Let’s “Talk” Math!

Investigating the use of mathematical discourse, or “Math Talk,” in a lower-achieving elementary class.

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Easterly Parkway Elementary 4th Grade
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**Teaching Context**

My math class is one of two fourth grade classrooms at Easterly Parkway Elementary. These math classes are leveled, based on each student’s PSSA test scores, performance in the first unit of the year, and teacher observations and recommendations. My class is comprised of 19 on-level and below-level achieving students.

I quickly realized that teaching the lower of the two math groups would be challenging when, early on, many students voiced their negative opinions of math. This dismayed me, and I knew I had to do everything I could to make math fun and give these students the best mathematics education I possibly could.

Although leveled classes group students of similar achievement levels together, within each class there are still multiple levels for the teacher to take into consideration. A typical math class would consist of a lesson, practice with the teacher, and independent work time.

While I found each of these components to be valuable for the students, I began wondering how the addition of a discourse component would benefit the class. In the PDS math education course, we were taught a great deal about teaching math through student-centered conversations. This process, called mathematical discourse (or more informally, “math talk,”) made sense to me and piqued my interest.

“Math talk” is a style of discussion in the classroom that allows students to learn through discourse. This discourse is discovery-oriented, meaning that the students are encouraged to figure out solutions and strategies by sharing their ideas and with minimal help from the teacher. The teacher facilitates and guides the discussion using designated
“talk moves” that prompt the students to think critically about their responses (Appendix B).

**Wonderings and Questions**

**Main Wondering**

I remembered back to my high school math experience and always thinking that I would have been more successful with the problems if I knew what each step meant and how the problems worked. This year when I prepared to teach math, I knew I wanted to include discourse as a method of conceptual learning for my students. My main wondering became:

*Can using mathematical discourse in a lower achieving level class benefit the students?*

**Sub-Wonderings**

With this question in mind, many others shortly followed. These became my sub-wonderings that I would explore in more detail to help answer my main wondering. These questions along with their explanations are as follows:

*Will we build a stronger community of learners through discourse?*

Because the group was a mixture of two classes that met only for an hour each day, I wondered how the level of community in the group was affecting the students’ ability to learn. I noticed through observations that the level of trust and comfort among the students in my math class was not as strong as it was with the students in my regular class who spent significantly more time together. I wondered if nurturing a positive,
accepting discussion environment would help my math students open up and feel more comfortable with each other.

**Will mathematical discourse help raise student engagement?**

Our group of students had been showing some reluctance to volunteer answers or explain their reasoning. When called on to provide the answer to a problem, some students answered, “I don’t know,” or seemed visibly uncomfortable with being in the spotlight. I hoped that in the context of a discussion, the students would feel more comfortable talking to each other instead of feeling pressured to answer a question, therefore becoming more engaged with the mathematical component of the lesson.

**Will math talk discussions raise student confidence?**

Upon realizing how unconfident so many of my students seemed to be, I set the goal to help each student reach a higher level of confidence in doing math. This would mean monitoring individual successes and shortfalls for each student, and providing individualized instruction when necessary. I knew this was a difficult goal to reach, but doing as much as possible for all of my students was something I felt passionate about because of their earlier comments about math. I thought that creating a stronger community by interacting through math talk might help me reach this goal with the class.

**What kind of topics or lessons would make a good math talk discussion?**

I anticipated that some topics or lessons would have certain qualities that would foster successful class discussions, but I didn’t know which ones or what qualities to look for. I wondered if using discussions to introduce new material would be beneficial, or if I would see greater success discussing review material. Maybe the hands-on geometry unit would be a good topic to discuss, or would it work better with a more algebraic unit?
After I had established my main wonderings and thought carefully through my sub-wonderings, something else crossed my mind: *What if this didn’t work at all? What if all my efforts end up making no difference whatsoever?* My final sub-wondering became what I considered a “buffer” question to save my inquiry in the case of a failed mathematical discourse effort:

*What teaching strategies will benefit this group of students?*

**Data Collections & Analysis**

I analyzed data in a few different ways, all of which were useful tools for reflection on the effectiveness of mathematical discourse in my classroom. Over the course of this inquiry, I analyzed video recordings of our discussions using the program Studiocode, kept both systematic observation notes and anecdotal records, and conducted two student surveys.

