PARENT WORKSHOPS FOCUSED ON MATHEMATICS KNOWLEDGE FOR PARENTING (MKP): SHIFTING BELIEFS ABOUT LEARNING MATHEMATICS

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The purpose of this study was to investigate the extent to which parents of first, second, and third grade students who attended a two-day workshop on mathematics strategies shifted beliefs about learning mathematics as compared to parents who did not attend the workshops. Parents impact their children's mathematics learning when the students are at home working on homework. This can be an important barrier to overcome. The results suggested parents could benefit from workshops focused on solving mathematics problems in multiple ways, similar to ways their children are learning mathematics.

Keywords: Affect, Emotions, Beliefs, and Attitudes, Classroom Discourse, Elementary School Education, Number Concepts and Operations

Introduction

Social media outlets indicate parents are frustrated with the way their children are learning mathematics, such as using multiple solution strategies to solve problems that seem to include unnecessary steps (Garland, 2014; Richards, 2014). This is important because when the children are at home, their parents often take on the role of teacher. Parents want to help their children with homework, but their own personal experiences with learning mathematics were likely procedural (Garland, 2014; Richards, 2014). The purpose of this study was to determine if completing a two-session workshop on mathematics pedagogy and content related to whole number concepts and operations shifted parents' beliefs about learning mathematics. Beliefs were measured by the abbreviated Mathematics Beliefs Scales (aMBS), created by Fennema, Carpenter, and Loef (1990) and later adapted by Capraro (2005). More specifically, the goal was to answer the following question: *To what extent do parents who attend a mathematics workshop on whole number concepts and operations differ, on average and over time, in their beliefs about learning mathematics as compared to parents who do not attend?*

Background

When an elementary-aged child asks his or her parent for help on homework, the parent thinks they should be able to help their child, but then they realize mathematics is being taught differently today than when they were in school (Richards, 2014). Some parents do not understand the justification behind why these new strategies are being used, and think they are a waste of time. Teachers have opportunities to gain a deeper understanding of the mathematics they are to teach through education classes or professional development, but parents may not have the same opportunities. By creating workshops that allow parents to work through the strategies their children use, this study investigated how those workshops influenced parents' beliefs about how students should learn mathematics. After all, parents are their children's teacher when the children are at home. Previous research findings from qualitative studies suggest that parents who participated in parent workshops felt like they (a) increased their content knowledge and improved their attitude towards mathematics (Knapp, Jefferson, & Landers, 2013), and (b) improved relationships between parents and their child (Kreinberg, 1989; Mistretta, 2013) and between parents and the school (Kreinberg, 1989). Although parents may not be confident when helping their child with mathematics homework before participating in the workshops, after participating in workshops parents were more

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confident with their mathematics ability when helping their child (Cotton, 2014; Kreinberg, 1989; Marshall & Swan, 2010).

The researcher proposes a connection between parents and preservice teachers (PSTs) due to the lack of quantitative research regarding shifts in beliefs and learning about mathematics by parents. The way PSTs think in terms of solving mathematics problems could be tangentially related to the way parents think about solving mathematics problems before participating in workshops. PSTs come to their education courses with experiences in learning mathematics procedurally, similar to parents. Having a productive disposition in mathematics includes being able to see mathematics as useful and worthwhile. Opportunities to help learners make sense of mathematics may influence their beliefs, especially when the beliefs are called into question. This shift is important because "changes in beliefs are assumed to reflect development" (Oliveria & Hannula, 2008, p. 14). Teachers can do this by solving problems in ways that call existing beliefs into question or by making mathematical discoveries on their own (Liljedahl, Rolka, & Rosken, 2007). Changing teachers' beliefs about mathematics can be difficult, however, because many preservice teachers think mathematics is about memorizing formulas and procedures (Szydlik, Szydlik, & Benson, 2003).

