What is math? Exploring the perception of elementary pre-service teachers

Megan Burton
5020 Haley Center
Curriculum and Teaching
Auburn University, AL 39849
meb0042@auburn.edu

Abstract

Sixty-two elementary pre-service teachers enrolled in a mathematics methods course were asked to "draw math" at the beginning and end of the semester. These drawings were used to examine the initial perceptions and how these changed by the end of the semester of methods and field experiences. Findings describe the various drawings and possible meanings behind the drawings. These drawings help explain the vision of mathematics that teacher candidates have before and after exploring teaching methods and implementing these methods with elementary students. This study provides insight into the experiences and images that pre-service teachers associate with both positive and negative emotions towards mathematics. Rich student dialogue about the drawings led to teacher reflection on how their emotions, attitudes, and experiences influence the way they teach mathematics to students.

Keywords: elementary, mathematics, anxiety, pre-service, illustration

Introduction

What is math? When asked this open-ended question there are many ways one could respond. Often people reflect back to their vision of school mathematics, while others reflect upon its relevance to the real world. This study explores elementary pre-service teachers' illustrations to this question in order to gain insight into their perceptions of mathematics before and after a semester of a mathematics methods course and field experiences. The impact of teachers' perceptions about mathematics and learning on their teaching practice is a well-researched problem (Schuck & Grootenboer, 2004; Swars, 2006). Thus it is important that researchers understand what the perceptions are and what influences these perceptions. Vinter (1999) found that teachers often struggle to find the application of much of the math they teach. This affects the impressions they give their students and limits their ability to make math relevant. They struggle to help students understand the purpose behind the math they do. This affects their ability to teach in a way outlined by the National Council of Teachers of Mathematics (NCTM) process standards of communication, representation, problem solving, reasoning and proof, and connections (NCTM, 2000).

Many elementary pre-service teachers struggle to understand the meaning behind the mathematics taught. Often this is due to the lack of experience with the content taught in the elementary grades (Ball & Bass, 2000; Sowder & Shappelle, 1995). Ma (2010) explains that a teacher's lack of experience with this content negatively impacts instruction, because connections, various representations, and depth are not present in the teacher's understanding. Thus instruction becomes more superficial and teachers are more likely to be bound to the

textbook, rather than adjusting to meet student needs and understandings. In addition to lack of experience with math, many elementary pre-service teachers have high levels of mathematics anxiety and negative emotions associated with mathematics (Swars, 2006). Through examining their own perceptions of mathematics, pre-service teachers (PSTs) can begin to explore how to deepen their own understanding, overcome anxiety, and connect the content to elementary students.

This article explores PSTs' perceptions of mathematics and the changes they experience from the beginning to the end of an elementary mathematics methods course. The PSTs' drawings of math and descriptions of the drawings reveal these initial perceptions and the changes they experience.

Understanding of Mathematics. A teacher's understandings and perceptions towards mathematics impacts the quality of instruction received by his/her students (Hill, Shilling, & Ball, 2004). Vinter (1999) found that many prospective teachers bring an abstract, rather than an applied, real world understanding of mathematics and this in turn affects their ability to make the content meaningful for their students. The types of instruction delivered by many elementary teachers provide evidence of this lack of understanding of mathematics applications. Resnick (1987) suggests that many times teachers prepare students to do school math, but this is not the same as mathematics beyond the classroom. Effectively solving mathematics problems beyond the classroom requires one to understand the meaning behind processes, rather than simply memorize algorithms. However, teachers in the United States often perceive the procedural knowledge as the important elements in mathematics and neglect elements such as conceptual knowledge and problem solving that impact lasting understanding and mathematical thinking (Ma, 2010). Teacher education is one place that can impact this view and begin to change this perception.

Chappell and Thompson (1994) expressed the importance of the teacher education and mathematical courses that PSTs experience in their pre-service training. They expressed the interweaving of beliefs, content knowledge, and attitude that affects instruction in the elementary grades. The pre-service training is crucial to the development of PSTs' beliefs, content knowledge and attitudes about the way math should be taught at various grades and their effectiveness as educators. Ma (2010) explains that many American elementary teachers teach all disciplines, rather than simply mathematics and lack the time and professional development to reflect upon beliefs, challenge attitudes, and grow in content knowledge once they are in the classroom. Therefore pre-service training needs to provide opportunities for this growth as much as possible.

