Integrating oral presentations in mathematics content courses for pre-service teachers

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In this paper we report on a study of assessment-based oral presentation tasks in a mathematics content course for pre-service teachers at a public university in the western United States. We used statistical inference to test for the significance of the observed improvement in pre-service teachers' attitudes towards using oral presentation tasks in their mathematical learning and towards teacher preparation. Our results suggest that use of oral presentation improves pre-service teachers' attitudes and beliefs towards mathematics learning. Moreover, responses to the post-presentation questionnaire provide insights on the benefits of using oral presentation tasks in mathematics courses for pre-service teachers.

Key words: Attitudes, Beliefs, Oral presentation, Pre-service teachers

Introduction

Since the last decade, there has been an increased desire for developing students' mathematical verbal skills and vocabulary (CCSSI, 2010; NCTM, 1989 & 2000). As a result, now the mathematics courses for pre-service teachers focus on strengthening pre-service teachers' mathematical content knowledge by improving verbal and writing skills. These verbal and writing skills are believed to foster conceptual understanding (Berry and Houston, 1995) and increase students' confidence (Butler and Stevens, 1997).

We noticed most of our pre-service teachers use incorrect terminologies and struggle in explaining concepts in a logical sequence. This made us consider how to help pre-service teachers in developing these skills as a large portion of their work involves oral mathematical communications. As the proverb says "No one learns as much about a subject as one who is forced to teach it" (Drucker, n.d.), oral presentations could be a valuable learning and teaching tool. This could help pre-service teachers learn to use correct mathematical vocabularies and to explain concepts. Fan & Yeo (2007) defined oral presentation as a classroom practice where students share ideas verbally and see and understand their own doubts. They noted that oral presentation gives students an opportunity to express their understanding in their own words.

Since pre-service teachers will be responsible for developing children's mathematical vocabulary and oral mathematical communication skills in the future, it is important to first develop their own understanding and disposition. Various studies have shown connection between mathematical disposition and mathematical learning (Maas & Schloeglmann, 2009; McLeod & Adams, 1989, Philipp, 2007). Disposition includes one's attitudes, beliefs and aptness to act in positive ways (NCTM, 1989). Attitude is a mental concept representing favorable or unfavorable feelings for objects, persons or other identifiable entities and a belief is a known or perceived information about an object (Koballa, 1998). For example, statements involving likes and dislikes reflect one's feelings toward an object and a statement such as, "*Math is hard*" represents one's beliefs. Fishbein & Ajzen (1975) noted that a person having a favorable attitude toward an object is more likely to perform or act with respect to the object. That is if pre-service teachers have favorable feelings and beliefs about oral presentations, they are more likely to use them in their own learning and teaching. Hence, it is worthwhile to investigate pre-service teachers' beliefs and attitudes toward oral presentations.

In this study, we investigate what are pre-service teachers' general beliefs and attitudes toward the use of oral presentation tasks in their mathematical learning and toward teacher preparation. We ask if oral presentation changes pre-service teachers' beliefs in their own ability to teach mathematics successfully to young children and in their own dispositions towards mathematics. In addition, we study pre-service teachers' self-reflection on the use of oral presentations on their own learning.

Theoretical Framework

Our theoretical framework is based on the theory of constructivism, social constructivism and multiple intelligence. From the point of view of constructivism, an individual develops meanings by organizing and reorganizing his own experiences and by constructing schemes ("a scheme is what can be repeated and generalized in an action" (Piaget & Garcia, 1991, p. 159)) (von Glasersfeld, 1995). We also consider individuals' meanings are constructed through social interaction (Steffe & Olive, 2010, Brooks & Brooks, 1993). In addition, from the point of view of multiple intelligence theory, each individual has a unique learning style. Hence, there must be different forms of learning opportunities (Fan & Yeo, 2007). In this study, we provide opportunities to pre-service teachers to use communication skills as one of the means to construct meanings besides writing assignments. Pre-service teachers were put into situations where they had to take responsibility for their own learning and continuously critique their own thought processes.

