



Using Drawings to Bridge the Transition from Student to Future Teacher of Mathematics

Ji-Eun LEE*

Oakland University, USA

Mary ZEPPELIN

Oakland University, USA

Received: 24 June 2013 / Revised: 18 October 2013 / Accepted: 1 January 2014


Abstract

This study examines a group of prospective teachers' reflections upon the way they were taught (Set 1) and the way they want to teach (Set 2) through drawings which respectively describe their past learning experiences as students and their future plans as teachers. The purpose of this study is to identify: (a) the emerging themes that appear in each set of drawing data, (b) the possible factors that influence prospective teachers' drawings, and (c) the implications for mathematics teacher educators. Overall, prospective teachers showed predominantly negative or mixed feelings about their past experiences as mathematics students. In response to their own past negative experiences and struggles, the prospective teachers tended to highlight emotionally supportive classroom environment and versatile instructional teaching strategies in their future plans. This study suggests that this activity of reflecting past experience and planning future teaching assimilates prospective teachers' identities as math students and math teachers and provides a window into the thinking of others.

Keywords: Pre-Service Teacher Education, Teacher Attitude, Reflective Drawing.

Introduction

One day, a woman was about to cook a roast. Before putting it in the pot, she cut off a small slice. When asked why she did this, she paused, became a little embarrassed, and said she did it because her mother had always done the same thing when she cooked a roast. Her own curiosity aroused, she telephoned her mother to ask why she always cut off a little slice before cooking her roast. The mother's answer was the same: "Because that's the way my mother did it." Finally, in need of a more helpful answer, she asked her grandmother why she always cut off a little slice before cooking a roast. Without hesitating, her grandmother replied, "Because that's the only way it would fit in my pot" (Langer, 1989, pp. 43-44).

*  Ji-Eun Lee, Oakland University, 2200 N. Squirrel Rd. 485F Pawley Hall Rochester, MI USA 48309 Phone: 1-248-370-2119. E-mail: lee2345@oakland.edu

We often hear that teachers teach the way they were taught. Although teaching is more complicated than cooking, we frequently hear this saying and often observe that teachers teach in a certain way because that is the way their teachers did it. Today's classrooms and students are ever evolving as the content and pedagogical measures in mathematics education continue to advance. The teachers of today are expected to demonstrate effective mathematics teaching that "requires understanding what students know and need to learn and then challenging and supporting them to learn it well" (National Council of Teachers of Mathematics [NCTM], 2000, p. 16). Successful mathematics teaching cannot be demonstrated just by parroting the way my teacher did. It requires "continuing efforts to learn and improve" (NCTM, 2000, p. 19) in a mindful way. The nature of mindfulness in Langer's (1989) work exemplifies the characteristics that impactful teachers demonstrate to improve their teaching: the ability to create new categories, the willingness to welcome new information, the capacity to present more than one perspective, the power to manage context, and the desire to put process before outcome.

We believe that teacher educators should provide turning points to help prospective teachers "unpack the way it is" (Hinchey, 1998, p. 17). In other words, as prospective teachers are about to embark on their own professional journey, they need to mindfully reflect upon their own learning experiences and use that process as a means to improve their own future teaching practices. With this in mind, we utilize drawing exercises in an attempt to promote this opportunity for reflection. The second author began incorporating drawings into an elementary mathematics methods course in early 2000. The first author began using the technique shortly after and together we have collected data of drawings from our prospective elementary teachers. Our archival data consist of several themes including teachers' depiction of "How I Feel about Math" and their portrayal of "My Math Teacher and Me." This study reports the findings from drawings of "My Math Teacher and Me."

We asked prospective teachers to draw their past mathematics learning experiences taught by their mathematics or homeroom teachers along with a descriptive paragraph at the beginning of a semester-long elementary mathematics methods course. At the end of the semester, the same assignment was given but students were instead asked to draw and write about their own mathematics classrooms in five years. The purpose of this activity is for prospective teachers to critically reflect upon the way they were taught and to mindfully plan and transform their own teaching. In this article we will discuss: (a) the emerging themes that respectively appear in the prospective teachers' reflections upon their past learning experiences and their future plans, (b) the possible factors that influence the prospective teachers' future plans, and (c) the implications for mathematics teacher educators.