**Studiocode**

Much of my data was collected through recorded discussions that I analyzed in the Studiocode program. In my research of mathematical discourse, I gathered ideas for components of a math class and successful discourse. I chose three components that I wanted to look for in my videos: teacher explanations, teacher questions, and student reasoning. I knew we already used teacher explanations and I wanted to see exactly how prominent a role it took in the instruction. Teacher questions and student reasoning were two things I wanted to use more to promote successful discourse, and I needed to see
what effect they had on the discussions. I would then be able to use this data alongside a trajectory chart (Appendix F) to see what level the class was at and decide what course of action to take to advance to the next level.

**Student Participation & Discussion Times**

The videos I recorded were also helpful for collecting quantitative data on student participation and discussion times. I wanted to find an estimate for how long the discussions lasted, how many students were engaged and for how long they were engaged. This data (Appendix D) gave me information on how this lower-achieving group of students responded to the discussions, and what worked well or didn’t work with them. This was a smaller, but still important, component of my research.

**Student Surveys**

Student surveys were my most valuable qualitative data. With my main focus of this inquiry on the benefits to students, I needed their input. I gave a pre-inquiry survey once the class had experienced a few discussions, and a post-inquiry survey once the unit was over. These surveys were anonymous and very similar to each other to keep my data consistent. (Appendix C) I asked multiple-choice questions about their favorite ways to learn and their comfort levels with the methods of teaching and learning they experienced in class. The open-ended questions I asked were about the students’ thoughts when they were called on, and in the post-inquiry survey I asked what they liked about discussions and what they would change.
These surveys ended up being invaluable data for this inquiry. They allowed the students to have input to their own learning and to the inquiry results. They also gave me insight into the minds of fourth grade math learners that I could not have gotten any other way. I was able to use this insight and feedback to set goals and make changes in the structure of the class and the format of our discussions to meet the students’ needs.

Explanation of Findings

Claim 1

The biggest realization this inquiry revealed to me was that mathematical discourse is beneficial, but should be a part of math class and not the main method of teaching and learning. It is one strategy of many that contributes to a successful math class. A few things helped me become comfortable enough to make this claim.

In my interview with a fifth grade veteran teacher (Appendix E), she described the benefits of other more explicit instruction strategies and explained why she doesn’t use discovery-oriented discourse as much when teaching a lower achieving group. After talking with her, I reflected more about the practices I was using in my class and realized that, to teach successfully, I would have to incorporate a variety of strategies. When I added more explicit instruction to the discovery-oriented environment I had been trying to create, I found that I was satisfied with how the students responded and completed their work for the lessons.

It was interesting to observe how my students’ attitudes to the discussion format changed from the beginning of the inquiry to the end. I could tell from my videos that when we began having discussions the participation rate was higher than normal, but by
the end it was lower than normal and the level of student distraction was higher. Through informal and systematic observations in my classroom and others, I have seen that students of all ages need to be kept engaged and will become bored if only one strategy or topic is focused on. I realized that they needed to be taught using a variety of methods, none of which should carry more weight than another.

Claim 2

*Discussion formats can be created and adjusted to be effective for any group of students.* In the post-inquiry survey my students took *(Appendix C)*, they expressed a wish for smaller groups and shorter discussions. They offered a variety of reasons for this request. Some felt that smaller groups would allow them to participate more, and others wanted more time to work on their daily practice pages.

Depending on the attention span and engagement levels of the students, discussions can be made shorter or longer. My class did well with discussions that lasted 10-15 minutes. If they were shorter, not many students would get to participate, but if they were longer the students would become distracted and bored and the time was not used efficiently.

The teacher’s expectations for the students in a discussion are also flexible. Using a mathematical discourse trajectory chart *(Appendix F)*, teachers can determine what level their class is on and guide the discussion appropriately while working toward the next highest level.
Claim 3

*Discussions lasting 10-15 minutes are appropriate for teaching students on a lower achieving level.* This claim stems from the previous claim about adjusting the discussion format. I started out holding discussions that were 20 minutes or longer, and I would stop the discussion when it was apparent that the students were becoming restless. This meant that while the “hook” and the “meat” parts of these discussions were usually good, the “closing” ended up being lost on many students or it didn’t happen at all.