Methodology

Study participants and course description

This study took place in a geometry course for elementary pre-service teachers at one of the public universities in the western United States. The study participants were twenty four elementary pre-service teachers in the third year of the undergraduate program. One of the researchers was the instructor for this geometry course. The geometry course is the second course in the sequence of two-semester mathematics course for pre-service teachers preparing to teach children in pre-Kindergarten through grade six. This sequence of mathematics courses, which follows the CCSSI (2010) offered to strengthen pre-service teachers' oral and written explanations of mathematical concepts. The textbook for this course is Beckmann's text (2013), which focuses on the reasoning behind mathematical ideas pre-service teachers will teach in the future.

Study design

The course was taught using an inquiry-based approach (Bruner, 1961) allowing pre-service teachers to explore the mathematical concepts in a hands-on way. Throughout the course, pre-service teachers were encouraged to present their work in front of the class regularly. Additionally, thirty-five minutes were assigned per class to accommodate two pre-service teachers for the oral presentations. The instructor implemented two assessment-based oral presentation tasks: pre-structured oral presentation and impromptu presentation (Fan & Yeo, 2007).

Fan & Yeo (2007) described pre-structured oral presentations as tasks that are prepared in advance and impromptu presentations as tasks carried out without rehearsals. Below, we describe the two tasks in the context of our study.

Task 1: Pre-structured oral presentation: Each pre-service teacher presented once in the semester about any geometrical concept (K-6) relevant to the course for 10-15 minutes. This activity counted 5% towards the total grade. Pre-service teachers were asked to choose a geometrical concept from the textbook, either covered in class or a new topic and their presentation dates.

They were responsible for reading the topic on their own, planning a draft of their presentation and informing the instructor about their topic two weeks prior to their chosen date for presentation. The instructor read their drafts and provided feedback before their oral presentation. Pre-service teachers also met with the instructor before their presentation to resolve doubts.

Task 2: Impromptu oral presentation: a) The same pre-service teacher had to answer instant questions related to the presentation from the audience (including the instructor) after the pre-structured oral presentation. This counted 3% towards the total grade.

b) Each pre-service teacher had to summarize a day's lesson twice throughout the semester. This counted 2% towards the total grade.

Data collection

We collected data in the form of pre-and post-tests (Appendix A), post-presentation questionnaire (Appendix B), and pre- and post-surveys (modified survey questionnaire from Fan & Yeo (2007) (Appendix C)). The survey consisted of nineteen questions on pre-service teachers' general beliefs and attitudes toward the use of oral presentation tasks, their beliefs in their own ability to teach mathematics successfully to young children and in their own dispositions towards mathematics. The pre-test/survey was conducted on the first day of the course, post-test/survey was conducted on the last day of the course. The post-presentation questionnaire was collected from pre-service teacher immediately after their oral presentation.

Results

Quantitative analysis

Below we discuss the pre- and post-surveys. Figures 1 and 2 show stacked column charts for the responses before and after the oral presentation tasks. Four pre-service teachers were not present on the first day and one pre-service teacher was absent on the last day of the course. Hence, n= 20 and 23 for pre- and post-surveys. Questions 4, 6, 8, 9, and 13-16 (see Appendix C) are worded such that a response with "agree" or "strongly agree" reflect negative feelings towards oral presentations. We observe a decrease in the green shaded area in the post-survey. In the remaining questions, we notice an increase in the green shaded area that represents the percent of the class who agree with the given statement. This shows an overall improvement in pre-service teachers' perception of using oral presentations in learning geometry.

