVA ($F(2, 92) = 3.55$, $p = .008$), post-hoc one-way ANOVA tests indicated small effects of number of courses on SOS beliefs ($F(2, 92) = 3.82$, $p = .03$, $\eta^2 = .01$), but not EAC beliefs ($F(2, 92) = .71$, $p = .50$, $\eta^2 = .02$). The mean differences in SOS beliefs between teachers with more than one course and those with one course was 0.48.

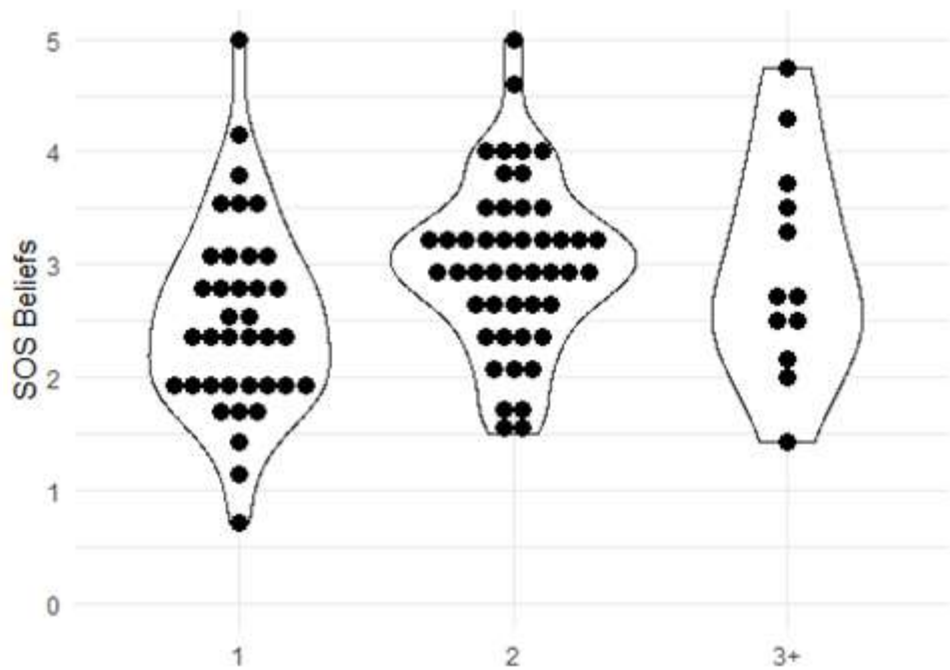

Figure 8. SOS Beliefs by Number of Different Mathematics Courses.

H3.A. EAC/SOS beliefs, comfort, and frequency will be positively correlated.

Hypothesis supported. There are positive correlations among the composite measures of EAC and SOS beliefs, comfort, and frequency of implementation. As shown in Figure 9, the greatest correlations were between EAC Beliefs and SOS Beliefs (*r*(90) = .63), as well as between EAC Frequency and SOS Frequency (*r*(90) = .60), and SOS Comfort and EAC Comfort (*r*(90) = .49). All of the observed pairwise correlations were positive, though the correlation between SOS Comfort and SOS Beliefs and the correlation between EAC Comfort and SOS Beliefs were statistically insignificant. Figure 10 illustrates the weak correlation between EAC Beliefs and EAC Comfort (*r*(90) = .23).

