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The Effects of Using Math Talks to Improve Instruction in a Kindergarten Classroom

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An Action Research Report
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Abstract

The action research study was conducted in four kindergarten classrooms, involving seventy-seven students and four classroom teachers. This investigation was intended to examine the effects of using math talks to improve the quality of math instruction. In order to implement math talks the teachers participated in fifteen hours of math talks coursework. Teachers were surveyed to gather baseline data to rate current math instruction experience. Teachers also completed weekly reflection surveys and were asked to communicate thoughts in relation to math instruction. Ten random students were surveyed to determine response to math. Four math talks lessons were video recorded and a daily observation journal was completed. After the research was completed, the teachers were surveyed again and data was reviewed to track changes. The results showed that math talks improved teacher perception of math instruction and curriculum, and that it encouraged positive student behaviors including engagement and articulation of thinking and reasoning. The results have shown that math talks have positively affected the math instruction of kindergarten learners.

The purpose of this study is to examine the effects of using math talk to improve math instruction in the kindergarten classroom math talk is an approach where teachers generate the conditions for dialogue that will be "reliably productive in terms of mathematical thinking and reasoning" (Chapin & Anderson, 2009 p.23). Implementing math talks offers a way to influence instruction while remaining within the parameters and expectations of the Common Core Standards and current math curriculum. It was expected that the current math curriculum would be sufficient to meet the rigor of the Common Core Math Standards that call for students to demonstrate and articulate thinking and reasoning. Teachers questioned the effectiveness of their current approach and believed that their current kindergarten math practices needed to be improved. Under the guidance of the district math coordinator and through collaboration with other kindergarten teachers, we examined the approach and implementation of math talk. The goal was to improve instruction, regardless of curriculum, through intentional use of language in math that supported students in communication, reasoning, problem solving and making connections.

When looking at state math scores in the building, students consistently score lower in the area of number sense. Burch (1998, as cited in Gersten & Chard, 2001) defines number sense as a child's ability to do mental mathematics, make comparisons and work flexibly with numbers. In addition, the adoption of the common core math standards generated a need to reexamine existing curriculum. With this information in mind we began to teach with the common core math standards as our goal with the math curriculum was to be used as a first resource. We found, however, that the curriculum did not include all lessons needed to move students toward proficiency as defined by the Common Core Standards. Grade level colleagues questioned what changes were needed to meet the needs of learners in order to reach proficiency in all areas of math under the Common Core Kindergarten Math Standards.

Kindergarten students in our school appeared to be less proficient in math than language. There may be factors that influence this lack of proficiency. Potential causes or contributors could be: poor instruction, lack of exposure and practice, poor number sense, lack of instruction in targeted areas, or absence of math support services. The district math coordinator suggested that the problem may not be with the curriculum, but rather best practice instruction. This suggestion that instructional practice may be a contributor to lack of proficiency led to this study. To what effect will the implementation of math talk improve math instruction in a kindergarten classroom.

This research began with four kindergarten classroom teachers participating in the course, Using Math Talks to Help Students Learn. Participants were taught the five steps toward productive classroom discussions and how to establish discussion norms that create a classroom culture that supports students as they learn to share their reasoning. These five steps are: using talk moves to engage students, the art of questioning, using student thinking to generate discussions, establishing a supportive environment and the teacher as discussion orchestrator. The course provided participants with opportunity to observe and practice what productive math talk sounds like and looks like. The teachers were given the tools to begin implementing math talks in the classroom including text resource, model lessons and language prompts. Four kindergarten teachers completed the course and agreed to implement and examine the effects that using math talk may have on math instruction.

The participants in this study included two regular kindergarten classrooms, each with one teacher and 18-20 students. The other participating classroom setting was a team teaching setting, with two teachers and 41 students. The teachers met once every two weeks and planned math instruction collaboratively using the identified district curriculum to identify where to include and use math talks. The evidence was gathered from participating teachers through surveys that documented how often they used math talks and reflected on student behavior and

learning in response to using the math talks. Teacher surveys were completed at the end of each week over a four week time period. Random samplings of math lessons using math talks were videotaped to capture the teacher and student usage and exchanges. As a research teacher, I kept a journal to record teacher and student observations of math talks within my classroom when using math talks. Student surveys were also collected and considered for feedback.