Mathematics Anxiety. Mathematics anxiety often begins in elementary school when students have negative interactions with the content and are taught by procedural, rather than conceptual teaching methods (Harper & Daane, 1998). Multiple factors impact mathematics anxiety. These include tying instruction to the exact procedures in the textbook, timed tests, hostile teacher behavior, embarrassing students in front of peers, only accepting one method of solving a problem, and lack of differentiation based on student needs (Jackson & Leffingwell, 1999; Swars, 2006). Thus pedagogical strategies used by mathematics teachers are critical in developing confident students without mathematics anxiety.

Hembree (1990) found the highest level of mathematics anxiety among college students

came from pre-service elementary teachers. This math anxiety often passes on to the elementary students they teach (Middleton & Spanias, 1991). To resolve mathematics anxiety, teachers need to have positive experiences with mathematics, see the purpose behind the mathematics they are teaching, write about mathematics, use manipulatives, work in groups, and have field experiences teaching mathematics (Perry, 2004; Swars, 2006). Vinson (2001) found that exploring the conceptual content in meaningful ways with manipulatives before learning the procedural aspects of mathematics reduced the mathematics anxiety among PSTs.

The impact of mathematics anxiety on teaching performance is clear. Teachers who are confident in their mathematics ability spend 50% more time teaching mathematics than those who have mathematics anxiety (Schmidt & Buchmann, 1983). Conversely, teachers with math anxiety spend less time implementing standards based instruction and more time teaching to the whole class and assigning seat work (Bursal & Paznokas, 2006; Bush, 1989).

A correlation exists between the levels of math anxiety found in elementary teachers and their content knowledge for teaching (author; Matthews & Seamon, 2007; Swars, Smith & Smith, 2009). Therefore the process of supporting PSTs in overcoming mathematics anxiety must include strengthening content knowledge for teaching (author; Swars, Smith & Smith, 2009). As teachers strengthen their content knowledge for teaching, they should simultaneously reflect upon their beliefs and perceptions of math in order to consciously address previous negative emotions (Swars, 2006).

Drawing. Researchers have used student drawings to examine students' thoughts and attitudes about various content areas for years. These studies usually involve elementary students, rather than the teachers themselves. Studies in literacy have researched perceptions of the subject areas through use of drawings of reading and writing (McKay & Kendrick, 2001a; 2001b). Studies about students' impressions of and attitudes toward scientists and science in many elementary and PST classrooms have given researchers an understanding of student perceptions (Finson, 2002; Thompson & Lyons, 2008). Drawings have also provided an avenue to explore children's attitudes towards environmental issues (Alberby, 2000). Drawing images before writing or verbalizing ideas can foster more creative responses and help generate ideas, because often language can slow down the creative process (Caldwell & Moore, 1991). The exploration of ideas through drawing does not require the cognitive demands often found when using language (Caldwell & Moore, 1991). These reasons support the use of drawing with adults, as well as children, to explore both conscious and unconscious thoughts, experiences, and emotions. This study relies on the theoretical understanding that the relationship between the conscious and unconscious mind can be expressed through images and thus given a voice where it otherwise might be ignored (Hillman, 1992).

Art therapy focuses on the emotional experiences and thoughts that can be reflected and expressed vividly through images (Lusebrink, 2004). Attitudes, behaviors and thoughts can all be affected by these emotional experiences that may appear in drawings. These same techniques can support meta-cognition and address the negative emotions often tied to mathematics by elementary pre-service teachers (Rule & Harrell, 2006). Drawings by pre-service teachers can reveal dispositions, attitudes, and experiences related to a subject area. They allow the artist to establish and reflect upon these attitudes and experiences in a non-threatening way (Rule & Harrell, 2006).

Foundational Framework. This study examined the symbolic representations of math drawn by PSTs at the beginning of a mathematics methods course and then explored the change that occurred in drawings at the end of the semester. Like previous studies with elementary students, this study uses drawings to reveal attitudes, thoughts, and emotions related to a subject area that may not easily be expressed through other means (Alerby, 2000; Finson, 2002; Mendrick & McKay, 2004; Zeldin & Parjares, 2000). Research in art therapy supports the conclusion that reflection and awareness of these attitudes, thoughts, and emotions can help promote a more positive shift (Lusebrink, 2004). Once people are aware of these negative perceptions and emotions, they are better able to analyze, reason, and change by creating positive experiences and exploring the causes for these perceptions and emotions.