From my data on student participation and discussions times, I saw that my students would consistently “burn out” somewhere between 15 and 20 minutes of discussion. This told me that with this particular group, and very likely with similarly leveled groups, there was a valuable window of time in which the students could participate and understand before becoming bored and distracted. I concluded that when preparing for discussions, the teacher should plan to end them before the class’ “burn out” time to maximize the value of the entire discussion time.

Claim 4

*Discussions are most effective for the entire group if teachers keep a record of student participation during discourse.* How a teacher chooses do this is a matter of personal preference. However, I learned the importance of keeping a record of who participates the most and the least, whether by being called on or volunteering.

To work toward my goal of building a stronger community in our math class through discourse, I felt a responsibility to make sure each student felt like he or she had the opportunity to speak and could be heard. I found that keeping an informal mental
record of student participation on a day-to-day basis helped me draw some other students in who had not been such active participants in the class.

Some of these students were not naturally motivated volunteers, and others displayed a lower level of confidence. When I called on them, I inferred that most were willing to share their thoughts and seemed glad to be noticed and encouraged. I concluded this when typically non-participatory students were able to share explanations of their reasoning and smiled when they received positive feedback from me or validation from one of their peers.

I was also able to involve students with shorter attention spans who would try to do other work or draw pictures during class. My strategies to keep these students’ attention were to ask them to agree or disagree with something their classmates had talked about, or ask them to help another student out or add on to something another student had said.

By willing all these students to participate, I had a better idea of who understood the material. We also started building a stronger community, as the student survey results demonstrated. In the pre-inquiry survey, many students were worried about giving a wrong answer when they were called on. In the post-inquiry survey, more students expressed gladness that they could help each other figure something out and said they were glad to be paid attention to.

Claim 5

“Math Talk” has a place and a time. After the novelty of these discussions wore off, I concluded that holding discussions weekly ended up being too often for my
students. Their enthusiasm declined and we started dipping into a routine of the same handful of students participating and the others “going along for the ride.” I noticed this as I reflected on the discussions with the other teachers in my room, and while I watched some of the later videos of recorded discussions. I decided to stop trying to have discussions once a week, and start thinking of when they would be most valuable with the lesson.

**Reflections and Future Practice**

As this many-month-long process comes to a close, I realize that I am still just beginning this inquiry. I now have a foundation to work from so I can continue exploring effective discussion practices in elementary math. When I started wondering about the effectiveness of using mathematical discourse, I had such a broad focus and quickly realized that it was impossible to answer all of my questions. I was able to narrow my focus, but I still feel like I have just a general sense of what does and does not work. At this point, I have a few different directions to choose from for future inquiries to explore this topic more thoroughly. I plan on continuing to conduct a series of smaller inquiries to explore one aspect or wondering of mathematical discourse at a time.

I collected a great deal of data through Studiocode, but didn’t use it much as I thought I would. The path my inquiry took me on ended up being more about the groundwork and general format of holding discussions. Now that I have that knowledge and experience, I would like to focus on using Studiocode and the trajectory chart to work with a class on using “math talk” as a more prominent learning tool.
In contrast, I collected very little data on student participation and discussion time, and I wish I had done more with this. The data I did collect for this was from the videos I had, but I would have gotten more data and higher accuracy if I had timed each discussion and kept tally charts on student participation. This is a step I will take in the future when teaching through discourse.

Although I did not see a dramatic increase in the class’ achievement levels (the test grades), the feedback that I got from the students encourages me to continue using mathematical discourse in my future classrooms. In the post-inquiry survey, a number of students communicated that they enjoyed helping each other solve problems and sharing their thinking. During the unit in which I implemented these discussions, I did my best to create an atmosphere of acceptance and open-mindedness so that my students would feel comfortable sharing their answers and explaining their reasoning.