The research identified the need for students to be engaged in meaningful learning. Meaningful learning is that which is fully understood, can be related to prior knowledge and can be applied. A foundational piece for meaningful learning in mathematics is acquiring skills for mathematical discourse; students who develop confidence in their use of language around mathematics improve critical thinking and problem solving skills.

NCTM and the Common Core Standards (2010) calls for practice that will allow students with an opportunity to solve problems through communicating, making sense of the problem, articulating their thinking and being able to follow the thinking of their peers (Moynihan, 2012; CCSS math, 2010). Daniel, Lafortune, Pallascio, & Sykes (2000) suggest that mathematics teaching should involve more than the acquisition of knowledge and skills; it should "improve one's ways of thinking, feeling, acting and being." One avenue to encourage such development is by providing students with the opportunity to practice their communication around and articulation of problem solving approaches and procedures. The teacher needs to be intentional in his or her approach to facilitating this language (Kostos & Shin, 2010). The teacher acts as a facilitator of discussions, supporting student understanding while students are involved in constructing their number sense through problem solving using multiple approaches and reasoning (Shumway, 2011). Math talk is an approach where teachers generate the conditions for dialogue that will be "reliably productive in terms of mathematical thinking and reasoning" (Chapin & Anderson, 2009, p.23) The approach uses discourse as a way of representing, thinking, talking, agreeing, and disagreeing, and providing students with dialogue tools in order to engage

with mathematics (Garcia, 2010). The research suggests that an increase in mathematical talk increases math skills (Klibanoff, Levine, Huttonlocher, Vasilveva & Hedges, 2001). Kostos & Shin (2010) identify that improved academic achievement is experienced when students facilitate their understanding through the use of language. It is possible to elicit, support, and extend student thinking through math talk (Suh, Tappert, Gibson, & Stevens, 2009).

The adoption of the Common Core Standards generated the need to consider current math curriculum and instruction to decide whether or not it was moving students toward proficiency in the area of mathematics. The critical question that was generated is: What can be done to improve math instruction at the kindergarten level in regards to common core standards and best practice instruction? The action taken to address this question was to implement the use of math talks to provide teachers with an approach to generate and support student discourse around mathematics. The study found that the implementation of math talks improved math instruction for teachers and students.

Description of Research Process

The kindergarten teachers that participated in this action research were instructed on the implementation and use of Math Talks by attending two fifteen hour Math Talks courses. Participants were taught the four steps toward productive classroom discussions and how to establish discussion norms that create a classroom culture that supports students as they learn to share their reasoning. The course provided participants with an opportunity to observe and practice what productive math talk sounds like and looks like. The teachers were given the tools to begin implementing math talks in the classroom. Upon completion of course, the teachers met to review district math curriculum and identify areas within the math instruction to use the techniques outlined in the Math Talks course. During the meeting times, the participating kindergarten teachers developed lesson plans to ensure that they would have a timeline in which

to establish and begin teaching math talk skills. The use of math talks during math instruction was scheduled into the second third week of school. Teachers continued to meet every two weeks to reflect and further plan instruction. This common planning ensured that math talks were being written into the math lesson plans of the participating kindergarten classrooms.

A variety of methods were used to collect data regarding what effect the implementation of Math Talk would have on math instruction in a kindergarten classroom. Teacher generated artifacts such as lesson plans to determine if teachers were implementing math talk for math instruction and weekly self-assessment journals to determine teacher perception of math instruction were used. Observational data was collected using video recording and field notes from surveys completed weekly by participating classroom teachers. Teacher and students attitude surveys were also completed providing baseline inquiry data. Additional data included teacher reflection that took place in the form of discussions at the planning meetings.