At the beginning and end of the semester PSTs illustrated their impression or thoughts about "math." Examination of drawings of math gave information about beliefs, emotions, thoughts and experiences that are a part of PSTs professional identity. The drawings identified key ideas that students need to be aware of when teaching. Analysis and categorization of the drawings led to exploration of the initial impressions of mathematics that PSTs bring to their teacher preparation courses and the changes experienced through opportunities to discuss anxieties, work with students, and explore various theories for teaching and learning mathematics.

Analytical psychology provides the basis for this study (Jung, 1953, 1977). PSTs bring experiences and emotions that are tied to the subject of mathematics that they may not even be aware of in their conscious mind (Jung, 1977; Raff, 2000). Illustrations demonstrate the perception or subconscious idea and emotion related to a topic (Finson & Beaver, 1995). By acknowledging and giving voice to negative emotions and experiences, such as mathematics anxiety, through drawings, one can deal more effectively with and move beyond those negative emotions and experiences (Rule & Harrell, 2006). By drawing these images, they are made aware of the experiences, emotions, and thoughts that influence their actions related to the subject. Awareness of these images enables PSTs to reflect upon how these influence teaching and professional identities. In turn, this reflection enables PSTs to begin creating new, positive images and experiences that reshape their attitudes and behaviors.

Rule and Harrell (2006) examined drawings that depicted specific experiences PSTs had in relation to teaching and learning mathematics. They found that most PSTs began with negative emotions and this changed for many over the course of a standards-based, reflective mathematics methods course. This study differs and yet builds on the work from Rule and Harrell (2006), in several ways. First, it asks PSTs to draw math, rather than specifying that the drawings need to be a specific experience. It also examines what was drawn in addition to the emotions depicted in the drawings. This is important, because often perception and emotions build long exposure with a topic, rather than specific experiences. Limiting PSTs to specific experience might limit their ability to communicate their overall perception. The methods for study contained no mention of relating the images to teaching and learning in the directions, whereas Rule and Harrell mentioned the value of examining the association of teaching and learning with these images. It was interesting to see the differences between PSTs who connected mathematics to teaching and learning and those who connected it to other experiences beyond the classroom. Finally, Rule and Harrell directed PSTs to draw the three most significant experiences, whereas this study asked PSTs to draw images of math, not specifying the most significant images. This distinction helped the researcher to examine the depersonalization that many PSTs draw in related to

mathematics.

Often the negative emotions surrounding a concept, such as mathematics, develop in ways that distort original experiences. Instead reflection upon past experiences tends to reflect the current emotional attachment that has evolved over time and repeated experiences with that concept (Raff, 2000). Sometimes images used to express the larger concept, such as mathematics, become literature snapshots of a particular event and at other times they present themselves more as representations. However, both reveal a deep insight into the true relationship of the artist to the subject, such as mathematics (Rule & Harrell, 2006). By examining his/her own understanding and perception of a subject, the PSTs can improve the negative emotions related to the concept and this in turn allows them to focus on the learning, without the obstacles associated with their negative experiential baggage. Watkins (1984) suggests that by investigating images and discussing feelings related to the images, the artists become empowered to engage actively in changing the negative perceptions related to the subject.

***Research Questions*.** This study focused on the following research questions:

1) What images do PSTs relate to math? More specifically what emotions are attached to the subject and what types of images do they draw?

2) What is the relationship between emotions and the type of image drawn?

3) How do these images change during a semester of field experiences and a mathematics methods course?

Methods and Procedures

Participants. Sixty-two PSTs enrolled in a mathematics methods course for elementary teachers at a midsized university in the southeastern United States were participants for the study. It involved three different sections of the course over a period of two years with the same mathematics instructor, who was also the researcher. While the instructor intentionally took a neutral posture to learn from the PSTs, their preconceived notions about the instructor's expectations may have influenced the drawings. The study included all PSTs from the sections as participants. The course was offered during the spring of PSTs' third year of a four year university teacher education program. Fifty-nine females and three males participated in the study. There were fifty-five Caucasian PSTs, four African-American PSTs, and three Latino PSTs.