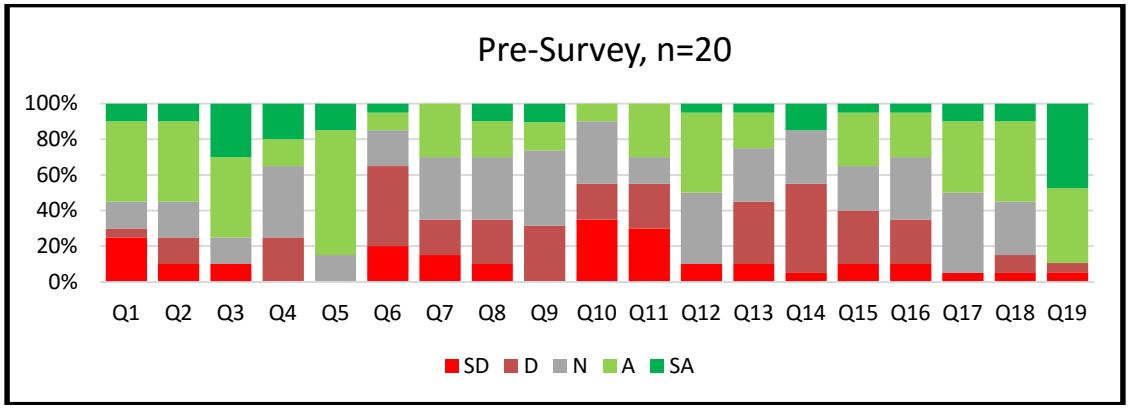

Figure 1: Stacked column chart for the survey responses before the oral presentation tasks.

To analyze the data from the two surveys, we first invert the responses from questions that highlight negative attitudes by treating a response of Strongly Agree as Strongly Disagree and so on. The responses are coded on a scale of 1-5 where 1=SD and 5=SA.

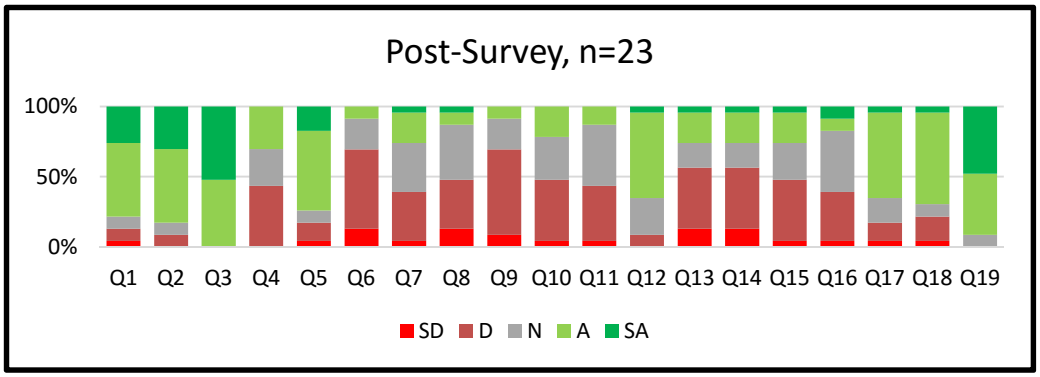

Figure 2: *Stacked column chart for the survey responses after the oral presentation tasks.*

Our study is threefold, we aim to investigate changes in attitudes of pre-service teachers toward oral presentations, in beliefs in their mathematics teaching ability and their disposition toward mathematics. Hence, we divide the survey into three categories. Questions 1-7 and 9-12 represent pre-service teachers' general attitudes and beliefs toward oral presentation. Questions 11, 12, 14 and 17 represent pre-service teachers' beliefs in their own ability to teach mathematics successfully. Questions 1, 5, 7, 8, 13, 15, 16, 18 and 19 represent pre-service teachers' disposition toward mathematics. We create the following score functions:

Oral presentation score = (Sum of responses to questions 1-7 and 9-12)/55*100

Teaching ability score = (Sum of responses to questions 11, 12, 14 and 17)/20*100

Disposition toward math score= (Sum of questions 1, 5, 7, 8, 13, 15, 16, 18 and19)/45*100[1]

We consider the responses of each pre-service teacher as paired data. Pre-service teachers who did not fill both the pre-and post-survey are not included in the paired t-tests but are counted in the summary of the responses. The paired differences in the three scores pass a normality test, thus we apply a paired t-test to see if the observed sample differences are significant. The improvement in the three scores is deemed significant at the 0.05 level of significance. Table 1 summarizes the results of our statistical inference:

Table 1

Summary of the statistical tests on the three score function. The data is considered normally distributed because the p-value of Anderson-Darling's test exceeds 0.05. The observed sample difference is significant because the p-value of the paired t-test is less than 0.05.