The first method of data collected was the baseline attitude survey (Appendix A) for the four participating kindergarten teachers. The teacher survey was used to gather information about their attitudes, opinions, and beliefs regarding math instruction and the implementation of math talks. The teacher survey provided baseline data and comparative data as it was given two times: prior to the study and again at the end. The survey asked the four participating kindergarten teachers to rate their current math instruction in regards to: how they feel about teaching math, their comfort with the Common Core Standards and expectations, opinion about district math curriculum, and if they have the tools for instruction to be successful with instruction. Answers were recorded on a Likert scale with the answer options of strongly agree, agree, disagree, and strongly disagree. Answers to these questions were recorded on a Likert scale with the answer options of yes, somewhat, or not at all. The second survey question prompted teachers to identify if math instruction provides students with an opportunity for critical thinking, articulation of thinking and reasoning, high levels of engagement and deep learning. The data from the survey

given before the implementation of math talks would be compared to the data from the second survey given after four weeks of using math talks. The information would be analyzed to find if and how teacher's attitudes had been affected through the use of math talks in the kindergarten classroom.

Another data method used was a weekly teacher survey (Appendix B). This survey was emailed to teachers at the end of each teaching week. The four participating teachers completed the survey four times over a four week period; a total of sixteen surveys were completed. This survey was used to collect observational data with questions that prompted teachers to evaluate instruction by identifying how often they were using math talks during the week. The survey then prompted the teachers to identify the class dynamic when using Math Talks. The focuses of the observations provided teacher perception about students: are students engaged, are they contributing, are they learning and do they enjoy math talks. Teachers responded to the above mentioned areas using a Likert scale with the answer options of strongly agree, agree, disagree, and strongly disagree. The final area of the survey allowed teachers to record narratives about observations, highlights and obstacles that were experienced when using math talks with their students. This observational data offered the participating teachers a place to record additional information that was not limited to any specific question. This information was reviewed for reoccurring themes and ideas. The data collected from teachers was analyzed and compared for how frequently they were using math talks and how they perceived student response to using math talks in the kindergarten math setting.

A second attitude survey (Appendix C) was developed for students and given to a random sampling of ten students within a classroom using math talks. The same group of random students was surveyed two times: once after experiencing math talks for two weeks during their math instruction time and then again at the end of study at four weeks. The data from this student survey were used to analyze student perception of math and how to use language to talk about

math. The questions asked students: Do you like math? Are you good at math? Can you use words to explain your math thinking? Do math talks help you learn? The surveys were limited to only five simple answer (yes, no) questions because of the age of the participants. They were also administered one-on-one because most kindergarten students are not independent readers in the first months of school. The data from the students would be compared against that of the teacher's perception of student's attitude data to analyze if a similar perception were developing with teachers and students. It was important to note the attitude of students with the goal of improved instruction.

As the research-teacher in the action research project, I kept an ongoing four week journal with daily entries regarding the use and implementation of math talks. I recorded student conversations, how they used the math talks and how they responded to using math talks. In addition, what I observed the students doing, I recorded my reaction to using math talks. I recorded both successes and challenges. The journal entries were analyzed for the frequency that math talks were being used, noting obstacles that may have occurred regarding implementation, instruction and student response. The journal entries also offered documentation on how students used the math talk language and how well they engaged with it. These items were compared to the weekly teacher survey data regarding perceived student use, reaction and engagement with math talks.

Videotaping of math instructional times involving math talks were completed four times from my classroom. These videos recorded two teachers using math talks approach with students and also students using the math talks language to communicate with peers and share their thinking. The videos will be reviewed by the research teacher and one other participating kindergarten teacher to analyze student behaviors to answer the questions: were students engaged, contributing, learning and enjoying their math instruction time while using math talks. The instruction will also be discussed to identify any obstacles or successes that the teacher may have

experienced using math talks. Videos will be compared to assess changes in teacher instruction and student discourse.

Analysis of Data

A variety of data collection methods were used for this research. A teacher math instruction attitude survey was conducted prior to the study and then at the end of the study. This survey collected data regarding how teachers felt about math instruction and how they believed students responded to the use of math talks. Students also completed math attitude surveys at two weeks and again at the end of the study. These surveys provided data to show if student's perception of math and the use of math talks changed. Teachers also completed weekly response surveys to identify how often they were using math talks, student response to math talks and general written comments regarding the use of math talks. Finally, math talk lessons were videotaped and I kept an observation log.

The teacher attitude survey was the first data collection tool administered. The survey was given two times; prior to math talks implementation and again after four weeks of implementation of math talks. Four kindergarten classroom teachers participated in the survey and their results are displayed on Figure 1 and Figure 2. Each response was recorded separately and the analysis consisted of comparing the initial baseline report with the post implementation response. The baseline and final response were compared the difference between baseline and final responses are noted as positive or negative.