During the semester PSTs spent one day a week at a practicum experience in the field. In addition during the weekly 3-hour mathematics methods course, PSTs spent 30 minutes working with 2 fourth graders exploring various mathematics content. A portion of the methods course involved discussing the lessons learned from the time with the fourth graders. In addition, PSTs explored various theories about teaching and learning mathematics, effective use of technology in mathematics, and the role of manipulatives in mathematics. This happened through exploring manipulatives, discussing readings, planning lessons, using children's literature, analyzing computational errors, and various other activities.

Data Collection. During the first class meeting, PSTs drew pictures of math. They were told to draw their initial impressions of "math." This could include experiences, emotions, content, or any images they might use to "draw math." The researcher instructed PSTs to draw whatever

came to mind and not to filter images. The instructor stressed that each participant had unique mathematical experiences and that by honestly examining beliefs, views, and images, deeper professional reflection and growth can occur (Lusebrink, 2004). Before asking the PSTs to draw math, the instructor explained that there were no expectations or evaluation of responses. The instructor emphasized that assignments determined grades in the course and that drawings would not be considered in assigning grades. Then PSTs wrote several descriptive sentences to accompany the drawing for clarification purposes. Fifty-seven made informal presentations of the drawing to the class. The instructor did not require the PSTs to present their drawings, but fifty-seven of the sixty-two chose to do so in order to clarify things about their drawings. For example, a PST who drew question marks wanted to explain that she always felt confused by math. The descriptions, presentations, and anecdotal notes were used to provide clarity of the intent behind the drawings.

The PSTs performed the same drawing activity the final day of class. PSTs drew math and wrote a few sentences about the drawing. The post course writings had an additional component in which PSTs also wrote two or three sentences describing if and how the course changed their impressions. In addition to the drawings, clarification sentences, and presentations, the researcher took summary notes of classroom discussions that highlighted references to the drawings that PSTs made. These drawings, sentences, and anecdotal notes about conversations referencing drawings provided material for investigation of the various mathematics views held by the PSTs and the changes these teachers experienced over the course of the semester.

Data Analysis. Each drawing was coded using open coding from grounded theory (Strauss & Corbin, 1994). Information obtained from the writing and presentations was used to support and clarify coding questions of the drawings. Specific codes were grouped by concepts and then categories. Each of these categories provides insight into PSTs notions of mathematics. The three overarching categories that emerged from this process are the three categories that were then used for examining the meaning and theory behind the drawings:

(1) positive, neutral, and negative emotions- Teachers' emotions are important, because this can be an indicator of the amount of time, energy, and enthusiasm spent in planning and implementing mathematics instruction (Schmidt & Buchman, 1983; Schuck & Gootenboer, 2004). Specific emotional prompts, such as faces with smiles or tears, determined if the drawings or descriptions were categorized as positive, negative or neutral.

(2) particular experiences and general meanings- This category evolved during the analysis of emotions. It was clear that most students with particular experiences drew upon negative experiences and held negative emotions towards mathematics. The display of one point in time, such as a student drawing on the blackboard, caused the drawing to be classified as a particular experience. A classification as general meaning meant that the picture simply meant that the image did not point to a specific experience, but rather the general impression of math. For example one PST drew multiple images of places math can be found or another drew mathematical symbols. General drawings connote math symbols or items related to math, rather than a specific memory related to math.

(3) classroom, abstract or real world connection- This category arose from the literature concerning elementary teachers' lack of connections and real world understanding of mathematics content that they teach (Ma, 2010; Resnick, 1987:Vinter, 1999). Pictures that were

connected to the classroom displayed images such as books, teachers, or a white board. Abstract ideas were images such as fractions, multiplication problems and algorithms. The symbol for addition, division, money, and multiplication were common abstract ideas. Real world connections had images such as shopping, architecture or cooking. A similar investigation of PST beliefs about math through drawings by Rule and Harrell (2006) led to the selection of this technique. The type of classification used for analysis in this study was derived from the evaluation technique used by Rule and Harrell (2006). Rule and Harrell examined the drawings based strictly on positive and negative emotions and experiences. The researcher intentionally designed this study to be broader in scope. Rather than asking students to draw an experience, they were asked to draw "math." This allowed broader codes to emerge, perhaps because PSTs had the freedom to choose attitudes, experiences, or thoughts about the subject as a whole. It created an opportunity for students to draw upon a larger idea of the content area.