A person's beliefs evolve over time, and are influenced by his or her experiences (Op't Eynde, DeCorte, & Verschaffel, 2002). Richardson (2003) implied there were three different experiences that influenced beliefs: personal experiences, experiences in an instructional situation, and experiences with specific content knowledge. These beliefs shape how a person views different situations, one being the way children learn about mathematics (Richardson, 2003). Most parents of elementary grade students were taught mathematics in more teacher-centered classrooms, where the teacher was the one who determined whether or not the student had the correct answer (Garland, 2014; Richards, 2014). When most of these parents were elementary students they were not encouraged to work with their peers to find more than one solution strategy, but according to "best practice," classrooms today are more student-centered, where the teacher acts as a facilitator and the focus of instruction is on making sense of problems and solutions with lesser emphasis on judging correct answers (Ertmer & Newby, 2013).

Research Design

The current study used a quantitative, quasi-experimental, non-equivalent control group design. The research design was chosen because participants self-selected either the control or intervention groups. The control group included participants who were unable to attend the workshop, but still participated in testing. For both the control and intervention groups, all interactions were conducted face-to-face at the same school site. The school site allowed the researcher to set up a table during school hours to meet with participants in the control group. The control group attended two face-to-face meetings during a time convenient for them. During the first meeting participants completed pretests, and during the second meeting they completed posttests. The majority of control group participants completed pretests and posttests within a two-week period, similar to the time between pretest and posttest for the treatment group.

Parents or guardians of 1st, 2nd, and 3rd grade students at multiple neighboring public elementary schools in Central Florida were invited to participate. For the purpose of this research, "parents" will include any person who takes on that role. First, second, and third grades were chosen because this is when mathematics homework first represents strategies that are likely different from instruction most parents received when they were in elementary school (Garland, 2014; Richards, 2014). The sample was one of convenience, given the location of the participating schools was near the researcher's residence, and parents volunteered to participate.

The abbreviated Mathematics Beliefs Scales (aMBS) (Capraro, 2005), was used to measure parents' beliefs about learning mathematics. The aMBS, originally created by Fennema, Carpenter, and Loef (1990), was developed to measure the mathematical beliefs of teachers. Responses to

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questions were measured using a five point Likert scale, ranging from strongly agree to strongly disagree. The original aMBS had 48 items, and because researchers commented that participants complained about the length and repetitiveness of the instrument, an exploratory factor analysis was run on all 48 items (Capraro, 2001). The 18 questions that were chosen because of the analysis explained 46% of the variance and could be split into three factors with six items in each. The three factors were student learning, stages of learning, and teacher practices. One sample question in the student learning subscale is, "Children will not understand an operation (addition, subtraction, multiplication, or division) until they have mastered some of the relevant number facts" (Capraro, 2005, p. 86). One sample question in the stages of learning subscale is, "Children should understand computational procedures before they master them" (Capraro, 2005, p. 86). One sample question in the teacher practices subscale is, "Teachers should allow children to figure out their own ways to solve simple word problems" (Capraro, 2005, p. 87).

The treatment group participated in two workshop sessions created to help parents engage in learning mathematics in ways similar to their children, according to "best practice" such as encouraging students to come up with multiple strategies that would allow them to think flexibly about mathematics. The workshop was repeated a total of three times to allow for flexibility to allow more parents to participate. Each workshop was held for two hours, including the time spent on pretests and posttests, so participants in the treatment group were engaged in learning mathematics content for approximately 2.5 hours, as the other 1.5 hours were used for administrating tests. Pretest for the treatment group was administered at the beginning of the first day of the session, and posttests were administered at the end of the second day.

