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Beyond Reflection: Using Word Clouds to Support Metacognitive Processes in Preservice Teacher Mathematics Education

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Beyond Reflection: Using Word Clouds to Support Metacognitive Processes in Preservice Teacher Mathematics Education

Abstract

In this study, the authors present the results of using word clouds as a tool in reflection to examine the potential for metacognitive process around pedagogical practice with preservice teachers (PSTs). This research utilized a qualitative method and case study design to answer the question, what is revealed about the metacognitive process of PSTs in an elementary mathematics methods course using word clouds as a learning tool to supplement reflection? The authors examined the effect of incorporating a pre- and postcourse written reflection assignment supplemented by a word cloud. The tool provided multiple perspectives and a visually enhanced image of written reflections to promote critical thinking about teacher beliefs and practice. In the results, three practiced based subcategories emerged: a deeper understanding of beliefs about professional practice, an acknowledgement of professional growth, and an increased perception of teaching efficacy. This study elucidates the juxtaposition between metacognition and PST beliefs, growth, and self-efficacy.

Introduction

As reform in teaching mathematics collides with the instructional foundations that many preservice teachers (PSTs) experienced as learners (White-Clark, Di Carlo, & Gichriest, 2008), challenges exist for methods courses to overcome PST beliefs often grounded in previous negative mathematical experiences. For many PSTs, learning mathematics consisted of memorizing a procedure taught by the teacher and repeated by the students (Fieman-Nemser & Remillard, 1996). This approach to learning limited a student's ability to understand the connected nature of the concepts of mathematics. Deep conceptual understandings are necessary for teaching mathematics in today's rigorous standards-based environment, and this depth often is lacking in elementary PSTs (Kajander, 2010). A critical component to teacher education programs is addressing the complex link between how students have learned mathematics themselves and how they are expected to teach elementary mathematics today (Lannin & Chval, 2013). Engaging in intentional reflection and metacognitive activities related to one's personal beliefs and experiences related to the teaching and learning of mathematics offers teacher education programs one way to address this problem. Through technology-integrated reflection assignments and an intentional metacognitive process, this research

explored the results of engaging PSTs in repeated reflection related to their previous and emergent personal beliefs about teaching mathematics.

Reflection and metacognition are similar concepts, although they are defined differently in literature. Each process holds a prominent role in teacher education and developing teacher practice (Darling-Hammond, 2006; Saylor & Johnson, 2014). "Reflection is an act of looking back in order to process experiences. Metacognition, a type of reflection, is a way of thinking about one's thinking in order to grow" (University of Michigan, n.d.), thereby making these concepts powerful tools for PST educators seeking a shift in pedagogical practice for elementary mathematics teachers. Reflecting back upon previous learning experiences with mathematics and simultaneously looking forward into one's future teaching practice may facilitate this shift. Metacognition and reflection are terms often used interchangeably, but most researchers distinguish metacognition as a particular form of reflection. According to Donelly and Linn (2014),

> The concept of metacognition refers to an individual's ability to monitor his or her own thinking. A metacognitive learner recognizes what he or she understands, when he or she needs more information, and what his or her strengths and weaknesses are related to the learning (p.41).

Effective practice in PST education includes the opportunity to apply metacognitive processes when thinking about one's own strengths or weaknesses, and the cyclical reflective action that has in developing teaching practice. A goal of the elementary mathematics methods course in this study was to engage PSTs in new learning experiences related to mathematical content and pedagogy. Simultaneously, PST was guided to actively reflect upon the differences between these new experiences and previous ones during their elementary education. Establishing an awareness of the influences that contributed to their beliefs about teaching mathematics allowed PSTs to redesign the vision of their future practice in a way that is more consistent with current, desirable mathematics teaching. Research has shown that elementary PSTs often have anxiety and misconceptions related to teaching mathematics (Vinson, 2001), and so the intent of this course was to simultaneously address teaching methods as well as reflect upon teaching beliefs. The metacognitive process applied critical thinking skills to extend the reflection process and enhance professional growth, allowing PSTs to evolve beyond the limiting nature of negative prior experiences and ineffective teaching methods during their own education.