Following Rule and Harrell's approach, the researcher grouped each drawing by category and tallied the number of images in each category. For example, nine pre-course drawings were placed under the category of positive. A member of the mathematics education faculty blindly conducted the same process to provide inter-rater reliability. Once her blind grouping was conducted, she evaluated and supported the initial findings, categories, groupings, and count. This confirmation provided inter-rater reliability and validity of the interpretation.

Change was determined by analyzing each PSTs' pre and post drawings for changes in each category. Each pre-course drawing was paired with the same PST's post-course drawing. Each set was examined for change. For example there was a count in the total change in emotions from negative to positive emotions. The mathematics education faculty member who confirmed the categories for the previously mentioned codes also confirmed these findings.

Results

Pre Course Drawings. Through the drawings and writings, PSTs expressed a variety of experiences and impressions of mathematics. Out of sixty-two drawings, negative experiences constituted a majority (32) with nine positive experiences and twenty-one neutral experiences. All the positive drawings related mathematics to the real world examples and actual mathematics content. For example, one PST drew fractions and math equations. She wrote that she was strong at math. This image was classified as abstract, because it only showed math symbols and equations. One real world drawing was a picture of a store with a 50% off sale. An example of a positive problem solving drawing was the student who drew various word puzzles and said she enjoyed the challenging thinking and logic involved in math. Most negative drawings related to the PSTs' emotions and experiences in school (see Figure 1 and 2). For example, three people drew themselves at the board with question marks. Question marks seemed to be a common expression for PSTs to show their feelings of confusion. Also, many PSTs who drew negative images drew textbooks and jumbled ideas or question marks in their drawings.

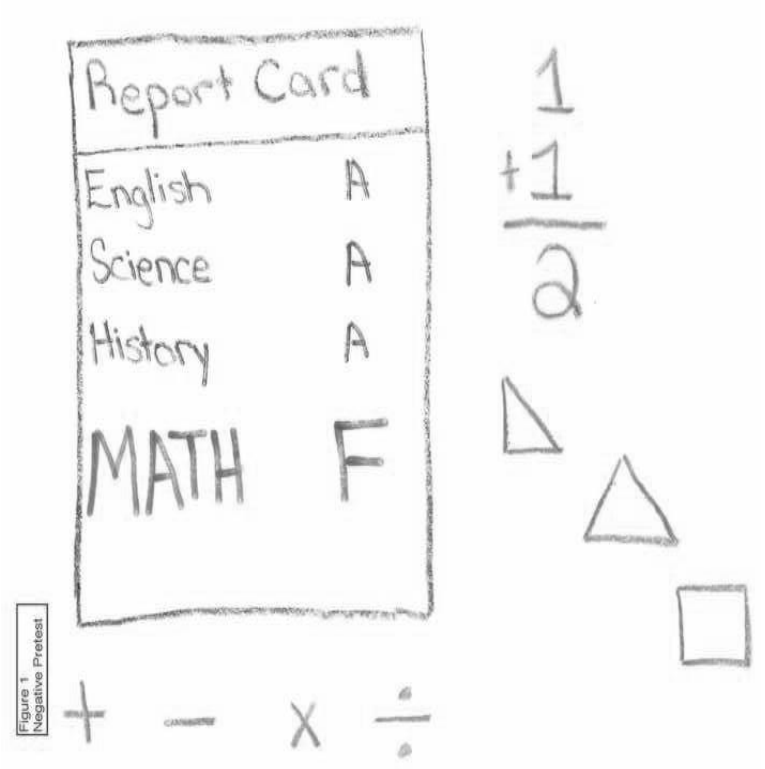

Figure 1

Table 1 shows the range of positive, neutral, and negative emotions connected to the drawings. Many of the negative drawings and writings had a common thread of the struggle that PSTs felt in trying to be successful in school mathematics. School mathematics refers to items in the textbook, on standardized tests, and lacking real world context. One PST explained, "I never understand it. I always feel stupid and like what the teacher says is a foreign language." Several wrote sentences expressing the desire to change these emotions in order to avoid negatively impacting future students.