The first question on the survey was a Likert scale that asked teachers to rate their current math instruction experience in relation to how well they like math, are comfortable with standards, satisfaction with curriculum, and if they feel they have tools to encourage twenty-first century skills. I wanted to know if teacher attitudes about their instruction and what it provided would be altered with the implementation of math talks. Teachers were provided with a Likert scale for responses: strongly agree, agree, disagree or strongly disagree with the statement. By having a range to answer rather than a forced choice of "yes" or "no", I was able to better capture the underlying attitude of the teachers. The multiple answer method also allowed the analysis to pick up any change in thinking which, given the short time of the implementations, was important to do. The data identifies that the participating teachers using math talks like teaching math more than they like teaching math prior to using math talks. In addition, teacher's perception of their current curriculum improved as they now indicate that they feel it supports the standards. The greatest area of improvement was noted regarding having the instructional tools to encourage critical thinking, collaboration, and problem solving. All four teachers strongly agreed that they have the tools to encourage these skills with the use of math talks. The results from the baseline and final surveys and differences between the two responses are represented in Figures 1 and 2.

Teacher Attitude Survey: Math Instruction Experience

	I like teaching math.			I am comfortable with the common core math standards and expectations			Our current curriculum supports the standards.			I have the instructional tools to encourage critical thinking, collaboration, and problem solving.		
	B	F	C	B	F	C	B	F	C	B	F	C
Teacher 1	4	4	0	3	3	0	2	3	+1	2	4	+2
Teacher 2	3	3	0	3	3	0	3	3	0	3	4	+1
Teacher 3	2	4	+2	4	4	0	1	3	+2	1	4	+3
Teacher 4	2	3	+1	3	3	0	2	3	+1	1	4	+3
Change totals			+3			0			+4			+9

Key: B=Baseline, F=Final Survey, C=Change
4=Strongly Agree, 3=Agree, 2= Disagree, 1=Strongly Disagree

Figure 1. How would you rate your current math instruction?

Question two of the survey asked, "What opportunities does your current math instruction provide students?" This was asked to measure if the current math instruction method provided the opportunity for students to develop critical thinking, articulation of thinking and reasoning, high engagement and deep learning. Critical thinking involves the ability to analyze information and draw conclusions that can be applied or used to predict further learning. The articulation of thinking and reasoning is the ability to use words to explain one's thinking. High engagement occurs when students are willing to participate and deep learning is the result of students experiencing core content while collaborating, communicating and problem solving.

The data indicates that all four teachers experienced positive impact on student behaviors related to math talks in relation to the above areas; critical thinking, articulation

of thinking and reasoning, engagement and deep learning. Teachers were provided with a Likert scale with the choices being yes, somewhat, or not at all. By providing a range, teachers who were seeing even subtle changes could utilize the "somewhat" response to show that progress toward the areas that were measured was achieved. The results of the survey may be found in Figure 2.

What Does Your Current Math Instruction Provide for Students

	Opportunities for critical thinking			Opportunities for articulation of thinking and reasoning			Activities of high engagement			Opportunities for deep learning		
	B	**F**	**C**	**B**	**F**	**C**	**B**	**F**	**C**	**B**	**F**	**C**
Teacher 1	2	3	+1	2	3	+1	3	3	0	2	3	+1
Teacher 2	2	3	+1	2	3	+1	2	3	+1	2	3	+1
Teacher 3	2	3	+1	1	3	+2	2	3	+1	2	3	+1
Teacher 4	2	3	+1	2	3	+1	2	3	+1	2	3	+1
Change totals			+4			+5			+3			+4

Key: B=Baseline, F=Final Survey, C=Change
3=Yes, 2=Somewhat, 1= Not at all

Figure 2. What opportunities does your current math instruction provide students?

To complete the attitude survey teachers were encouraged to share any thoughts or concerns they have regarding math instruction. The baseline comments expressed teachers concern about curriculum and a lack of comfort around math instruction time. This concern was reflected in the comments. Teacher 1 wrote, "There is a need for training that supports the Common Core Standards and math talks. With strong collaboration opportunities there will be professional growth and enhanced student learning."