Preservice teachers in this study extended beyond conventional written reflection assignments by integrating technology to convert their reflections into word clouds for additional discussion and analysis. The University of Oxford

(n.d.) defines a word cloud as, "a graphical representation of word frequency that presents a picture of the most common words used with those used more often displayed larger." Word clouds are widely used as visual analytics to understand content quickly (Liu, Shen, & Hu, 2015; Miley & Read, 2011). The simple visual image created by word clouds can support learning through multiple perspectives by enabling the student to both read and see their reflections. Miley and Read (2011) highlighted the ability of the word cloud to offer a personalized learning experience for students by engaging the reflective process from a variety of perspectives and uniquely created for each student. Henniger (2003) also believed in providing the opportunity for students to intentionally reflect, and this application of technology extends beyond other common ways to integrate technology such as for writing or organizing information.

In this study, the authors present the results of using word clouds as a tool in pre- and post-course reflection assignments in an elementary mathematics methods course. The authors explored the question: What is revealed about the metacognitive process of preservice teachers in an elementary mathematics methods course using word clouds as a learning tool to supplement reflection? Data revealed that this experience activated a metacognitive process focused on a future goal of teaching mathematics.

Theoretical Framework

The theoretical concept of metacognition grounded this study. Flavell (1979) was one of the seminal researchers who described metacognition as a concept that deals with both knowledge and experiences. This conceptualization supports metacognition as a focal theory, as participants were actively engaged in concurrent thinking about prior and present knowledge and experiences related to mathematics teaching. Building upon this description, Brown and Palincsar (1982) offered the definition that metacognition refers to knowledge about cognition and regulation of cognition. After both Brown (1987) and Flavell (1987) more fully developed the idea of metacognition, Artzt and Armour-Thomas (1992) identified behaviors that aligned to metacognitive activities, providing the analytical structure for the findings of this study. The identified behaviors included understanding, analyzing, and planning as predominantly metacognitive activities, while implementing, exploring, and verifying were classified as activities that could be either cognitive or metacognitive (Artzt & Armour-Thomas, 1992). Using this framework of research and the established recognizable behaviors to guide this investigation helped to improve the validity of the research findings. Because PSTs were expected to reflect and regulate

personal cognition as it related to their beliefs about teaching mathematics, metacognition provided a sound framework.

Literature Review

Reflection and Teacher Education

Many researchers acknowledge reflection as an integral part of PST preparation (Darling-Hammond, 2006; Jay & Johnson, 2002; Khourey-Bowers, 2005; Ottesen, 2007; Ray & Coulter, 2008; Richardson, 1990; Saylor & Johnson, 2014), but the act of reflecting remains complex and elusive to define or teach (Jay & Johnson, 2002). At the foundational level, the critical role that reflective practice holds for teachers was highlighted by Dewey (1933), who conceptualized reflection as, "thinking that is the active, persistent and careful consideration of any belief or supposed form of knowledge in light of the grounds that support it and the further conclusions to which it leads" (p. 6). Since then, reflective practice research evolved through various typologies including the definition, process, and content of reflection (Jay & Johnson, 2002). Building on the work of Dewey, Schön (1987) described reflective practice as "a dialogue of thinking and doing through which I become more skillful" (p.31). Osterman (1990) further defined reflective practice as "a more challenging, focused, and critical assessment of one's own behavior as a means towards developing one's own craftsmanship" (p. 135), noting the distinct differences between reflective thinking and reflective practice, making this concept particularly useful in teacher education courses.