Related issues in the literature

Issues on mathematics teacher preparation. Previous research studies on mathematics teacher preparation have developed into several themes including previous experiences, knowledge structures, and belief systems (Ambrose, Clement, Philipp, & Chauvot, 2004; Frykholm, 1999; Munby, Russell, & Martin, 2001). These themes are interrelated and ultimately influence the effectiveness of mathematics teaching methods. It has been purported that prospective teachers in the United States lack sound subject matter knowledge, and that their beliefs about mathematics teaching and learning do not quite match the new vision for teaching and learning (e.g., Ball, 1990; Ma, 1999). Teacher preparation programs offer various opportunities to enhance subject matter knowledge and to influence prospective teachers' beliefs. Even so, these beliefs are often difficult to change in the limited time the programs have. As noted in several previous studies, a major obstacle is the prior experience and

knowledge that prospective teachers carry into the program (e.g., Eisenhart, Borko, Underhill, Brown, Jones, & Agard, 1993; Thompson, 1992). In particular, the beliefs about what to teach and how to teach it have been shaped through years of experience spent observing what their own K-16 teachers did when they were students and it is almost unrealistic to completely unite their prior experience with the new vision of mathematics teaching (e.g., Ambrose, 2004). As Doerr, Lesh (2003) and others have noted, the prospective teachers' prior experience is obstacle, not because they have observed poor teaching, but because they have not been exposed to how teachers think. One problem for prospective teachers is that their actual teaching practice is commonly limited to a few hours in field experience settings when they take the mathematics methods course. Because of this, many researchers encourage teachers to reflect upon their own teaching as a way of changing their beliefs and determining best practice for their students (e.g., Cooney, 1999; Schön, 1983; Simon, 1995). With this in mind, we believe that reflecting upon their own learning experiences is an alternative way to provide prospective teachers with opportunities to think about effective teaching and learning processes.

Drawings as research method

Over the last several decades, psychologists and other researchers have utilized drawings to facilitate the rich exploration of children's and adults' views on multiple phenomena (Mitchell, Theron, Stuart, Smith, & Campbell, 2011). In the field of education, drawings are used predominantly to investigate young students' perceptions, emotions, and attitudes towards various content areas. For example, students' drawings of scientists and mathematicians were used to examine children's perceptions of mathematics and science (e.g., Finson, 2002; Picker & Berry, 2000). Zambo and Zambo (2006) used thought bubble pictures to examine students' feelings toward mathematics. Perceptions of literacy and environmental issues were also examined through students' drawings (e.g., Alerby, 2000; Kendrick & McKay, 2004). Some previous research studies suggested extending this method to include adults or pre-service and in-service teachers (e.g., Finson, 2002). Our archival data collection efforts are consistent with these suggestions. We recently discovered a number of published studies that use drawings to investigate prospective teachers' attitudes and feelings about mathematics (e.g., Burton, 2012; Rule & Harrell, 2006). The majority of research studies on pre-service and in-service teachers' subject matter knowledge, attitudes, and beliefs primarily use paper and pencil tests, structured interviews, or specific math concept related performance tasks. The alternative approach, utilizing drawings, can help to determine additional factors that influence prospective teachers' beliefs and knowledge that cannot be solely obtained by a paper and pencil survey or specific math concept oriented performance tasks. This approach may also provide a less stressful research environment. Realizing the existence of math anxiety in the general public (Burns, 1998) as well as in the teaching profession (Trice & Ogden, 1986/1987), we believe an alternative approach, like drawing, will provide ways of facilitating teacher candidates' self-reflection.

Methodology

Participants

We gathered two sets of drawings and accompanying written descriptions which respectively focused on prospective teachers' past mathematics learning experiences as students and their future plans as teachers. These samples were taken from 100 prospective teachers who enrolled in one of five sections of an elementary mathematics methods course over two semesters. This elementary mathematics methods course is a 4-credit, required course for all elementary education majors at a

Midwestern United States university and is typically taken prior to student teaching. All of the prospective teachers had successfully completed their mathematics content courses prior to this methods course. Participants consisted of 84 female and 16 male teacher candidates.

Throughout the semester, participants engaged in various modes of instruction, including lectures, large and small group discussions on theories and educational trends or issues, and hands-on activities that involved technology tools and manipulatives. In addition, participants were asked to complete several course assignments in their field setting while they interacted with actual students. Those assignments included developing and implementing a mathematics lesson and assessment for their field students.