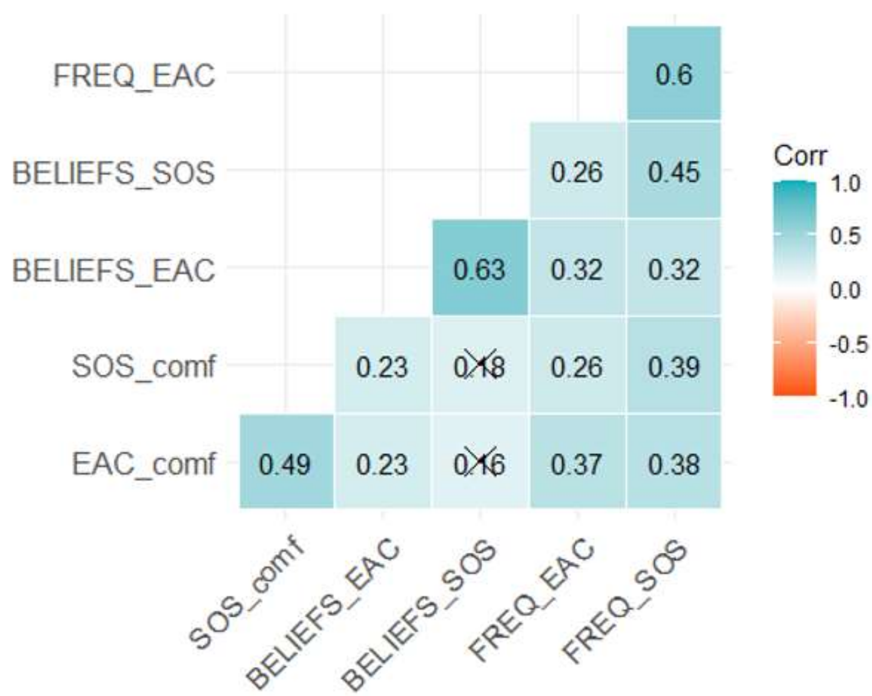

Figure 9. Pairwise correlations among EAC/SOS beliefs, comfort, and frequency. *Note*. Crossed-out correlations are statistically insignificant at $\alpha = 0.05$.

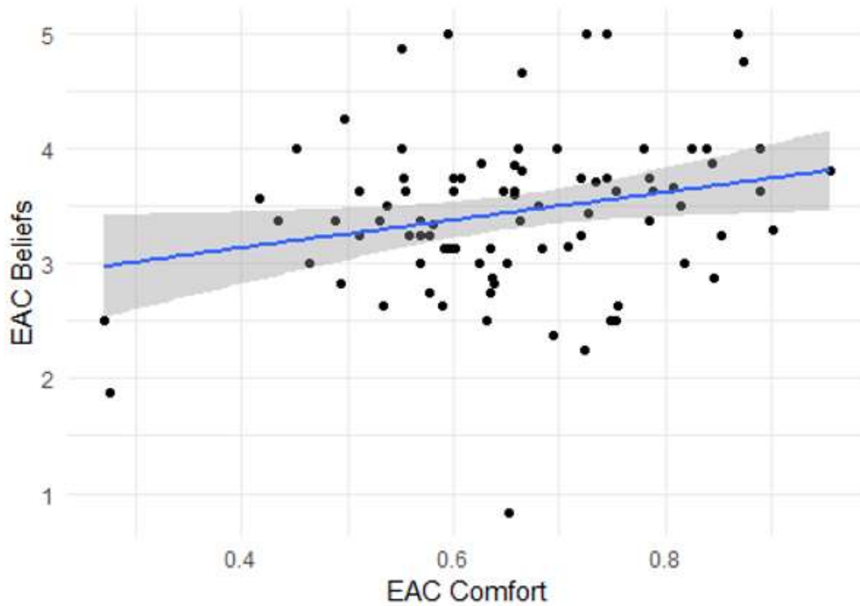

Figure 10. Scatterplot illustrating correlation between EAC beliefs and EAC comfort.

H3.B. EAC/SOS frequency will be negatively associated with the number of different courses taught.

Hypothesis not supported. There were no statistical differences between participants who teach 1, 2, or 3+ different types of mathematics courses in their reported EAC frequency (F(2, 93) = .52, p = .60, η^2 =.01) or SOS frequency (F(2, 83) = .44, p = .64, η^2 =.01). See Figure 11.