Kolb (1984) promoted reflection as a means to promote critical analysis and problem solving, but Ray and Coulter (2008) highlighted that "Reflection can be as simple as asking questions such as, 'What just happened?' or as metacognitive as, 'What would I do differently if I were to do this again?'" (p. 7). These key questions capture the essence of this study by requiring PSTs to examine their own mathematical understandings and redesign more effective methods for their future students. By guiding teachers through a metacognitive examination of their beliefs about teaching mathematics, PSTs can authentically experience the power of reflective practice as well as cultivate similar metacognitive strategies in their future students (Lambert & Cuper, 2008). Researchers have found that when metacognition as a type of reflection is used to allow PSTs to examine their own misconceptions or uncertainties, they are able to develop new approaches and grow as reflective practitioners (Capobianco, 2007; Lambert & Cuper, 2008; Ray, Powell, & Strickland, 2006).

The Influence of Technology on Reflection

Prior research on the benefits of integrating technology to enhance systematic self-reflection and metacognition (Lambert & Cuper, 2008) prompted the need for this study exploring other technology based tools and their potential application to teacher education. Such cognitive monitoring of teaching beliefs can have a significant role in achieving the desired shifts necessary for elementary mathematics teaching (Kajander, 2010). The process can help PSTs identify a concrete goal to overcome past negative experiences in learning mathematics and regulate progress towards a new goal (Flavell, 1976). Other researchers who built upon the work of Flavell (Hacker, 1998; Larkin, 2010; Whitebread et al., 2008) also supported this position. For example, Larkin (2010) defined metacognition as "the process of reflecting on our own thinking and keeping track of how our thinking is getting us closer to or further away from our goal" (p. 12).

Lambert and Cuper (2008) explored the direct connection between reflection and the ability of technology to support reflection in a relevant way. By infusing technology to enhance the educational process, teacher education programs can provide relevant and authentic experiences that will prepare tomorrow's teachers to explore ways that capitalize on emerging technology. Solvie and Kloek (2007), for example, explored the ability of technology to support a constructivist approach to learning as well as cultivating communication and collaboration outside of the classroom environment. Similarly, Ray and Coulter (2008) examined the application of weblogs as a tool for reflection. This study builds upon prior research related to the use of technology to enhance the writing process for reflection, such as a weblog or online journals (Ray & Coulter, 2008). Differently, this research incorporated a word cloud to offer multiple perspectives and a visually enhanced image of PST reflections to promote critical thinking about teaching beliefs and practice.

Method

This research utilized a qualitative method and case study design to answer the question, what is revealed about the metacognitive process of preservice teachers in an elementary mathematics methods course using word clouds as a learning tool to supplement reflection? The exploratory research question combined with a structured analysis illustrates a common feature of qualitative projects, which is to create understanding from data in a way that logically links the research question and analysis, a clarifying characteristic of a qualitative case study identified by Yin (2009). This case study was bound by the

reflection assignments under analysis within the context of the mathematics methods course (Merriam, 1998).

Setting and context. The elementary mathematics methods course that employed the use of the word cloud for supplementing reflection enrolled twelve female undergraduate PSTs, all who acted as participants in the study and were pursuing a degree in elementary education. The course met for 90 minutes twice a week for 15 weeks. The course instructor, one author for this study, began the semester with a reflection assignment and also had students use an online word cloud generator to convert the reflection into a word cloud image. The writing prompt simply asked students to reflect upon how they feel about teaching elementary mathematics. At the conclusion of the semester and using the same reflection prompt, students repeated the assignment. The students were asked to write a summative reflection about the role of the word cloud in their learning. Following this assignment, the instructor conducted an in class discussion on the overall experience of this multistep exercise.

The integration of a written reflection, enhanced by the visual depiction of the reflection, and then an examination and discussion of the generated word cloud offered a unique and integrated strategy for this study. By presenting a learning opportunity in a variety of modalities that spans diverse learning preferences, students were encouraged to engage in deeper understanding rather than simple, surface level learning (Biggs, 1999; Franzoni & Assar, 2009; Marton & Saljo, 1997). The class discussion of the word cloud activity simulated one method that Jacobse and Harskamp (2012) recommended to promote metacognitive thinking, which is verbalizing thoughts around a task. This process also applied best practice for designing metacognitive activities from Lin's perspective (2001), which emphasized the support of the social environment. The experience, itself, can build knowledge about oneself as a learner and subsequently, learning was enhanced (Lin, 2001; Donelly & Lin, 2014; Kuhn & Dean, 2004).