Following the pretest, participants were asked to solve the following problem, "*Andrea has 14 cookies. Jamie gave her some more. Now Andrea has 32 cookies. How many cookies did Jamie give Andrea?"* Participants were encouraged to use two different methods to solve this problem. Solving the problem using a second strategy was a difficult task initially. All participants solved by subtracting 14 from 32 using the standard algorithm and did not know how to solve using a second strategy. Through questioning techniques participants engaged in using drawings, concrete tools, and other computational strategies to solve problems. Participants made sense of base ten blocks, ten frames, the hundred chart, and an open number line. Then, participants were given another problem. After participants tried to solve a problem on their own using at least two different strategies, they shared their strategies with a partner, and tried to made sense of the different strategies. Participants used the tool that made the most sense to them, and, after sharing with a partner, they had a better understanding of other strategies. The researcher chose the order in which participants shared their strategies from more concrete to more abstract, to help them make connections between the different strategies. Then, possible student errors were discussed, first with a partner then with the whole group. The first error, which involved regrouping, was difficult for participants to communicate where the student made their mistake. They knew the answer was incorrect, but were unable to explain why. Through questioning techniques, participants were able to make sense of why the answer was incorrect. The goal was to encourage participants to "think outside the box" when supporting their children at home.

During the second workshop session, participants were given multiplication and division problems and asked to solve them in two different ways. For example, participants solved the multiplication problem "*Amy has 4 boxes. Each box has 7 bags of chips. How many bags of chips does Amy have?"* First, a participant shared a strategy that involved using repeated addition. The participant drew four boxes and put the number 7 in each one. Then the participant wrote 7 + 7 = 14, 14 + 7 = 21, and then 21 + 7 = 28. Another participant wrote 7, 14, 21, 28 and we had a discussion on the similarities and differences between the two strategies. Later strategies included finding doubles. For example, one participant wrote 7 + 7 = 14, 14 + 14 = 28. Participants made a connection between this strategy and the first two strategies, repeated addition and skip counting. Because participants

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had worked through several solution strategies in the previous workshop, they were able to construct new strategies much easier than when they began the first session. Participants were comfortable sharing with their partner, and then sharing with the group when asked by the researcher. If a tool was not brought up, the researcher would ask a question like, "how could we use ten frames to help us solve the problem?" Through discussion, participants made sense of using an open number line, ten frames, an array, and an area model, in addition to other number strategies. The researcher helped participants to make connections between multiplication and division problems through questioning techniques. In addition, participants made connections between division and addition as well as division and subtraction. By allowing participants to share strategies and make sense of other strategies, they were engaged in the discussion. Finally, participants were given example solutions to determine student errors while using the standard algorithm for multiplication and long division. After the group discussion, participants were given the posttest.

Findings

Participants in this study had students who attended one of four neighboring public elementary schools, all with similar school demographics. The majority of participants had children who attended the school site where the workshops were held, with the second largest population of from the school approximately one mile away from the school site. The breakdown of the number of participants in each of the three treatment groups and the control group is listed in Table 1.

Table 1: Participant Information (Frequencies and Percentages)

		Total
Workshop (42%)	Series 1	6 (21%)
	Series 2	4 (14%)
	Series 3	2 (7%)
Non-Workshop (58%)		17 (58%)

Demographic information was obtained from the 29 parent participants, and the researcher discovered the majority of participants: identified as being "white (n=22), were in the 36-45 age range (n=22), were either married or in a domestic partnership (n=24), earned at least a bachelor's degree (n=24), were working full time (n=21), and never had a teaching related position (n=27). All participants said their child brought home mathematics homework, and some said they helped their child everyday (n=10), while others said they never helped their child (n=5). The rest of the participants were split on all other options ranging from one to four times per week.

The purpose of this study was to determine the extent to which parents or guardians who attended a workshop on mathematics strategies differed on average and over time with parents who did not attend the workshop regarding beliefs. When statistical significance was found on the aMBS, additional analyses were run on the three different factors to determine which factors had a statistically significant difference.

A two-factor split-plot (one within-subjects factor and one between subjects factor) ANOVA was conducted. The within-subjects factor was time (pretest or posttest) and the between-subjects factor was group (treatment or control). Assumptions of baseline equivalency, homogeneity of variance, independence, normality, and sphericity were tested, and were met for everything except normality and sphericity. The violation of the assumption of normality suggested the increased likelihood of a Type II error, however the ANOVA is a robust test. The assumption of sphericity was violated for each separate test so statistics from the Greenhouse-Geisser conservative F test were reported when analyzing statistical results. Additionally, effect sizes according to Cohen's values (1988), for small (.01), moderate (.06), and large (.14) effect sizes will be reported.