Data source

Prospective teachers' reflections upon their past mathematics experiences and plans for future teaching were identified through the drawings and corresponding descriptions that they completed on two separate occasions during the semester. The first set of drawings and descriptions (Set 1) was collected at the second class meeting. Participants were asked to draw a picture that portrayed their past math teachers or other memorable mathematics learning experiences on a standard sheet of paper. Participants were also asked to include a written paragraph that described their picture and clarified the meaning embedded in their drawing, as suggested in other similar studies using drawings as research methods (Mitchell et al., 2011). These were shared in a small group discussion and a few volunteers even presented their drawings to the class. The second set of drawings and descriptions (Set 2) was collected on the last day class. This time, participants were asked to draw a picture that portrayed their own elementary mathematics classes in five years. Participants' drawings were presented in various formats including hand-drawings, computer clip arts, and collages. Some drawings contained realistic descriptions of classroom settings or people while others used metaphorical objects or words. In order to encourage participants to respond honestly, it was promised that the quality of their artwork and writing would not be assessed and students would earn full credits by simply completing their work. These two sets of drawings were worth approximately 5 percent of the total course assignment points.

Data analysis

Participants' drawings and written descriptions were examined based on aspects of open-ended coding and a double-coding procedure (Miles & Huberman, 1994; Strauss & Corbin, 1998). This study was not intended to utilize the pre/post design that asks the same question to compare changes. Instead, the sets of drawings and written descriptions were analyzed separately highlighting participants' views on teaching and learning mathematics when they positioned themselves in different roles (i.e., as a student or as a teacher).

We created a text translation of the drawings by listing specific items or settings depicted in each (e.g., "a crying face in the middle surrounded by numbers and signs of operations"). We then noted specific words and phrases in the corresponding written descriptions. The text translations and notes made from the written descriptions were used together as data and categorized into several themes. Initially, we reviewed the data independently to identify recurring themes and intentions. We then revised and refined the identified themes together through comparison and discussion and then coded our findings. Doing this together allowed us to resolve coding discrepancies immediately. After the completion of coding, frequencies of coded themes were

identified. In the results section, selected excerpts and examples of drawings were used to illustrate the common themes identified.

Results

Analysis of Set 1

Set 1 portrayed past mathematics learning experiences and was categorized into three main themes that represent positive, mixed, and negative feelings toward mathematics learning experiences. Table 1 shows the categories of themes and frequencies followed by additional explanations of the sub-themes identified.

Table 1. *Themes in Set 1*

Major Themes	Sub-Themes	Number of Entries (%)*
Positive experiences: Entries that describe positive aspects of past teachers or personal experiences in their classrooms	• Positive portrayal/description of teachers' and/or the participant's subject matter knowledge	4
	• Positive portrayal/description of teachers' and/or the participant's affective aspects	8
Mixed experiences: Entries that describe both positive and negative aspects of past teachers or personal experiences in their classrooms	• The participant's inconsistent perceptions about the teacher	4
	• The participant's liking of mathematics and disliking of the teacher's teaching practices	3
	• The participant's disliking of mathematics and liking of the teacher's teaching practices	4
	• Varying perceptions about mathematics by grade level	7
Negative experiences: Entries that describe negative aspects of past teachers or personal experiences in their classrooms	• Participants' negative emotions towards mathematics	18
	• Participants' negative emotions towards teachers	20
	• Physical distance and emotional disengagement between the teacher and student	22
	• Static nature/environment of math instruction	25

(* Note: The percentages total more than 100% as some entries contain multiple sub-themes)

It was noted that, even within one entry of drawing/description, participants frequently referred to several sub-themes; identifying multiple dimensions of their thoughts on the different aspects of teaching and learning that they experienced as students. Thus, one entry often contained multiple themes, particularly those that fell into the negative category. The coding process focused on whether the specific theme was present or absent in each participant's drawing/description.

Positive experiences. Twelve out of 100 entries expressed positive past math experiences with their teachers. While a few words/phrases referred to teachers' knowledge (e.g., knowledgeable, talented), most presentations and descriptions were about their emotional experiences. For example, some of the most frequently used expressions included: pictures of smiley faces, hearts, a teacher and a student holding hands, and words like fun, enthusiastic, approachable, supportive, helpful, and patient (see Figure 1).