Data sources. The data for this study derived from two primary sources. First, researchers examined the final reflection assignment on the overall, multi-step process. Second, the course instructor took detailed hand written field notes during the class session when final reflections were discussed. Each student reported aloud on their use of the tool and the ways in which it influenced their thinking about the reflection assignment in relation to course content. The researchers used the actual pre- and postcourse reflection papers responding to the prompt and the word clouds as secondary data sources for triangulation and to

validate and/or dispute findings identified from the summative word cloud reflections (Creswell, 1998; Maxwell 2010).

Data analysis. Qualitative data analysis procedures were used to examine the summative word cloud reflection papers and field notes. Specifically, the researchers applied a directed approach for content analysis. This approach to data analysis was most appropriate since existing theory and key concepts related to metacognition guided the initial analysis, and thus facilitated the first coding scheme (Hsieh & Shannon, 2005). This approach, referred to as deductive category application by Mayring (2000) is a more structured process of content analysis than the conventional approach (Hickey & Kipping, 1996) through the use of guiding categorical codes rather than emergent ones.

The initial directed analysis of the reflection papers and discussion field notes sought to determine the presence of metacognitive thinking by using coding categories aligned to the metacognitive behaviors defined by Artzt and Armour-Thomas (1992) including understanding, analyzing, and planning constituting predominantly metacognitive activities. Relevant phrases and terminology expressed in the data that represented evidence these metacognitive behaviors were noted within each of the guiding codes. Text that revealed terminology consistent with implementing, exploring, and verifying were noted as secondary codes since Artzt and Armour-Thomas (1992) identified these behaviors as either cognitive or metacognitive. In these cases, data were further examined for contextual use to determine proper classification. The authors first independently coded reflection data and after independent review, the authors collaborated to compare and discuss discrepancies in either explicit or contextually implied evidence of these themes.

Upon establishing consistent evidence of the initial codes aligned with the analytical framework of Artzt and Armour-Thomas (1992), a secondary analysis of only the data revealing metacognitive thinking was performed. A secondary analysis of the initial findings revealed three emergent practice-based subcategories: a deeper understanding of personal beliefs about professional practice, an acknowledgement of professional growth, and an increased perception of teaching self-efficacy. To ensure the reliability of the secondary analysis categories, the researchers once again worked independently and then collaboratively, triangulating the findings with the word cloud images to support the written reflections and field notes of the final class discussion.

Findings

In this study, the authors gained insight into the use of word clouds as a tool to promote metacognition in PST reflection assignments and the influence of the metacognitive process on PSTs beliefs. This study met the need to support different preferences when learning, in this case written, visual, and verbal, in the higher education classroom. Preservice teachers examined their own thinking using word cloud images that displayed prominent visual patterns of professional and personal vocabulary expressed in class reflection assignments. In doing so, data revealed evidence of metacognitive behaviors and insight into deeper understandings of personal beliefs about professional practice, an acknowledgement of professional growth, and an increased perception of teaching self-efficacy. The class reflection assignments, supported by the word cloud, prompted significant metacognitive thinking that influenced changes in personal teaching beliefs. Research has demonstrated the ability of technology to support metacognition (Ray & Coulter, 2008). This study extends upon prior research by demonstrating the use of word clouds to activate metacognitive thinking. Data from this study showed a prominent connection to metacognitive behaviors identified by Artzt and Armour-Thomas (1992).

Figure 1 below demonstrates the process and categories used for primary and secondary data analysis resulting in three, practiced based themes. The primary analysis focused on all gathered data for metacognitive or potentially metacognitive behaviors articulated by Artzt and Armour-Thomas (1992). A secondary analysis of identified metacognitive behaviors revealed the primary findings for this study.