Score functions	P-value for Anderson-Darling's normality test	Mean sample of differences (After-Before)	P-value for the paired t-test
Oral presentation score	0.06682	6.84%	0.0062
Teaching ability score	0.5124	4.41%	0.04131
Disposition towards math score	0.07238	4.05%	0.02888

[1] 55, 20 and 45 are the maximum possible scores for each score and can be obtained by multiplying the number of questions by 5 which is the score of a *Strongly Agree* response.

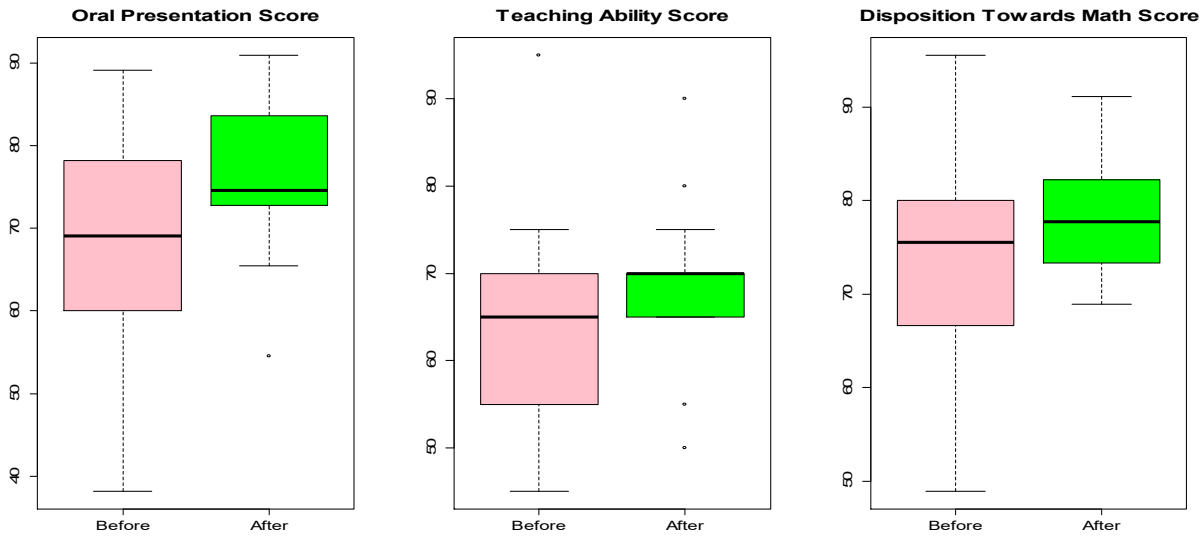

Figure 3: *Box-plots for the survey responses before and after the oral presentation tasks.*

Figure 3 displays side-by-side boxplots for each of the three scores we introduced. The box in each figure represents the middle 50% of the data. The solid line in each box represents the median (the 50th percentile) and the whiskers extend to show the minimum and the maximum. Outliers are displayed as dots in each panel. The graphs show improvement in the three scores after the oral presentation tasks.

Next, we analyze pre-service teachers' pre- and post-test scores. Each question is worth 10 points and is graded on a 2-5-10 scale. 2 points are awarded for identifying a correct answer with no explanation, 5 points for identifying a correct answer with explanation missing some logic and 10 points for a correct answer with correct explanation. The grades are recorded on a 30 point scale then converted to a percentage. Each pre-service teacher shows an improvement in their comprehension of the basic concepts that are tested. Our sample size of 21 shows an average improvement by 38.7% in the scores of the post-test compared to the pre-test. The data pass a normality test (Anderson-Darling test with a p-value of 0.0688), and the paired t-test results in a p-value of $8.39 * 10^{-8}$ indicating a statistically significant improvement in the post-test scores. However, we are not claiming this improvement is only due to the implementation of oral presentation tasks.