Table 1*: Emotions*

Emotions	Pre-drawings	Post-drawings	Change
Positive	9/ 14%	38/ 61%	29/ 47%
Neutral	21/ 34%	24/ 39%	3/ 5%
Negative	32/ 52%	0/ 0%	-32/ -52%

Figure 2

Analysis of the emotions in the drawings led to categorization based on if the drawings referred to particular experiences or were more general (see table 2). Thirty-three of the sixty-two drawings displayed memory of a particular point in time. For example, one PST drew herself at the chalkboard in tears. In her writing, she explained that she remembers feeling her third grade math teacher was angry with her lack of understanding of a problem she was told to solve at the chalkboard (see figure 3). In her presentation she described this specific moment in time vividly as a point she thought she would not survive, because had no idea how to solve the problem. She described this specific experience as representative of her feelings of math.

Table 2: *Theme of Drawings*

Theme	Pre-drawings	Post-drawings	Change
Particular Experience	33/ 53%	19/ 31%	-14/ -22%
General	29/ 47%	43/ 69%	14/ 22%

Twenty-nine PSTs drew general drawings, rather than a specific point in time. For example one PST drew a confused face with math facts pouring into her head from a mysterious bowl labeled “math secrets.” This was not referring to a specific memory, but instead represented her overarching view of math as being given to her from the teacher, rather than making sense of math on her own (see figure 4). Another PST drew fractions, addition problems, subtraction problems, money, and a clock. This was an example of a general drawing, rather than a particular experience.

Figure 3

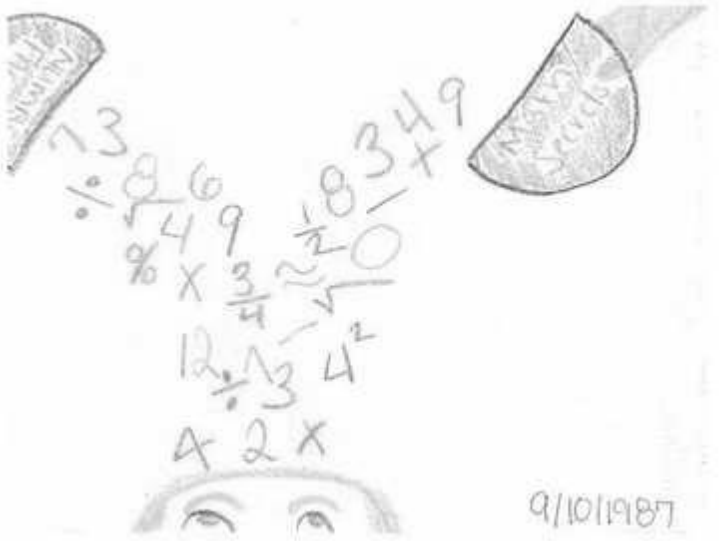

Figure 4

The final category evaluated if the images related math to the classroom setting, real world setting, or were more abstract (see table 3). There were twenty-eight classroom settings, seven real world settings and twenty-seven abstract settings from the pre-course drawings. Every image drawn in a classroom was negative and every image relating to real world math was positive. The abstract images had a mix of written responses varying between positive, negative,

and neutral emotions. Figure 5 is an example of an abstract image. The mathematical expressions and symbols do not necessarily refer to school or real world setting, but instead are used in the process of doing math in either setting. The PSTs who drew themselves cooking, shopping, or building all expressed a passion and conceptual understanding of connections, real world meaning, and reasoning essential to mathematics.

Table 3:*Setting for Drawings*

Setting	Pre-drawings	Post-drawings	Change
Classroom Setting	28/ 45%	22/ 35%	-6/ 10%
Read World Setting	7/ 11%	11/ 18%	4/ 7%
Abstract	27/ 44%	29/ 47%	2/ 3%

Figure 5

Post Course Drawings. At the end of the semester, all PSTs reflected in the final writing, that they now saw the connections between the real world and the content they were teaching. While many were still hesitant and concerned about their own understanding, they expressed growth and a more positive perception of math. Many of the final drawings and writings illustrated a new perception that math is fun, meaningful, and makes sense. PSTs expressed

more confidence in teaching mathematics, but also more confidence in their own personal mathematical abilities.