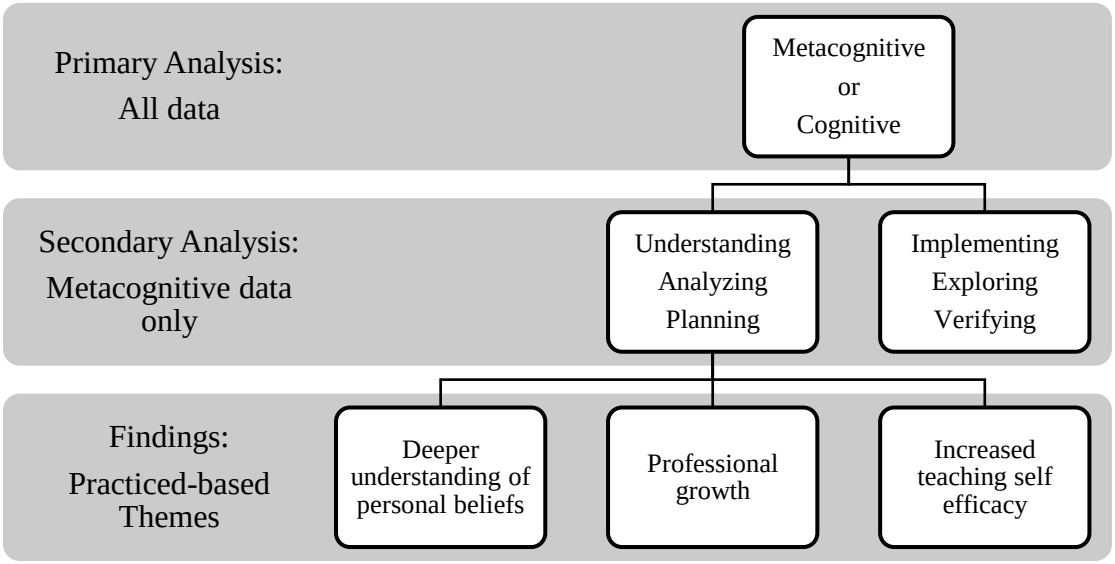

Figure 1. Data analysis and coding process.

Metacognitive Behavior

Understanding and verifying. Clear evidence existed in PSTs language revealing both understanding and verification of thinking. For instance, one student wrote, "I have a very negative view on teaching math", verifying her personal beliefs. Another student said, "I like the way this word cloud came out because it definitely stressed the important parts of my paper. I was very pleased with the outcome. The biggest words in my cloud are students, confident, building, and love, and seem to be the most important in my teaching philosophy." Another student who discussed her mathematics anxiety in a candid way demonstrated an understanding of her past experience as an influence in this negative emotion by writing, "Two of the largest words in my word cloud were confused and confusion. I think that these accurately represent my attitude towards math based upon my past experience." One student's response demonstrated the ability of the word cloud to validate her professional decision to become a teacher by writing, " I also noticed that "students" was the second biggest word used in my Wordle. This is significant to me because it reminded me why I want to be a teacher in the first place, for the students."

Analyzing and exploring. The analysis of data allowed researchers to draw connections between PSTs' language that both analyzed and explored their

thinking as revealed through the word cloud, each of these instances representing metacognitive processes. One student wrote, "The biggest words stress the importance of the teacher and student relationship through learning." This response highlighted the student's analysis of the word size and the abstract construct that size represented to her, which was the relationship between the student and teacher. Another student expressed how this creative approach facilitated her ability to visually analyze her growth with, "I can visualize my reflection and see how much I have improved!" A different student took a similar approach by analyzing her word cloud and stating, "After doing my Wordle, I was happy to see that the words on it were much more positive than last time. My first Wordle was full of negative words such as "stress", "nervous", "fear", and "worried". One student's exploratory thinking was apparent when she wrote, "This was the first time that I had ever used a word cloud and I thought it was very interesting. It was funny, however, to see words from my anecdotal story come to life."