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There was a large effect size (.201) and sufficient power (.708) for the interaction for the between-within factor for the entire aMBS. Additionally, there was a statistically significant within-between subjects interaction effect between group and time (F = 6.771, df = 1, 27, p = .015). ($M_{pre\ x\ control}$ = 54.41, SD = 10.186; $M_{pre\ x\ treatment}$ = 50.33, SD = 6.401; $M_{post\ x\ control}$ = 53.41, SD = 10.278; $M_{post\ x\ treatment}$ = 56, SD = 7.604). This statistically significant result suggested that there were differences, on average, between treatment and control group over time regarding beliefs reported from the entire aMBS.

Then the aMBS was split into the three factors identified by Capraro (2001), student learning (factor 1), stages of learning (factor 2), and teacher practices (factor 3). While there was a non-statistically significant result for factors 1 and 2, there was a statistically significant within-between subject interaction between group and time (F = 7.48, df = 1, 27, p = .011). ($M_{pre\ x\ control}$ = 21.71, SD = 4.18; $M_{pre\ x\ treatment}$ = 20.50, SD = 3.12; $M_{post\ x\ control}$ = 20.47, SD = 4.24; $M_{post\ x\ treatment}$ = 23.25, SD = 3.33) for factor 3. Additionally, there was a large effect size (.217) and sufficient power (.751) for the interaction for the between-within factor for aMBS-factor 3. This statistically significant result suggested that there were mean differences, on average between groups over time regarding beliefs about teacher practices. Results are displayed in Table 2 and Table 3.

Table 2: Greenhouse-Geisser Results for Statistically Significant Beliefs

Variable	Source	df_1	df_2	F	p	Partial η^2	Power
aMBS	Time * Group	1	27	6.771	.015	.201	.708
aMBS –F3	Time * Group	1	27	7.48	.011	.217	.751

Table 3: Mean and Standard Deviations for Pretest vs. Posttest Split by Group

	Pre			Post		
	Total	Treatment	Control	Total	Treatment	Control
N	29	12	17	29	12	17
Beliefs (RQ2)						
Mean	52.72	50.33	54.41	54.48	56	53.41
Standard Deviation	8.92	6.40	10.19	9.21	7.60	10.28
Belief Factors (AQ3 – F3)						
Mean	21.51	20.5	21.71	21.62	23.25	20.47
Standard Deviation	3.76	3.12	4.18	4.07	3.33	4.24

Figure 1 and Figure 2 displays the means from the pretest and posttest, between the treatment and control groups for the entire aMBS and the aMBS-Factor 3. These figures provide a visual representation of the statistically significant interaction between time and group as reported from Table 2 and Table 3.

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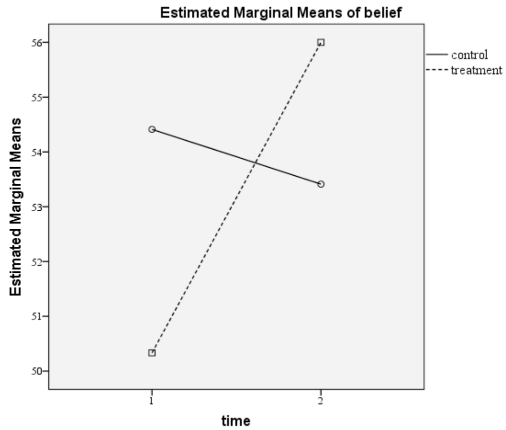

Figure 3. Profile Plot for Beliefs.