Qualitative analysis

In addition to quantitative analysis, we analyze the responses of the post-presentation questionnaire using a qualitative research method called the constant comparative method (Boeije, 2002). Here, we use an axial coding method (Strauss & Corbin, 1998). We compare and contrast the responses of the pre-service teachers on the questions in the post-presentation questionnaire. We identify the similarities and differences on each of the responses.
Out of 24, twenty three pre-service teachers report that they challenged themselves more to develop a deeper understanding of the topic for oral presentation. They report that the concepts they did not understand before or missed during exams, were cleared as they studied more for the oral presentation. However, one of the pre-service teachers mentioned, "maybe" she challenged herself more to get a deeper understanding of the topic, Graphs and Graphical representations, for oral presentation. She reports, "When I had to find graphs that could be confusing to students,

I had to look at them from the perspective of the student." This suggests that even though this pre-service teacher was not sure whether she challenged herself more or not, she expended some efforts to explore graphs and to understand which graphs might be confusing for students. This is an important skill for pre-service teachers to develop understanding of the concepts that students might have difficulties with and how to address those issues. Hence, oral presentation might help pre-service teachers in recognizing the misconceptions of children through exploration of the topic.

Others mentioned, they explored many avenues, books, internet and videos to understand the concept better before explaining it to others. They ensured the concept made sense to them completely before presenting it to others. One pre-service teacher wrote, "I researched a lot and read the chapter like 10 times. I looked up YouTube videos on how teachers could teach this lesson." Another pre-service teacher reported, "I tried to really understand volume in case any questions were brought up. You have to have a full understanding of math before you teach it." This suggests oral presentation motivates pre-service teachers to study thoroughly the text books, to spend more time in studying and researching, and to pay more attention to the topic by teaching themselves before presenting it to the class.

These oral presentation tasks helped pre-service teachers reduce their own doubts on the concepts they had. For instance, one pre-service teacher wrote, "I did not completely understand the moving and additivity principles before, now I feel like I do." Another reported, "I selected a topic that I did not completely understand during lecture. I had to re-read the section in the chapter and I looked up videos online to further my reading." Pre-service teachers revealed that oral presentation had helped them to understand the concepts better by giving them the opportunity to investigate more about the concepts on their own. For example, one pre-service teacher whose topic was Platonic solids reported, "I read the information given in the chapter and I also did some research online. I was curious about the role Plato played and the Grecian history behind the platonic solids."

Conclusions

Our quantitative analysis provides evidence that implementing oral presentation tasks in the geometry classroom resulted in a significant improvement in preservice teachers' attitudes towards the oral presentations. It improved their confidence in their ability to teach mathematics and improved their disposition towards mathematics in general. Our qualitative analysis shows why our pre-service teachers feel oral presentation tasks are beneficial for their learning. For example, oral presentation tasks serve two purposes- developing mathematical meanings and assessing one's own understanding. Oral presentation tasks encourage pre-service teachers to take responsibility for their own learning and give them autonomy to take initiatives to make connections between ideas and a particular concept through self-arguing and validating their reasoning. In addition, oral presentation tasks give opportunities to pre-service teachers to present their ideas and to reflect on others' ideas. This facilitates the "meaning making process" (Brooks & Brooks, 1993).

References

Beckmann, S. (2013). *Mathematics for elementary teachers with activities (4th edition).* Upper Saddle River, NJ: Pearson Education.

Berry, J. & Houston, K. (1995). Students using posters as a means of communication and assessment. *Educational Studies in Mathematics*, *29*(1), 21–27.