Planning and Implementing. The planning and implementation of lessons is a critical part of teacher education. The findings of this analysis revealed the ability of the word cloud to assist students with clarifying their future planning and implementation of mathematics lessons, specifically after completing a mathematics methods class. For instance, one student wrote, "I want my students to love and be confident in math, I want to be able to teach math in an effective way so that my students understand the basic building blocks of math." Several responses provided further evidence of PST's thinking about the planning and implementing of future lessons prompted by the use of the word cloud technology:

> This could be a good tool for students in the classroom to show their work off. . . . Students can present work using the word cloud using the keywords that have been selected. . . . I would definitely use word clouds in my future classroom! . . . . This word cloud is something I would love to do with my students in the beginning and end of each school year. . . .Reason was a big word on my cloud, which may seem meaningless at a glance, but by teaching students the reason behind the formulas they can become critical thinkers and truly understand mathematical thought and its importance.

Influences on Preservice Teachers' Beliefs

As PST educators, the opportunity to further explore the intersection of the metacognitive process and variables that effect teaching and learning became apparent through the secondary data analysis of this study. These critical and

influential variables included personal beliefs, self-efficacy, and professional growth. Preservice teachers' summative reflections on using technology to create word clouds provided clear evidence of this activity activating metacognitive behaviors, thereby expanding the process of reflection to critically thinking about one's own thinking. Sub-categorical themes also emerged from this analysis that suggested the metacognitive process having an influence PSTs developing teacher practice. These themes included establishing a deeper understanding of personal beliefs and professional practice, an acknowledgement of professional growth, and an increased perception of teaching self-efficacy.

Deeper understanding of personal beliefs and professional practice. Preservice teachers expressed a deeper understanding of personal beliefs and future professional practice. The specificity and sophistication of responses revealed an understanding of the critical connection between these important elements in developing teachers. For instance, 5 of the 12 PSTs directly addressed the importance of the relationship between students and teachers in the learning process, one specifically referenced her wish to have the classroom feel like "family". Also, 7 of the 12 students articulated a clear understanding of how their past experiences have influenced their beliefs and understandings about teaching mathematics, including the negative influence these beliefs can have on their future practice. Of these seven students, five expressed an intentional desire to not replicate their own negative experiences in their future classrooms. This finding is meaningful because the specific impact that teacher beliefs can have on student achievement is apparent in prior research (Battista, 1999; Ernest, 1988; Pittman, 2002), and Battista, in particular, explained how teachers with misconceptions or incorrect beliefs can be detrimental to student learning.

Data analysis further revealed an examination of beliefs and practice through comments such as:

> Having this perspective about my own thoughts and feelings truly brings to life how I
>
> > feel on the inside . . . By teaching students the reason behind the formulas they can become critical thinkers and truly understand mathematical thought and its importance
> >
> > . . . .the big main words of stress and confusion on my word cloud helped me see how it reflects my description of math and my math anxiety. . . .After reflecting upon my word cloud and having this class, I see more clearly than ever the importance of conceptual learning in math.

Acknowledgement of professional growth. Preservice teachers articulated a feeling of professional growth, specifically from the precourse

reflection to the postcourse reflection. One student, in particular, actively decomposed her prior understanding and elaborated on the development and growth towards new understandings:

> After looking at the word cloud of my essay, the main words that I see are confidence, mathematics, manipulatives, teaching, and math. In my first word cloud of my first reflection of the class, confidence was the common word that was one of the frequently used words as well. Looking back on the semester's course, I think I had different definitions of confidence. In the beginning of the semester, I had confidence in my own math academic ability. On the other hand, I now have the confidence to actually teach mathematics to my future students. Therefore, I can connect my confidence of my math ability with my self-confidence in teaching math (see Figure 2).