Figure 1. Example of Set 1 drawing: Positive past math experiences

Mixed experiences. Eighteen entries contained both positive and negative experiences. These drawings and written descriptions illustrated participants' mixed emotions about their math teachers or the subject matter. For example, one entry was divided into two sections: one part has a sun and smiling faces, while the other part has clouds and lightning. Its written description states that the picture portrays two different sides of her teacher: very warm, funny, and helpful and at the same time very strict and moody (see Figure 2-a). The other entries in this category were divided into three subcategories: (1) Overall, I enjoyed math but did not like the way my teachers taught, (2) Overall, my teachers were great, but I did not like math, and (3) I had different experiences grade by grade; generally, positive experiences in the early grades, negative experiences in later grades (see Figure 2-b).



Figure 2-a

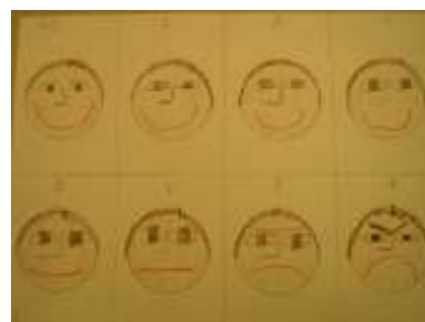


Figure 2-b

Figure 2. Examples of Set 1 drawings: Mixed experiences

Negative experiences. The remaining entries highlighted negative past experiences. Some negative images included sad faces, sleeping students, clouds, and multiple question marks. They often also included words like confusion, boring, frustrated, and struggle. These results support the idea that adults' math anxiety is deeply rooted in their early mathematics interactions with teachers (e.g., McLeod, 1992; Newstead, 1998). A few common themes in the drawings/descriptions further explained the root of participants' negative experiences: (1) A big emotional and physical distance between the teacher and the student, and (2) The static/unchanging nature of math instruction.

In terms of the emotional and physical distance, not a single drawing in the negative responses portrayed the scene of student and teacher working together. In most of the drawings, teachers were lecturing at the board in front of the classroom or were sitting at their desks or overhead projectors in front. Some drawings and written descriptions even went so far as to depict teachers' backs turned to their students. There was a distinct physical distance between teachers and students (see Figure 3-a).

Twenty-two entries in negative responses explicitly or implicitly expressed the emotional disengagement between teachers and students. Several extreme expressions include portraying teachers as monsters, witches, dead people, and even

a woman holding a gun (see Figure 3-b). Other drawings and descriptions in this category typically show teachers who love math and students who did not like doing math. For example, many pictures show teachers' outfits, materials in their desks, or posters around the classroom covered with positive and encouraging words, such as "I love math," "Math is so simple," "Math is fun," "Math is easy," "math + math = my life," "Math rocks." However, in the same pictures, the feelings and attitudes on the students' part were described quite negatively. Several examples include: teachers' names were "Mrs. Confusing" and "Mr. No fun"; teachers say "blah, blah..."; students say, "What am I doing here?" "I don't get it" "I don't understand"; students think "recess" or something else; students are sleeping (see Figures 3-c, 3-d, 3-e, 3-f).



Figure 3-a



Figure 3-b



Figure 3-c



Figure 3-d



Figure 3-e



Figure 3-f

Figure 3. Examples of Set 1 drawings: Emotional and physical distance between the teacher and the student

Regarding the depiction of math class and teachers' ways of teaching, 25 entries categorized as negative responses addressed the teachers' unchanging pedagogical practices or physical and emotional environments of math classrooms, saying: "teachers taught math pretty much the same way"; "K-8 math teacher were very similar"; "desks were in rows – never changed throughout the years." Typical images or descriptions included: students sit in rows, teachers showing examples on the board, students doing worksheets independently, students memorizing formulas, teacher giving homework, paper/pencil test, and showing all assignments coming from the textbook (see Figure 4-a, 4-b, 4-c).