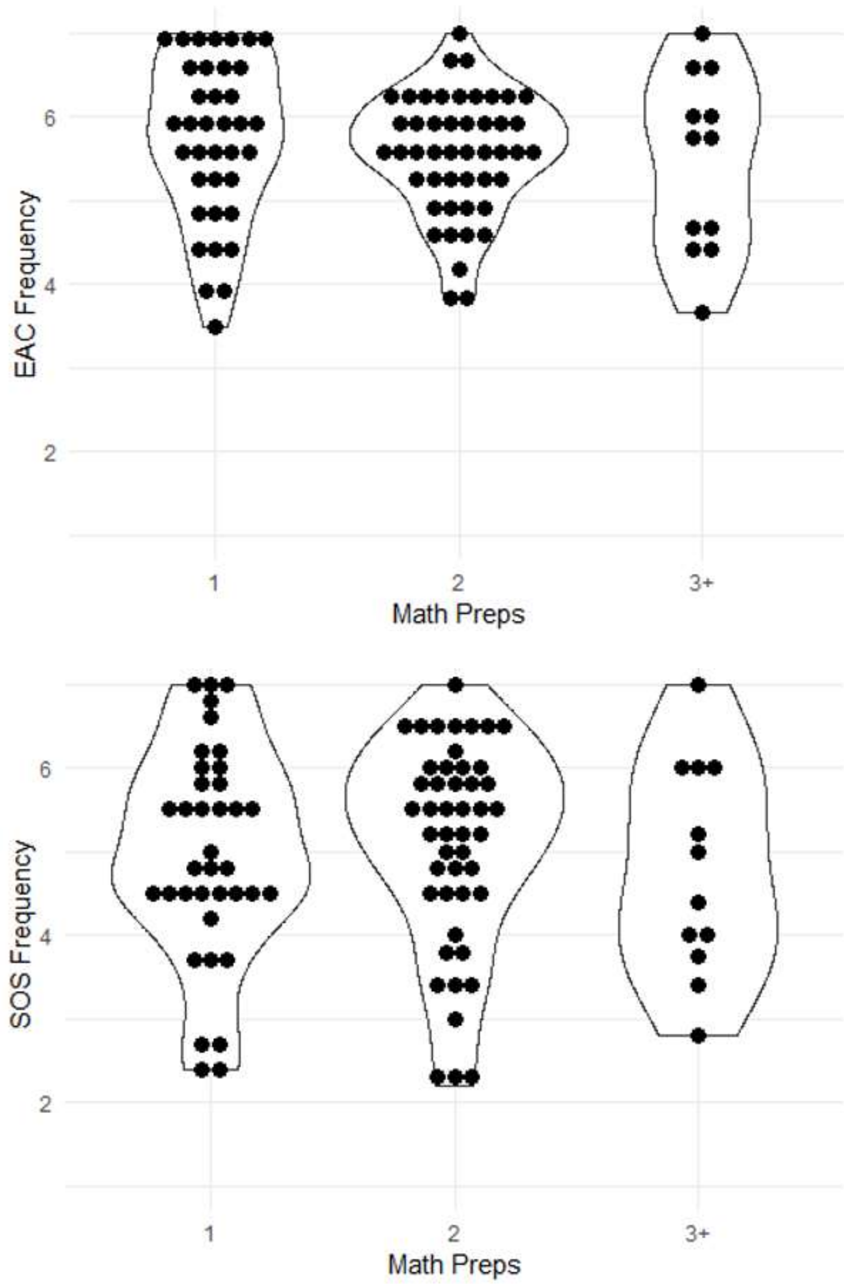

Figure 11. Distributions of EAC and SOS Frequency by number of different math courses taught.

CHAPTER 5: DISCUSSION

The purpose of this study was to learn more about middle grades mathematics teachers' self-reported teaching context, their beliefs about Explicit Attention to Concepts and Student Opportunities to Struggle instructional practices, and how those may be interrelated. I combined 98 teacher's responses to beliefs, comfort, and frequency prompts to indicators of the teachers' professional preparation, experience, and school context in order to test eight hypotheses based on my review of related literature.

Many of the findings highlight similarities among the 98 middle grades teachers in this study. Though the teachers are spread across 34 schools and 22 districts, I found similar levels of experience and professional preparation across indicators of school context, including rural status, percentage of ELLs, or percentage of students with low family income. Likewise, teachers with advanced degrees or more years of experience were approximately equally likely to teach advanced classes and more than one type of mathematics course. With few exceptions, teachers reported similar influence of state and district assessments and curricular materials, as well as similar implementation of EAC and SOS practices, regardless of the courses they teach. EAC and SOS beliefs were similar for teachers of regular and advanced content, as well teachers with varying percentages of ELL and low income students. Finally, I found that teachers who teach multiple types of courses do not use EAC or SOS practices more or less frequently than those who teach one type of math course.

The data suggest some statistical relationships too. Rural teachers placed lower prioritization on both EAC and SOS beliefs in their instruction than teachers in non-rural schools, and teachers holding a graduate degree reported greater prioritization of EAC and SOS beliefs than those with only a bachelor's degree. In addition, teachers responsible for teaching only one type of math course reported higher SOS beliefs (though not EAC) than those teaching multiple distinct courses. There was a strong positive correlation between teachers' EAC and SOS beliefs, as well as moderate correlations among composite scales of EAC and SOS comfort and frequency of implementation. Increases in any of these variables tended to coincide with increases in the others. However, the positive association was not statistically significant between teachers' SOS comfort and their SOS beliefs, as well as EAC comfort and EAC beliefs. Teachers who were more comfortable with these practices did not necessarily express stronger beliefs about them. Or put differently, it may be that teachers who hold strong beliefs about EAC or SOS practices do not necessarily feel comfortable using the strategies in their classroom.

Though several features of this study are original (e.g., no previous studies have examined whether school context is related to EAC and SOS beliefs or practices), the results are in line with related research. For example, West and Schwerdt (2012) also found little differences in teacher experience across different school contexts. Regardless of the demographic of students, teachers with several years of experience were spread out across indicators of school context, as well as teachers carrying a master's degree. Additionally, using different measures of teachers' EAC and SOS beliefs and practices, Stein et al. (2017) also found moderate positive correlations among the variables. Stein et al.'s study did not address potential differences across school context.

Implications for Middle Grades Mathematics Teaching

Although these results may differ for other sample populations (e.g., other regions or groups of teachers), the findings were very promising. It was encouraging to see such a wide range of experience of teachers across different districts. Regardless of whether a school is in a rural area or has a larger population of low income or ELL students, teachers with higher degrees and more experience do not appear to shy away from working in what some might assume are more challenging school settings. It was also surprising to note that higher educated teachers were not more likely to be teaching more advanced classes.