I think that many of the questions I had are ones that could not have been answered in the short period of time I had to conduct this inquiry. As I continue inquiring over the next few years, I will start using math talk in the beginning of the year so that there is more time to build and strengthen a community of learners. By implementing discussions in a qualitative way based on the content of the lessons, not a quantitative way based on the amount of discussions in a week, my hopes are that the students would think of discussions as less of a routine and more a treat or an opportunity.

Overall, I have found that when mathematical discourse is implemented with a group of lower-achieving students, it is an effective learning tool and an asset to the classroom learning community.
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Appendix A: Inquiry Brief

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ii. Rationale

iii. Main Wondering & Sub-Wonderings

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Appendix C: Student Surveys & Results

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ii. Pre-Inquiry Survey Results

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i. 3rd grade

ii. 5th grade

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Appendix A: Inquiry Brief

Context

I am completing a full-year student teaching internship in a fourth grade classroom at Easterly Parkway Elementary. There are two fourth grade classes at Easterly Parkway and we have been reorganizing for math since the second unit of the school year.

My math class is comprised of 20 students, broken down into 10 girls and 10 boys. This is a leveled group of students who have been identified as lower achievers in mathematics. This identification is based on each student’s pre-assessment scores and teacher observations on how quickly and correctly each student completed his or her work.

Most of our students are on level for fourth grade math achievement according to district standards. We have three students who receive Title 1 instruction during class time. These students are expected to participate in everything we do normally in class and receive extra assistance from the Title 1 teacher during regularly scheduled class time.

One student is at a third grade achievement level and works in the hallway with a paraprofessional. This boy is counted as part of our class but not in our room for instruction. He receives different homework and is assessed at different times and with different materials than the rest of the class.

Two of our students receive instruction for learning English, attending daily ELL classes. However, these students attend math class full time without assistance from the resource teacher. One of these students is from Spain, while the other is from Egypt.
Many of our students have difficulty staying on-task during guided practice or paying attention during a lesson. My mentor and I are frequently assisting the same students while the rest are left to work independently. There is a volunteer that comes once a week to assist us during math. She often works with our English language learners. She also helps some other students who have questions or need prompting to stay on task.

We just started the Size, Shape and Symmetry unit, which explores length measurement, properties and types of polygons, angles, and area.

**Rationale**

From the start, this class presented us with many challenges. A great amount of our time and energy has been spent procuring student attention during instruction, keeping students on-task for guided practice, and motivating students to participate. Many of our students are easily distracted from their work or are possibly unmotivated to complete their work, and only a handful of them volunteer their answers and explanations.

I enjoy doing and teaching math, and have a strong desire to have my students feel competent at the very least, if not proficient. In other words, I knew I couldn’t get all my students to like math but I wanted to help them experience success in math this year.

My first thought was to give these issues time to dissipate, as the students would hopefully become more comfortable in the new setting. As we continued to teach this group, I realized that instead of improving, these issues were becoming more of an
obstacle in our class. At this point, I began thinking of what changes could be made to adjust our class format to work more effectively with our students.

**Influences**

I began exploring the possibility of using student-centered mathematical discourse as another strategy to teach math in our class. This idea was focused upon heavily in my PDS MTHED course. The theory behind “math talk” discussions is that students are asked to explain their thinking to each other and therefore they will develop a full understanding of the topic. Through this discourse, the teacher can get a clear idea of how deep a student’s mathematical knowledge is.

Our textbook for MTHED was a guide to classroom discussions in elementary school math classes, and highlighted five talk moves for teachers and students to employ in discussions. These are the moves that I am focusing on to facilitate our discourse. A case study of a bilingual classroom that implemented math talk discussions introduces an action trajectory chart for teachers and students. This chart provides guidelines and labels the levels of math-talk learning in the classroom community. This chart will be my guide to how successful our discussions are.

**Main Wondering**

Can discussions using math talk moves and student work samples benefit a class that is on a lower achievement level and typically works at a slower pace?

**Sub-Wonderings**

Will frequent discussions raise student engagement in math?
Will discussions help us develop a classroom community?

What type of material makes for a good math talk discussion?