This concern appears to be somewhat addressed as the final survey comments shared that math talks had a positive influence on them as teachers and received a

positive response from students. Teacher 3 included the following thought, “I feel like math talk has completely changed the way I even think about math. The language, kindness, problem solving and critical thinking that kids are doing is that I never dreamed of. Not only are the kids sharing their thinking with their friends in profound and critical ways, but they are engaged and loving it! I am enjoying it as well.” Teacher 1 expressed that math talks influenced her instruction and shared, “Math talks has changed the way I think about teaching important concepts. It brings incidental learning into understanding.” Teacher 3 had similar comments, “Math talks have really enhanced my math time. My students have embraced the concept and are doing a great job thinking deeper.” She also identified a challenge, “The biggest stumbling block is me. I am still trying to internalize the language.”

A student attitude survey was collected as the second piece of data. The survey was given two times, to randomly selected group of ten students, midway through the study and again at the end of the study. The group consisted of 5 boys and 5 girls of varying ability levels. Three students identified liking math less. So that answers to the survey would be more relevant and use the vocabulary of the students, they were given a Likert scale with answer choices of, “love it”, “like it”, “sometimes”, and “yuck”. Figure 3 shows responses to if students like math. Figure 4 shows responses on how the students perceive themselves as mathematicians and their perception of the use of math talks to increase their explanations of thinking and learning. Students could respond with basic “yes” or “no” responses.

The results reveal little change in the student data from baseline to final, but there were notable pieces. The students as a whole perceive themselves at being good at math

as reflected in their initial responses. Only one student response out of ten revealed a "no" answer in each one of the areas that were surveyed. Student attitude may have been revealed more in depth if open ended responses the "yes" and "no" questions were offered. By providing an opportunity to reflect and answer with open ended responses, students could explain their reasoning for the answer they shared. It is interesting to note that even though two students responded that they can't use words to explain their thinking, they still indicate that math talks help them learn comparing the pre and post responses, positive and negative changes were noted.

Student Math Attitudes Survey Part 1

	Do you like math?		
	B	**F**	**C**
Student 1	4	4	0
Student 2	2	3	+1
Student 3	3	3	0
Student 4	2	2	0
Student 5	2	2	0
Student 6	4	3	-1
Student 7	4	4	0
Student 8	4	4	0
Student 9	4	3	-1
Student 10	4	3	-1
Change totals			-2

Key: B=Baseline Survey, F= Final Survey, 4=Love it, 3=Like it, 2=Sometimes, 1=Yuck

Figure 3. Do you like math?

Student Math Attitudes Part 2

	I am good at math.			I can use words to explain my math thinking.			Math talks help me learn.		
	B	**F**	**C**	**B**	**F**	**C**	**B**	**F**	**C**
Student 1	2	2	0	2	2	0	2	2	0
Student 2	1	1	0	2	1	-1	2	2	0
Student 3	2	2	0	2	2	0	2	2	0
Student 4	2	2	0	1	1	0	2	2	0
Student 5	2	2	0	2	2	0	2	2	0
Student 6	2	2	0	2	2	0	1	2	+1
Student 7	2	2	0	2	2	0	2	2	0
Student 8	2	2	0	2	2	0	2	2	0
Student 9	2	2	0	2	2	0	2	2	0
Student 10	2	2	0	2	2	0	2	2	0
Change totals			0			-1			+1

Key: B=Baseline Survey, F= Final Survey, 2=yes, 1=no

Figure 4. Student perceptions of math performance and math talks.

The next data analyzed was a teacher survey collected at the end of each teaching week. I needed to know if teachers were using math talks and how often. The surveys indicated that all four classrooms were using them 3-5 times a week. In addition to how often they were being used, I wanted to know what student behaviors teachers were observing during the use of math talks. Teachers were provided with a scale of answer options regarding student enjoyment, learning, participation and engagement that included: strongly agree, agree, disagree or strongly disagree with the statement. There were no disagree or strongly disagree responses; this indicated that students were enjoying math talks, learning, engaged, and participating. Student learning occurs when students communicate and collaborate around core content. Engaged students participate by sustaining eye contact with the speaker, voluntarily by raising their hands, and

contributing to discourse. The results from the weekly teacher surveys are noted in Figure 5.