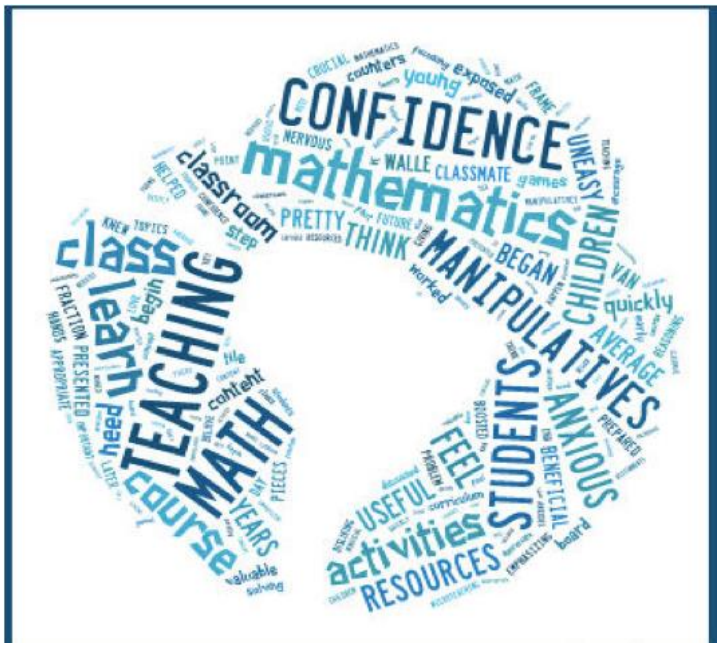

Figure 2. Preservice teacher word cloud reflection.

Similarly related to professional growth, another student explicitly wrote, "Comparing this word cloud to my first one, they seem like a completely different person wrote them. These words are more positive and they show growth." One PST connected the technology's ability to support her visually in recognizing her growth by stating, "I love making these word clouds because I can visualize my reflection and see how much I have improved!"

In a more general sense of growth, several students referenced the larger words in subsequent reflections as being "more positive" or demonstrating their dispositions about math as being "more at ease", thereby detecting a change within themselves about which they were "happy". In a distinct description of growth, one participant wrote, "One word that really stuck out to me as one of the larger words was "learned". I was glad that came up a lot in my essay, because after this class I honestly feel as though I learned so much about teaching math to young children."

Increased perception of teaching self-efficacy. A final theme that emerged related to teaching self-efficacy. More specifically, an active acknowledgement of growth students gained by using the visual tool contributed to an increased perception of teaching self-efficacy. Strong support for this theme was apparent with 10 of the 12 students using language such as confidence, love of math, being at ease to teach, motivated to help their future students learn and benefit from class activities, and feeling less intimidated, anxious, and fearful of teaching mathematics. One student expressed this clearly by writing,

> Words that appear a little smaller than last time on this word cloud, such as intimidated, confident, different, and anxious also apply to my teaching philosophy in math because I want to teach my students in a different way so their outlook on math will not be negative. I plan to motivate my students to be confident, rather than intimidated and anxious like I was.

Finally, one participant articulated her growth and improved efficacy after examining her word cloud by saying,

> The biggest words are math, understand, students, teach, important and confidence, showing that I am more welcoming to math and to teaching math in the future than I ever thought I would be. I not would consider myself confident to teach math, but after everything I learned this semester, I am happy to say that I am confident and ready (see Figure 3).

Figure 3. Preservice teacher word cloud reflection.

The culmination of these findings demonstrated that the integration of technology using word clouds coupled with reflection can prompt meaningful metacognitive thinking in PSTs education. This metacognition, in turn, revealed a change in PST thinking and beliefs consistent with the necessary paradigm shifts for teaching mathematics more effectively to today's learners. More importantly, this project demonstrated that a visual extension of a written reflection assignment using a word cloud can activate a metacognitive process that can have positive influences on PST education, growth, efficacy, and practice. By intentionally infusing creative technology tools purposefully into the design of teacher education programs, instructors can provide authentic experiences that will help prepare tomorrow's teachers to explore ways to capitalize on other emerging technology, as well. In mathematics method education, this combination of experiences and the resulting benefits demonstrated in this study have the potential to address the current gap in mathematics education.