> "I always thought I was bad at math and dreaded this course, but now I see that math isn't just memorizing stuff the teacher tells you. It is talking about stuff, exploring different ways of doing things, and thinking about what makes sense. I am actually good at it, now that I understand that."

A comparison of the emotions attached to the final drawings with the initial ones showed, a positive growth in emotional affect (see Table 1). Positive drawings increased by 29 and there were no negative drawings in the final drawings. The drawings that showed positive emotions in mathematics contained images of collaboration, manipulatives, real world connections, and discussions. No changes towards negative emotional connections to mathematics in the drawings were shown. Those that initially drew positive drawings kept these, but several included more images of collaboration and simplified the mathematics in the drawings to match the mathematics that they will use in the elementary classroom. Table 2 illustrates that post course drawings were more general, rather than depicting one specific experience with mathematics. Fourteen students changed from drawing a specific memory to drawing a general perception of mathematics. The final drawings exhibit positive images of specific classroom experiences rather than the negative images initially drawn. In addition, drawings displayed more collaboration and meaningful learning (see figure 6).

Figure 6

Table 3 indicates that students began to see mathematics beyond the classroom setting. A

decrease of six (10%) school setting images was seen in post course drawings versus pre course drawings. Real world images increased by four (7%) and abstract images increased by two (3%).

Discussion and Implications

Findings from these drawings contribute to the research concerning the perceptions of elementary mathematics teachers to math content. Several key observations provide insight into PSTs and have implications for teacher education programs. The PSTs in this study confirmed the high math anxiety and negative attitudes towards math that have been described by previous research (Bursal & Paznokas, 2006; Swars, 2006). More than half of the pre course drawings were negative and only nine of sixty-two were positive. This study provided further evidence of the negative experiences PSTs bring to the classroom (Bursal & Paznokas, 2006; Van Dooren, Verschaffel, & Onghena, 2002). However, it goes deeper than simply recognizing these negative emotions and experiences by examining how PSTs view the concept of math. The details in the images, writings, and presentations provide substance and visual understanding of the anxiety experienced by many.

One interesting finding among the drawings was the discovery that the negative experiences are often related to the classroom rather than real world math. This aligns with the work of Nicol (2002), who suggests this lack of real world connection negatively impacts students. Time for PSTs to make real world connections between math concepts should be an essential portion of elementary methods courses (Ma, 2010; Van Dooren, Verschaffel, & Onghena, 2002). The drawings illustrate the importance of real world connections in fostering positive attitudes towards mathematics. When PSTs connected math with real world experiences, they viewed math in a positive light and displayed confidence in the content. This supports the recommendations made by NCTM for real world connections to math (NCTM, 2000). When PSTs changed their depiction of mathematic to a more positive depiction, it included images of discussions, manipulatives, understanding, and connections to the real world beyond the classroom. Even when the drawings focused on classroom images, the writings on the back or details in the drawings referred to the importance of making connections. Those who expressed math in a positive light at either the beginning or the end did not make references to textbooks, isolation, or working problems on the board. Instead meaningful, connected, and engaging math was the focus. After a semester exploring the methods for teaching elementary content within a context connected to working with students, PSTs expressed a change in beliefs about the concept of mathematics through their drawings.

Through the initial drawings many PST's communicated and reflected upon their emotions and past experiences associated with the content, including mathematics anxiety. An unplanned effect of the study was the prominent influence the initial activity had upon the course discussions. Students reflected upon these initial perceptions throughout the semester as various methods and content were introduced. This simple task provided insight into the perceptions PSTs hold as they enter teacher preparation programs and the impact that positive experiences with students and content can make upon these perceptions. Throughout the class informal conversations about the impressions of math occurred. When PSTs discussed algorithms they shared their experiences memorizing and implementing standard algorithms. Many shared that they never understood why they did certain procedures, but the teacher told them it worked. PSTs could evaluate the content and their experiences with their students with a conscious understanding of their lens that developed from their personal experiences as a learner. For