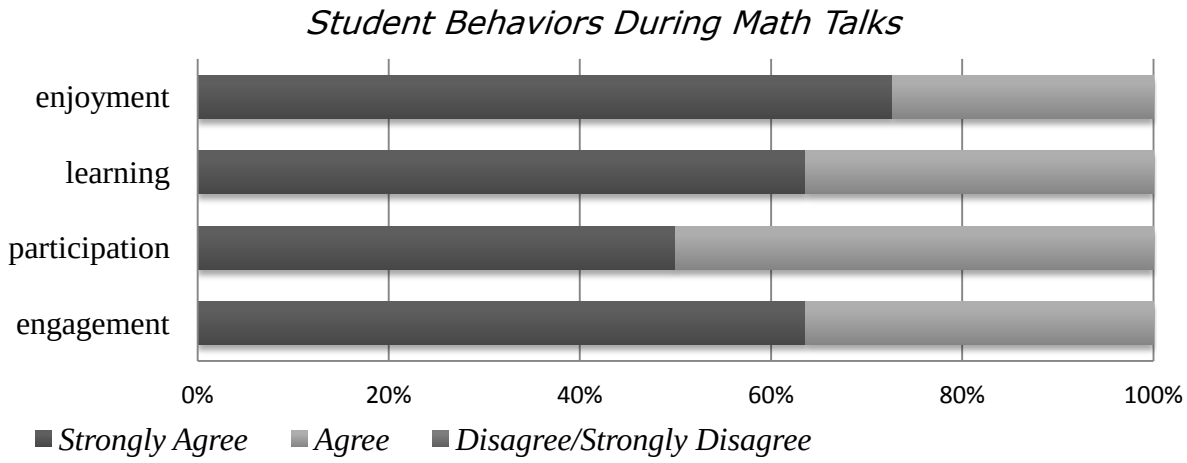

Figure 5. Teacher rated student behaviors during math talks.

To complete the weekly survey teachers were encouraged to describe additional observations that included any highlights or obstacles regarding math talks experiences. The following are quotes from the participating teachers. Teacher 1 commented, “The students are repeating and sharing ideas. The students are so excited to repeat what another student says. More students are raising hands to repeat than ever.” Teacher 3 noted the potential impact of math talks, “If we would do nothing but this kind of talk using questions like, ‘Do you agree or disagree and why?’ and ‘Can you repeat that?’ our kids would be further then they have even been before with their thinking.” Another positive comment was shared by Teacher 2, “The students respond very positively to the discussions and seem to be doing well learning the language.” She also noted a challenge, “I still have not internalized all that language and so I don't apply it as well as I would like.”

Additional data was analyzed from teacher observation notes. The purpose of the notes was to measure student engagement during math talks. Student on task behaviors include eye contact with the speaker, participation by raising their hand to contribute and by responding when asked to do something. I observed that although students may not always sit still, those who were wiggling appeared to be able to stay focused and participate on the talk. Off task behaviors such as having conversations with others that were not related to the math talk or not being able to respond when called upon were not exhibited. I also observed students who appeared as though they were not paying attention, but were able to repeat the learning that was being shared by peers. Other students who were unable to repeat, knew how to use the math talk phrase, "Could you repeat that please?" so discourse could continue.

I also observed on multiple occasions, incidental learning as a result of using the math talk approaches. These approaches consisted of allowing students to explain their thinking, having peers repeat the important learning, and having students identify another way of solving a problem. Students discovered counting by twos and threes when we explored how to answer "how many" in our counting jar. There were variations in the counting; some students counted visually, others tapped the objects as they counted, and others removed them one by one. One student demonstrated counting by twos while another counted the objects by threes with the assistance of a peer. Another incidental learning piece occurred when students were determining what number came next on our calendar. One child explained that he counted from one while the other started at ten; they both arrived at the same answer, one counting by ones while the other used the strategy of counting on. A third incidental learning experience occurred when the

students disagreed about how to read a two digit number. Through sharing their thinking, they discovered that numbers are read left to right and that the value changes.