Limitations

Limitations exist for research that applies a directed approach to analysis, as this approach somewhat challenges the naturalistic paradigm upon which qualitative research relies (Hsieh & Shannon, 2005). By using metacognitive theory and associated behaviors to initiate data analysis and coding, the potential exists for researchers to infuse bias into the results and find evidence that is in support of the identified theoretical base or to be blind to other contextual aspects

of the gathered data (Hsieh & Shannon, 2005). To minimize these limitations related to neutrality or objectivity (Lincoln & Guba,1985), researchers independently performed the primary analysis prior to collaborating and refining the coding of data, to allow for discussion on discrepancies in the identified evidence of each theme. Furthermore, researchers remained open to sub-catagories that extended beyond the codes established, which allowed for extended findings (Hsieh & Shannon, 2005).

Contributions to Practice

These findings are important for methods course designers and instructors because Lin (2001) acknowledged that designing metacognitive activities that can influence multiple forms of development is both "a theoretical and practical challenge" (p. 23). Additionally, prior research has shown that PSTs beliefs have a significant influence informing teacher practice (Pajares, 1992; Wilkins, 2008), and that the need to gain a clear understanding of teacher beliefs has been clear in teacher education research (Pajares, 1992). Engaging PSTs in exercises such as those used in this study provide evidence of the connection between metacognitive thinking and the ability to influence essential variables for developing teachers such as belief systems and self-efficacy. In a teacher education methods class, this is critically important because these beliefs may either promote or resist the potential impact of teacher education on developing pedagogy for PSTs. Current research continues to show that PSTs enter teacher preparation programs with a skewed vision and belief system related to the teaching and learning of mathematics, often formed by previous negative experiences (Greshman, 2009; Grossman et al., 2009). This study elucidates the juxtaposition between metacognition and PST beliefs, growth, and self-efficacy. Experiences such as the reflection assignments in this course, guided by the technology driven metacognitive process, may serve as a way to dismantle PSTs existing beliefs grounded in negative experiences and revise their perspectives for future teaching.

This research further highlights and extends the word cloud's ability to activate metacognition, and also emphasizes the implications for teacher education when PSTs are prompted to think about thinking. Findings illustrate the process of metacognition using a visual prompt to support another type of reflection. The use of technology extended an assignment beyond written reflection, while allowing PSTs to experience authentic exercises that also may inform their intentions for future teaching strategies. This integrated approach extends metacognitive teaching strategies in such a way that capitalizes on technology integration, which also attends to PSTs multiple learning preferences

and the ability to teach diverse learners. Supported by the transfer of visual processing, word clouds allowed a perspective to be represented in the reflective thought process. This study draws attention to the ability of word clouds to contribute to metacognition, and also accentuates the influence this metacognitive process can have on PSTs personal understandings and beliefs, professional growth, and teaching self-efficacy.

As educational practices proceed through substantial shifts in the 21st century, teacher candidates are expected to teach differently than they learned themselves in elementary school. Tools in technology, creativity, critical thinking, and a focus on deeper understanding are an emphasis that is prominent in today's educational environment. Rather than a passive approach to learning, teacher candidates must be engaged in their own reflection in order to grow professionally into the practice of becoming an effective teacher. Metacognitive skills promote deeper learning and can empower teacher candidates to have the confidence to become sound instructional decision makers. Further inquiry blending tools in technology, such as word clouds, around metacognition as a reflective practice would add to this emerging line of research and perhaps be used in future course design. This study illustrates how embedding creative uses of technology can enhance course design and elevate the promise of methods courses and their ability to be a positive influence on future teaching practice.

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