Figure 4-a

Figure 4-b

Figure 4-c

Figure 4. Examples of Set 1 drawing: Static nature of math instruction

Analysis of Set 2

Drawings and written descriptions from Set 2 portray participants' math classrooms or themselves as active teachers in five years. This set illustrated the beliefs, pedagogical knowledge, and attitudes of participants, as they are close to becoming professional educators. Without doubt, the majority of Set 2 entries are predominantly positive, highlighting what kinds of teacher they want to be and what kind of math classroom they want to create. Table 2 shows the categories of themes and frequencies followed by additional explanations. Each entry can belong to multiple sub-themes according to the presence of specific themes in the drawings/descriptions.

Table 2. Themes in Set 2

Major Themes	Sub-Themes	Number of Entries (%)*
Uncertainty: Entries that describe mixed feelings about their future teaching	<ul style="list-style-type: none"> Mixture of some level of uncertainty and hope for improvement 	3
Emotionally supportive classroom: Entries that describe the teacher-student relationship	<ul style="list-style-type: none"> Teachers' encouragement of students Close physical distance between the teacher and student Students' positive attitude towards mathematics and teachers 	57 23 45
Incorporation of various teaching methods: Entries that describe various ways of teaching mathematics	<ul style="list-style-type: none"> Use of various representations Constructive pedagogy Connections 	74 55 25

(* Note: The percentages total more than 100% as some entries contain multiple sub-themes)

Uncertainty: Only three entries expressed some level of fear, frustration, confusion, and lack of confidence in their ability to teach mathematics effectively. They do show, however, that success increases as math-teaching experience is gained (see Figure 5).



Figure 5. Example of Set 2 drawing: *Uncertainty (gradual improvement)*

Emotionally supportive classroom. In 57 entries, participants expressed that they would emotionally support their students' learning. These drawings and descriptions clearly indicated teachers' efforts to encourage students as shown in statements and exclamations such as: "You can do it"; "There is no stupid question!"; "Go explore, you can do it"; and "My door is always open for questions." Smiling faces on both teachers and students appeared frequently in the drawings, as well. There were 23 entries that described close physical distance between the teacher and student (e.g., a teacher sitting at a round table with students, the teacher and students holding hands). In 45 entries, students' were shown making positive comments about mathematics and the teachers were identified (e.g., students saying "I am never frustrated in this math class", "We love our math teachers", "Math is fun", and "Math rocks".)



Figure 6-a



Figure 6-b



Figure 6-c



Figure 6-d

Figure 6. Examples of drawings in Set 2: Future plans

Incorporation of various teaching methods. Seventy-four entries demonstrated participants' willingness to incorporate a variety of representations in their math instructions. These entries included specific manipulatives, pictorial representations, and written and verbal explanations of the mathematical process. Fifty-five entries expressed the participants' desire to change the general format of instruction to be a more student-centered, cooperative learning environment. Examples mentioned include grouped seating arrangements, learning centers, group/partner work, and phrases such as "adaptable for all different types of learners", "learn from each other", "many ways to teach", "exploration" frequently appeared. Twenty-five entries showed participants' plans to make sense of mathematics through various mathematical connections. Included are connections within mathematics, literature, technology integration (e.g., virtual manipulatives, computer programs), and real-life applications. The drawings that highlighted the sub-themes in "emotionally supportive classroom"

and “incorporation of various teaching methods” are illustrated together in Figure 6 since most drawings in Set 2 addressed multiple themes.

Discussion and implications

In an attempt to examine teacher candidates’ reflections upon the way they were taught (Set1) and the way they want to teach (Set 2) in the near future, we present the common themes and features of prospective teachers’ drawings and written descriptions. Prospective teachers’ mathematics knowledge, beliefs, and attitudes will eventually be translated into their future teaching methods. Therefore, it is important for prospective teachers’ to be aware of their own perceptions toward teaching and learning mathematics. In this study, we provide prospective teachers with opportunities to reflect upon how they were taught and to envision how they will teach by bridging the gap between teacher candidates’ past mathematics experiences and future plans.

Findings from the negative images and words in the Set 1 drawings/descriptions explained the possible causes of participants’ mathematics anxiety that were investigated in previous research studies (e.g., Newstead, 1998; Taylor & Fraser, 2003; Trujillo & Hadfield, 1999). Also, the descriptions of their past teachers’ methods that highlight the static/unchanging nature of instruction confirm the findings in other studies addressing typical traditional math or science instruction (Battista, 1999; Schoen, Fey, Hirsch, & Coxford, 1999; Lindgren & Bleicher, 2005; Stodolsky & Grossman, 2000). The common features of typical mathematics classes in the previous studies and the current study include: mimicking what the teacher demonstrates; a focus on computational procedures; little relevance to students’ lives; and multiple drills and worksheets from textbooks with almost no exploration, investigation, or explanations. This study added additional data regarding prospective teachers’ past learning experiences and their perceptions of mathematics, which seem to be deeply imbedded and consistent.