The observation notes include notes of reoccurring math talk language being used by the students and teacher. Teacher behaviors included revoicing and clarifying of student thinking and ideas. The phrases: “Who can repeat that? Who can share a different way? Can you explain your thinking? Do you agree or disagree?” During discussion the teacher was using more questions than statements. The students repeatedly used the phrases: “Can you repeat that, please? I agree or disagree because…” Within the math talks phrases and repeated language of teacher and peers, the students were engaging in the practice of being able to explain their thinking.

I also observed that using math talks can be challenging due to the time that a lesson may take. When students are engaged in math talks, they formulate, share and expand upon their thoughts; this is an emerging skill. It takes longer than teacher lecture on a concept or idea. This creates difficulty for a teacher when trying to impart a particular concept or piece of knowledge is hindered by limited time.

The final data source collected was math talk lesson videos. The videos identified that student participation and engagement were high. For example in the math game lesson, the teacher did not have to address any off task behavior such as students talking or lack of attention on speaker. The teacher introduced a dice game, but instead of giving them directions, she allowed students to discuss how to discover how to play. Four to ten students raised their hands when response was needed. Students also had their eyes on the student sharing and could repeat the thinking that was being shared. An example of

this was when a student shared, “You can shake it. When it lands you can read the number.” Another student added, “When you roll the dices, they tell you what number to go on.” Four students used the phrase, “Could you repeat that please?” when repeating other students thinking. The teacher asked, “What do you think?” and revoiced the student thinking.

This completes the data collection and analysis of results for this project. I will discuss recommendations and actions based on the conclusions drawn from the data. In addition, I will explore ideas for future research.

Action Plan

This section will discuss and identify the question: “To what effect will the implementation of math talks improve math instruction in a kindergarten classroom?” The analysis of the data revealed a primarily positive impact of math talks from the teacher perspective. The student survey data was less informative as attitudes did not change markedly. Asking students to explain their responses would provide more evidence on the impact of math talks from the student perspective.

The teacher surveys indicated that the use of math talks improved teacher overall feelings about teaching math. Teachers also indicated that math talks provided them with the tools they needed to encourage student behaviors including critical thinking, articulation of thinking/reasoning, high engagement and deep learning. An overall improved feeling toward math instruction and evidence that math talks provided them with tools to improve student behaviors may be related. Though the curriculum remained the same, the teacher’s perception of the curriculum improved with the use of math talks.

These ideas were further corroborated in the teacher written responses. Three of the four teachers responded that their math talks changed their math instruction in a positive way. I feel when a teacher's perception of their curriculum and tools is positive; it will be reflected in the instruction.

The teacher survey data also supported that students responded to math talks. They were able to use the language that encouraged discourse to explain thinking, agree and disagree, and request peers to repeat their thinking. The lesson videos, teacher observation notes and teacher written responses supported that the students used the language of math talks such as, "I agree/disagree because…", and "could you repeat that please?" The observations and teacher perception of student behaviors indicated that engagement was high even though lessons could be long. Students appeared eager to participate and use the key phrases to share their ideas or expand on the ideas of their peers. This level of engagement and student discourse may be the reason that little to no negative student behaviors were noted in the data. How we teach mathematics will influence how students view math and more importantly, how they view themselves as learners of math (Moynihan, 2012). Research suggests that student attitudes and emotions are strongly related to a student's ability to learn mathematics (Daniel et al, 2000).

The student survey data generated questions and did not offer the information that I believe it could have. It noted that students liked math overall and they believed that math talks helped them learn, but I do not know the reasoning behind their responses. There were very slight differences in the responses of students but to understand what caused these changes or lack of change, students should be given the opportunity to

explain and support their answers. I would include or add student response notes in further student attitude surveys.

An exciting aspect of using math talks was the incidental learning that occurred as noted by the four teachers and observed on video lessons. When teachers are asking questions and students are leading the discussion with their thinking and ideas, simple lessons like counting and calendar go deeper as students demonstrated counting by twos and using the concept of counting on. Instruction is enhanced because it is not limited to a single focus or skill and meets the needs of a variety of learners; rather, the skills are being applied in other areas. Transferring of skills from one activity to another is an indicator of learning. The incidental learning being discussed among students increases and may secure understanding.