When observing the outcomes about teacher beliefs for EAC and SOS practices, it was noted that teachers teaching multiple courses rated their SOS beliefs lower. These teachers might be teaching intervention classes on top of their regular or advanced ones. It may be hard to let struggling students struggle, especially when it comes to students with a history of lower mathematics performance and who may already express lower motivation to engage with mathematics.

Limitations

Although this study included a relatively large group of teachers, it is important to recognize that the results are limited by the fact that this is just one study including only one sample of teachers in one region of one state. Participating teachers elected to join the 3-year project, potentially introducing sampling bias toward more committed and innovative teachers than the general population of educators. If this study were reproduced in another state or within a different project, results could be different. Another limitation to this study is that this was purely an observational study. All the relationships observed are simply statistical associations with no experimental intervention. Therefore, we cannot see if there are any cause-effect relationships.

Additionally, items on the survey administered to teachers may need to be further evaluated to ensure reliability and validity. The composite scales derived from the survey responses are limited to the quality of each survey item and were self-reported by teachers (though not included in this study, video data collected from the teachers' classrooms may help validate the survey responses). The patterns in survey responses about EAC and SOS strategies are merely statistical trends that do not help us understand why the pattern exists. Adding a qualitative study might be useful to investigate possible explanations and more details as to why these patterns occurred.

Future Research

To extend the findings of this study about association between school context and a teacher's beliefs about EAC and SOS practices, we can take this study a step further by looking at cause and effect relationships between school context, EAC/SOS beliefs, comfort and frequency, and incorporating student achievement. This way we can examine how much school context and teacher EAC and SOS beliefs, comfort, and frequency impact student achievement. There is also a lot to be learned about changing teacher perspectives. Can a professional development program or a specific curriculum influence teachers' EAC and SOS beliefs? In what ways? Studying possible approaches to educating teachers, and which modes of education lead teachers' beliefs to change, could lead to improving student achievement in the middle grades.

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APPENDIX.

Teaching Context Survey (Abridged)

For these items, please indicate the degree to which each of the following influences what you teach in your math courses.

	Not Applicable	Little to No Influence	Moderate Influence	Strong Influence
Your state's content standards	o	o	o	o
Your district's curriculum guidelines	o	o	o	o
Textbook or instructional materials	o	o	o	o
State tests or results from tests	o	o	o	o
District tests or results from tests	o	o	o	o
Students' special needs	o	o	o	o
Parental or community preferences	o	o	o	o
Preparation of students for the next grade or level	o	o	o	o

The following questions are focused on your beliefs about mathematics instruction.

Each item asks you to choose between two statements. Both have value, and you may believe both are important to your teaching. Nonetheless, we ask you to choose one over the other. That is, please position the slider to indicate which statement you believe has greater priority in terms of your perspective on teaching mathematics. The further you move the slider to one side or the other, the greater priority you give that statement.

Please take your time in responding to the survey items.

Students are more likely to succeed in math when they can:

Apply a particular method to solving similar math problems	Make connections among math topics

0 1 2 3 4 5

When a new math topic is introduced, teachers should help their students:

See relationship(s) between previous and new math topics	Learn and practice ways to solve problems in the topic

0 1 2 3 4 5

Prior to solving a challenging math problem, a teacher should ask students to:

Solve a related problem with a similar solution method	Make a representation of the problem

0 1 2 3 4 5

It is more important for students to:

Understand the meaning behind a math procedure	Be able to correctly perform a math procedure

0 1 2 3 4 5

Students learn better when they:

Find connections between two solution approaches to a problem						Learn one way to solve a problem at a time
	0	1	2	3	4	5

(+ 10 Additional Items)

The following questions are focused on the **frequency of your teaching practices**. There are 20 items in this section, 5 per page.

Thinking of your math instruction as a whole, approximately how often do your students engage in the following activities?

	Never	2–3 times/year	Once a month	2-3 times/ month	Once a week	2-3 times/week	Daily
Make connections between previous and new math topics	o	o	o	o	o	o	o
Make a visual representation of a math problem	o	o	o	o	o	o	o
Discuss the meaning behind a math procedure	o	o	o	o	o	o	o
Find connections between two solution approaches to a problem	o	o	o	o	o	o	o
Connect student reasoning to physical, visual, and symbolic representations	o	o	o	o	o	o	o

(+ 3 Additional Pages, 5 Items Each)

Please indicate your gender.

O Male

O Female

O Other/Prefer not to respond

Including this year, for how many years have you taught mathematics?

____

What is the highest degree you hold?

O BA or BS

O MA or MS

O Multiple MA or MS

O EdS

O PhD or EdD

O Other ____