We believe that the results in Set 2 depict participants’ reactions to synthesizing their past learning experiences. In other words, the reflection upon the prospective teachers’ past learning experiences using drawings provided an opportunity to elicit the reasons for the struggles they encountered as students and to respond to potential struggles that their future students might have. We also believe that the Set 2 results were influenced by the prospective teachers’ learning experiences in the methods course. The multiple pedagogical measures demonstrated and used in the methods course might influence the prospective teachers’ depiction of their future mathematics classrooms.

We believe that the reflection process we initiated using drawings along with written descriptions encouraged participants to develop plans to bridge their past and future mathematical teaching experiences. We believe that their plans will continue to change throughout their professional lives as teachers. These prospective teachers now know how they think and how other prospective teachers think about teaching mathematics. The implications for math teacher educators are paramount: this activity assimilates prospective teachers’ identities as math students and as math teachers and provides a window into the thinking of others. As this study contributes to raising awareness about the gap between past experience and future math teaching, the importance of modeling through constructivist pedagogy and reflective practice is evident. These prospective teachers will not mindlessly be cutting off a small “slice of the roast” unless it needs to be done in order to fit into the pan!

A follow-up study is needed to resolve some limitations of this study. We noticed that the importance of the teachers’ subject-matter knowledge was very vaguely represented in the drawings/descriptions. For example, some participants stated that

they felt much more confident and comfortable after taking this methods course without specifics. Of course, to utilize various instructional methods, teachers must hold strong subject-matter and pedagogical knowledge. However, it is not clear whether or not participants implicitly addressed the importance of teacher subject-matter knowledge in the way we interpreted. It is also not evident whether or not this result indicates that participants weighed more affective aspects than cognitive aspects as qualities of good math teachers. This result may be influenced by the fact that this study was conducted within the context of a methods course and the immediacy of the methods experience the participants had just encountered. The key question would be whether or not this tendency persists and to what degree of intensity does it persist once the participants are in the field. Thus, it will be a meaningful follow-up study involving prospective teachers as they become novice in-service teachers to determine if the same gains hold for participating in the methods course.



Ji-Eun LEE is an Associate Professor at Teacher Development and Educational Studies (TDES), School of Education and Human Services (SEHS), Oakland University (OU), Rochester, M. Her research interest is focus on mathematics teaching, teacher education.

Mary ZEPPELIN is a special instructor at Oakland University, is distinguished as an outstanding teacher. She is also recognized for changing the traditional methods of teaching mathematics, as advocated by the National Council of Teachers of Mathematics, in the areas of middle school classroom teaching, university teaching, publishing innovative curricula, and presenting professional development workshops and service.

References

- Alerby, E. (2000). A way of visualizing children's and young people's thoughts about the environment: A study of drawings. *Environmental Education Research*, 6(3), 205-222.
- Ambrose, R., Clement, L., Philipp, R., & Chauvot, J. (2004). Assessing prospective elementary school teachers' beliefs about mathematics and mathematics learning: Rationale and development of a constructed-response-format beliefs survey. *School Science and Mathematics*, 104(2), 56-70.
- Ambrose, R. (2004). Initiating change in prospective elementary school teachers' orientations to mathematics teaching by building on beliefs. *Journal of Mathematics Teacher Education*, 7, 191-119.
- Ball, D. L. (1990). The mathematical understandings that prospective teachers bring to teacher education. *Elementary School Journal*, 90, 449-466.
- Battista, M. T. (1999). The mathematical miseducation of America's youth [Electronic version]. *Phi Delta Kappan*, 80(6), 424-433.
- Burns, M. (1998). *Math: Facing an American phobia*. Math Solutions Publications.
- Burton, M. (2012). What is math? Exploring the perception of elementary pre-service teachers. *IUMPST: The Journal, Vol 5 (Teacher Attribute)*. [www.k-12prep.math.ttu.edu]