example, those who were required as students to provide explanations reflected upon the importance of this in their own learning and this helped other PSTs who did not see the need for explanations. Those who understood algorithms as students listened to PSTs with misconceptions who found the use of invented algorithms to be a very helpful strategy towards understanding. One PST who initially reacted negatively to the notion of student generated algorithms reflected upon her drawings of math and noted that maybe this would have created less anxiety and more understanding if math had been taught this way to her. During the semester, PSTs often referred to their drawings and initial perceptions of mathematics. The drawings seemed to help PSTs begin to verbalize their perceptions of mathematics and then use this as a springboard for reflection on practice. Teacher educators need to allow time for PSTs to reflect upon the perceptions and beliefs they bring to the classroom in order to explore other ways students learn and to explore new ways of teaching. This reflection allows PSTs to acknowledge biases and begin to explore how to create more meaningful experiences for students (Rule & Harrell, 2006). PSTs who entered the methods course with hesitation due to their own struggles with math as elementary students often found their struggles could help them relate and better explain the content to their students.

Because conscious reflections on attitudes can alter negative complexes (Hillman, 1992), the mathematics attitudes may have been changed through the symbolic analysis, which was both a part of the unique methodology of the study and a conscious reflective process. This reflection upon the drawings is one of the reasons that the images can be analyzed, but assumptions about why they changed cannot be made. The researcher did not initially intend for the activity of drawing to impact the study, but rather be an assessment of PSTs' perceptions. However, as described, the PSTs made references to the drawings throughout the semester, so the researcher may infer that this did have an impact on the student's experiences over the semester. PSTs demonstrated an overt awareness of these perceptions throughout the course that could have been amplified due to the initial task of drawing these perceptions. Their emotions attached to math became a natural part of the conversations about methods and their experiences with students. This corresponds to a finding by Tooke and Lindstrom (1998) that thinking about the problems children encounter in learning mathematics helps PSTs overcome mathematics anxiety. These PSTs were challenged to draw their own perceptions of math and many used this opportunity to express their own problems they encountered as a student. This drawing, in turn, made them more aware of problems students might have throughout the semester. In addition to reflection upon drawings, there are multiple factors that could have influenced the change seen in pre course and post course drawings. The experience of teaching mathematics to fourth grade students, time in field placement, or experiencing the content in the methods course from a Standards-based approach (NCTM, 2000) might have played a role in the positive change in the drawings of the PSTs. This would support the research that suggests experience in elementary schools and Standards-based instruction in methods courses creates a positive change for PSTs (Author, 2006; Harper & Daane,1998; Vinson, 2001).

This study expanded the knowledge base about PSTs perceptions of mathematics. Allowing them to draw their impression without parameters enabled them to address unconscious thoughts that may affect their abilities as both a teacher and a student. It expanded on the findings of Rule and Harrell (2006), because it went beyond the experiences PSTs had to include the overarching images of math and connections they made. The study found that before

fieldwork and mathematics methods courses, PSTs who connect mathematics with school have negative perceptions. These images of school are traditional in focus, such as using a textbook, working in isolation, going to the board, or receiving a low score on a test. PSTs who connect mathematics to the real world see mathematics in a positive light. While this reinforces what the current research shows, the use of drawings allowed the researcher to find this information in an unprecedented way. Rather than using surveys or interviews, drawings were the vehicle to discover this finding. In addition, the drawings became a powerful teaching tool, because it provided help to students in discussing perceptions and emotions during the course.

While this study offers insight into the perceptions that elementary PSTs hold, further studies are needed. Deeper examination of the change process that occurs during content courses could provide insight into the factors that affect the changing perception detected in this study. Continuing this activity by having PSTs at the end of internship and inservice teachers draw math could show how these perceptions change and are refined as they progress in their development as teachers as well as the sustainability of the newfound positive perceptions. In addition, it would be interesting to compare the images of inservice teachers with the students they teach in order to see the correlation of perceptions.

Asking PSTs to draw, write, and explain their conceptions of math provides further understanding into the mathematics anxiety that many experience, the pedagogical stances they bring into teacher preparation courses, and their understanding of connections between concepts and real world uses of school mathematics. These understandings can provide insight into supporting PSTs as they develop positive affect, effective pedagogical strategies, and content knowledge for teaching mathematics.

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