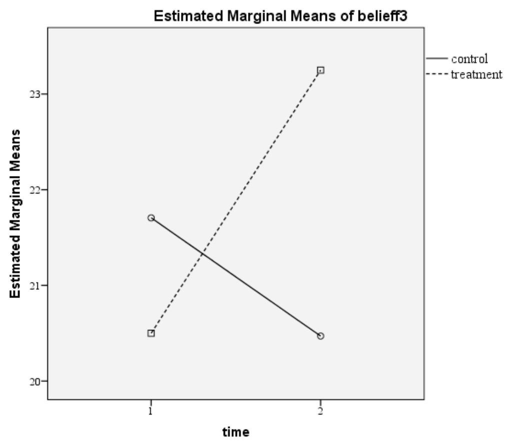

Figure 2. Profile Plot for Beliefs, Factor 3.

Conclusions

Results were statistically significant between groups and over time with a large effect size. The treatment group changed their beliefs to ones that were more focused on students constructing their own knowledge. Additionally, there was no statistically significant difference between groups over time for factor 1 (student learning) and factor 2 (stages of learning), but there was a statistically significant change between groups over time for factor 3 (teacher practices) with a large effect size. Parents in the treatment group had beliefs that leaned more towards students learning about mathematics in a learner-centered environment after completing the workshops. Parents in the control group did not shift their beliefs from the pretest to the posttest. This indicates that the workshops may have shifted parents' beliefs about student learning to beliefs that students should learn in a learner-centered environment.

These statistically significant results indicate that parents may have shifted beliefs about student learning through participation in workshops. This supports previous findings related to preservice and inservice teachers (ISTs) that suggest belief change could occur through participation in an instructional situation (Liljedahl, Rolka, & Rosken, 2007; Richardson, 2003). This significance could be explained because parents were participating as learners in a student-centered environment, which was different from the direct instruction they may have experienced as young learners (Garland, 2014; Richards, 2014). Through participation in the workshops, which were learner focused, parents may have understood the importance of allowing *their* child to learn mathematics in a student-

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centered environment instead of one focused on the parent guiding their child to the answer. Previous research indicates beliefs are influenced by a person's experiences (Op't Eynde, DeCorte, & Verschaffel, 2002).

One limitation of this research was that participants completed a belief instrument where their beliefs were self-reported. Researchers have found that teachers need to be observed multiple times to determine their underlying beliefs, which can be different from their self-reported beliefs (Cross & Hong, 2012; Leatham, 2006). Due to the similarities of teachers and parents regarding helping a student with a mathematical task, this may be true for parents as well. Because the parents were asked to complete the instrument, their underlying beliefs may not have been apparent. Additionally, instrumentation validity may be a threat because while there was some evidence supporting the reliability and validity of the aMBS (Capraro, 2005), this instrument was not tested on parents and the small sample size in the current study did not support testing statistical validity and reliability evidence for the scores from the instrument. The parents in the study did not represent a random sample because they were selected based on convenience and self-selection, which may have introduced self-selection bias. The lack of random selection from the population limits the generalizability of the study findings. Additional workshops will need to be conducted and data will need to be collected and analyzed in different parts of the country to be able to generalize these findings.

Future research could be conducted in undergraduate and graduate programs. If PSTs and ISTs are involved in this type of research, they might have a better understanding of why it is important to get parents involved in this manner. This could, in turn, help PSTs and ISTs determine common errors students might bring to whole class discussions, and why those errors arise by allowing parents to share solution strategies. Parents may be the biggest supporter for a teacher when working with their child on homework, but parents need the tools that will be most helpful.

Although the duration of the workshops was short, parents who participated in the workshops indicated a shift in their beliefs about learning mathematics to a more learner-centered environment. These statistically significant findings indicated that workshops for parents were beneficial. By giving parents the opportunity to engage in mathematics in ways similar to the way their children learn in the classroom, beliefs about mathematics were challenged. Prior to the workshops, and according to the belief instrument that parents completed, parents' beliefs leaned more towards working *with* their child on homework instead of allowing their child to come up with their own strategies. The findings in this research study suggest more research on parent workshops is crucial.

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