The study also found that math talks language is not exclusive to the subject of math. Teachers noted that students were able to use the language in social settings and in all curricular areas. I believe that math talks can offer teachers and students discourse tools that will move them toward the speaking and listening goals as outlined in the Common Core Standards. This implies that math talks have the potential to improve more than just math instruction and if consistently practiced and applied as students move through the grade levels, could assist them in the life skills of collaboration and communication.

The challenge in the implementation and use of math talks is in providing teachers with the training to understand math talks and to use the approach correctly and consistently to increase effectiveness. The teachers participating in this study took fifteen

hours of course study. Despite the training, one teacher noted that she was still working to internalize and use the language well. It is important to note that though the process may appear as a simple set of phrases and questions, there are varying levels of implementation with the students in the classroom. Teachers need to be willing to take the role of facilitator while students lead with their thoughts and ideas. Teachers wanting to use math talks may benefit from more modeling and examples so that they can increase their own skills.

As a follow-up to this study, I will monitor student math scores and attitudes toward math over a school year. I think it would also be important to collect student thoughts in regards to math talks, and not limit answers to yes and no. I will also monitor student engagement to determine which students are participating. I will look for students maintain eye contact, number of times they raise hands or voluntarily contribute to the discourse in order to have evidence of student engagement and participation. It would be interesting to compare this future data with that of the student attitude survey.

The implementation of math talks in the kindergarten setting had a positive impact on math instruction. When teachers are provided with the math talks training and support they were able to use it multiple times a week in their classroom. The result was reporting of improved instruction. Teachers expressed that they liked teaching math more as the result of using math talks. They also reported that math talks gave them the tools to encourage critical thinking, collaboration and problem solving opportunities for students. The student behaviors further supported this idea as they were engaged, participating and using the math discourse to communicate their thinking.

As we move forward with using math talks in the classroom, I think it is important to provide teachers with professional training and support. As more teachers become fluent with math talks, they can mentor other teachers. The participating teachers in this study noted that they would like more training so that they can continue to grow in the practice and offer more to their students. I would also like to see other grade levels using math talks. The study found that the language carried across subject and social settings.

The Common Core Standards are calling for collaboration and communication skills and math talks offer teachers and students a tool to develop those skills. I look forward to engaging further with the math talks practice and will revisit course material on the topic. After taking the course work and working with students in the classroom with math talks, I believe that I have a broader perspective on its practical use. I am optimistic about the findings of this study and the success that both teachers and students experienced. I am certain that with continued professional development and practice, math talks can provide our students with opportunities to develop and practice the life-long learning skills of collaboration and communication.

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Appendix A

Teacher Attitude Survey

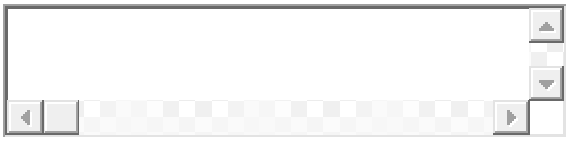
1. How would you rate your current math instruction experience?

	Strongly Agree	Agree	Disagree	Strongly Disagree
I like teaching math	●	●	●	●
I am comfortable with the common core math standards and expectations	●	●	●	●
I think our curriculum supports the standards	●	●	●	●
I feel I have the instructional tools to encourage critical thinking, collaboration, and problem solving	●	●	●	●

2. Does your current math instruction provide students with the opportunities for:

	yes	somewhat	not at all
critical thinking	●	●	●
articulation of thinking/reasoning	●	●	●
high engagement	●	●	●
deep learning	●	●	●

3. Please share any thoughts or concerns you may have regarding math instruction.



Appendix B

Teacher Math Talks Monitor

1. How often do you use math talks?

- not at all
- 1-2 times week
- 3-4 times week
- 5 times week

Q2

2. How would you rate student behaviors during math talks?

	Strongly Agree	Agree	Disagree	Strongly Disagre
students are engaged				
students are contributing				
students are learning				
students enjoy math talks				

Q3

*

3. Please describe additional observations (highlights or obstacles) regarding math talks.

Appendix C

Student Math Survey

1. Name:

Name:

2. Do you like math?

love it **like it** **sometimes** **yuck**

3. Are you good at math?

- Are you good at math? Yes
- No

4. Can you use words to explain your math thinking?

- Can you use words to explain your math thinking? Yes
- No

5. Do math talks help you learn?

- Do math talks help you learn? Yes
- No