- Cooney, T. (1999). Conceptualizing teachers' ways of knowing. *Educational Studies in Mathematics*, 38, 163-187.
- Doerr, H.M. & Lesh, R. (2003) A modeling perspective on teacher development. In R. Lesh & H.M. Doerr (Eds.). *Beyond constructivism: A models and modeling perspective on mathematics problem solving, learning and teaching* (pp.125-139). Hillsdale, NJ: Lawrence Erlbaum.
- Eisenhart, M., Borko, H., Underhill, R., Brown, C., Jones, D. & Agard, P. (1993). Conceptual knowledge falls through the cracks: Complexities of learning to teach mathematics for understanding. *Journal for Research in Mathematics Education*, 24(1), 8-40.
- Finson, K. D. (2002). Drawing a scientist: What we do and do not know after fifty years of drawings. *School Science and Mathematics*, 102(7), 335-345.
- Frykholm, J. A. (1999). The impact of reform: Challenges for mathematics teacher preparation. *Journal of Mathematics Teacher Education*, 2, 79-105.
- Hinchey, P. H. (1998). *Finding freedom in the classroom: A practical introduction to critical theory*. New York: Peter Lang.
- Kendrick, M., & McKay, R. (2004). Drawings as an alternative way of understanding young children's constructions of literacy. *Journal of Early Childhood Literacy*, 4(1), 109-128.
- Langer, E. J. (1989). *Mindfulness*. Reading, MA: Addison-Wesley.
- Lingren, J. & Bleicher, R. E. (2005). Learning the learning cycle: The differential effect on elementary preservice teachers. *School Science and Mathematics*, 105(2), 61-72.
- Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah, NJ: Erlbaum.
- McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D.A. Grouws (Ed.). *Handbook of research on mathematics teaching and learning* (pp.575-596). New York: Macmillan.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage.
- Mitchell, C., Theron, L., Stuart, J., Smith, A., & Campbell, Z. (2011). Drawing as research method. In L. Theron et al (eds.), *Picturing research: Drawing as visual methodology* (pp. 19-36). Rotterdam, Netherlands: Sense Publishers.
- Munby, H., Russell, T., & Martin, A. (2001). Teachers' knowledge and how it develops. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed.) (pp.877-904). Washington, DC: American Educational Research Association.
- National Council of Teacher of Mathematics. (2000). *The principles and standards for school mathematics*. Reston, VA: NCTM.
- Newstead, K. (1998). Aspects of children's mathematics anxiety. *Educational Studies in mathematics* , 36, 53 – 71.
- Picker, S. H. & Berry, J. S. (2000). Investigating pupils' images of mathematicians. *Educational Studies in Mathematics*, 43(1), 65-94.

- Rule, A. C. & Harrell, M. H. (2006). Symbolic drawings reveal changes in preservice teacher mathematics attitudes after a mathematics methods course. *School Science and Mathematics, 106*(6), 241-258.
- Schoen, H. L., Fey, J. T., Hirsch, C. R., & Coxford, A. F. (1999). Issues and options in the math wars. *Phi Delta Kappan, 80*(6), 444-453.
- Schön, D. A. (1983). *The reflective practitioner: Toward a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.
- Simon, M. (1995). Reconstructing mathematics pedagogy from a constructivist perspective. *Journal for Research in Mathematics Education, 26*(2), 114-145.
- Stodolsky, S. S. & Grossman, P. L. (2002). Changing students, changing teaching. *Teachers College Record, 102*(1), 125-172.
- Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage Publication.
- Taylor, B.A., & Fraser, B.J.(2003). *The influence of classroom environment on high school students' mathematics anxiety*. (ERIC Document Reproduction Service No. ED 476644).
- Thompson, A. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp.127-146). New York: Macmillan.
- Trice, A. D., & Ogden, E. D. (1986/87). Correlates of mathematics anxiety in first-year elementary school teachers, *Educational Research Quarterly, 11*(3), 3-4.
- Trujillo, K.M., & Hadfield, O.D. (1999). Tracing the roots of mathematics anxiety through in-depth interviews with preservice elementary teachers. *College Student Journal, 33* (2), 219-232.
- Zambo, D. & Zambo, R. (2006). Using thought bubble pictures to assess students' feelings about mathematics. *Mathematics Teaching in the Middle School, 12*(1), 14-21.

www.iejee.com

This page is intentionally left blank