Boeije, H. (2002). A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Quality and Quantity, 36,* 391–409.

Bruner, J. S. (1961). The act of discovery. *Harvard Educational Review, 31*(1), 21–32.

Brooks, J. G., & Brooks, M. G. (1993). *In search of understanding: The case for constructivist classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Butler, F. A., & Stevens, R. (1997). Oral language assessment in the classroom. *Theory into Practice*, *36*(4), 214-219.

Common Core State Standards Initiative. (CCSSI). (2010). *The common core state standards for mathematics*. Washington, D.C.: Author.

Drucker, P. F. (n.d.). Quotes. Retrieved from http://www.goodreads.com/author/quotes/12008.Peter_F_Drucker

Fan, L., & Yeo, S. M. (2007). Integrating oral presentation into mathematics teaching and learning: An exploratory study with Singapore secondary students. *The Montana Mathematics Enthusiast, Monograph 3,* 81-98.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Koballa, T. R. (1998). Attitude and related concepts in science education. *Science Education, 72*(2), 115–126.

Maas, J., & Schloeglmann, W. (2009). *Beliefs and attitudes in mathematics education: New research results.* Rotterdam: Sense Publishers.

McLeod, D.B., & Adams, V.M. (1989). *Affect and mathematical problem solving: A new perspective.* New York: Springer Verlag.

National Council of Teachers of Mathematics. (NCTM). (1989). *Curriculum and evaluation standards for school mathematics.* New York: Routledge & Kegan Paul.

National Council of Teachers of Mathematics. (NCTM). (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

Piaget, Jean, & Garcia, R. (1991). *Toward a Logic of Meanings*. Hillsdale, NJ: Lawrence Erlbaum.

Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 257–315). Charlotte, NC: Information Age.

Steffe, L. P., & Olive, J. (2010). *Children's fractional knowledge*. New York, NY: Springer.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory (2nd ed.)*. Thousand Oaks, CA: Sage Publications, Inc.

von Glasersfeld, E. (1995). *Radical constructivism: A way of knowing and learning* (Vol. 6). London: Falmer.

Appendix

A. Pre-/ Post-test Questionnaire:

1) Imagine floating in outer space above the North Pole. Looking down on the earth, which way is the earth rotating, clockwise or counterclockwise? Explain your answer.
2) What do you understand by area of a shape? Explain.
3) What is area of a circle? Explain why it makes sense.

B. Post-presentation questionnaire:

1) Did you challenge yourself more to get a deeper understanding of the topic for oral presentation?
2) Was the process (preparation for oral presentation and the oral presentation) beneficial for your learning? If yes, why? If not, why?
3) Were you able to demonstrate your oral presentation skills in front of the class?
4) Are you confident with your use of mathematical vocabulary while explaining math orally and in writing?

C. Pre-/ Post-Survey questions:

Q1. Oral presentations improve my understanding of mathematical concepts.
Q2. Oral presentation skill is important in mathematics learning.
Q3. Oral presentation skill is important in mathematics teaching.
Q4. Oral presentation makes me feel inadequate.
Q5. Listening to other classmates' presentation helps me understand other's perspectives.
Q6. Oral presentation is a waste of time.
Q7. I am not afraid of mathematics presentation in front of the class.
Q8. I don't know how to get started when I am doing mathematics.
Q9. I feel lost when I am doing mathematics oral presentation.
Q10. I like to do mathematics oral presentation.
Q11. I would like to have more mathematics oral presentations for my mathematics lesson.
Q12. I like to implement mathematics oral presentation while teaching math.
Q13. I have trouble understanding ideas that are based on mathematics.
Q14. If I taught in in a team or with a teaching partner, I would like to have another teacher teaching the mathematics.
Q15. I get frustrated when I do mathematics.
Q16. I do not do well on tests that require mathematical reasoning.
Q17. I feel confident in my ability to teach mathematics.
Q18. I feel confident in my mathematics ability.
Q19. I see mathematics as practical and useful.