If a discussion format is ineffective in helping students learn, what other strategies might produce more success?

**Data Collection**

The following methods of data collection will aid me in answering my wonderings.

Survey – I would like to survey the class once now and once later to find out what they like and don’t like about math class. By fourth grade, students are developing a sense of what works for them and what doesn’t. I feel that their opinions are valuable for me to consider adjusting my teaching and the format of our discussions to fit with this class dynamic. I will ask question such as:

What they enjoyed in math in the past

What specific topics come easily or are more challenging

How comfortable they feel participating in the presence of their peers and how comfortable they are asking a teacher for help

These surveys will help me answer my sub-question as to whether a discussion format can help build a community.

Coded Videos – I will analyze recordings of class discussions using Studiocode software, looking for instances of teacher questioning and explanations, as well as student ideas, reasoning, questioning and participation.
Anecdotal Notes – I am writing anecdotal notes during class about things that work, obstacles I encounter, and ideas I have.

Timing – I will keep a record of how long each discussion takes to create a guideline for when and how often discussions will be useful. This data will be recorded in an Excel spreadsheet.

Record of Student Participation – I will keep a record of which students participate and how much during discussions. This data will be recorded in the same spreadsheet as the timing data.

Student Work – I will look at the amount of correct work in activity pages, homework and tests. I will record this in my anecdotal notes.

**Timeline**

We will have at least one, possibly two discussions per week throughout the course of this inquiry. As I do the weekly plan for math class I decide which lesson will work best to incorporate a discussion. We are constantly adjusting our math plans based on how much we accomplish on a daily basis. Therefore, I cannot schedule the discussions any more than one week in advance.
Every other week I will record a discussion, and the week after a discussion is recorded I will use Studiocode to highlight instances specified in the timetable below.

Every time we hold a discussion I will collect data on either how long it lasts (time) or student participation.

I will review and organize my anecdotal notes once a month.

February

7th-11th
Record a discussion

Write Brief & Annotated Bibliography draft

14th-18th
Develop survey #1
Get survey checked by mentor & PDA
Give survey #1 to class
Analyze survey
Collect data on student participation
Studiocode video for teacher questioning
Revise Brief & Annotated Bibliography draft
Brief & Annotated Bibliography draft due 18th
21\textsuperscript{st}-25\textsuperscript{th}

Record a discussion
Collect data on time
Review and organize anecdotal notes
Collect research
Write Brief & Annotated Bibliography final

March
28\textsuperscript{th}-4\textsuperscript{th}

Studiocode video for student reasoning
Collect data on student participation
Revise Brief & Annotated Bibliography final
Brief & Annotated Bibliography final due 2\textsuperscript{nd}

7\textsuperscript{th}-11\textsuperscript{th}

Record a discussion
Collect data on time
Collect research

14\textsuperscript{th}-18\textsuperscript{th}

Studiocode video for teacher explanations
Collect data on student participation
Review and organize anecdotal notes
Collect research

21st-25th

Develop survey #2
Get survey checked by mentor & PDA
Record a discussion
Collect data on time

28th-1st

Give survey #2 to class
Analyze survey
Collect data on student participation
Studiocode video for student talk time (mathematical) & questioning
Write final paper draft

April

4th-8th

Trip to Texas
Revise Final Paper draft
Final Paper draft, due 8th

11th-15th

Record a discussion
Collect data on time

Review and organize anecdotal notes

Final research collection

18th-22nd

Final week for data collection

Collect data on student participation

Studiocode video for teacher questioning & explanations

Review and organize all data

Compile Powerpoint presentation

Write final paper

25th-29th

Revise Powerpoint & practice presentation

Revise Final Paper

Inquiry Conference 30th

Final Paper due 1st
Appendix B: “Math Talk” Moves & Rules

Moves*

Re-voicing: the teacher repeats what a student has said in order to clarify for the class.

Example: “So you’re saying that these two shapes are different because…”

Repeating: ask students to repeat what another student has said in his or her own words.

Reasoning: ask students to apply their own reasoning to someone else’s.

Example: “Do you agree or disagree? Why?”

Adding On: prompt students for further participation to add a thought to something another student has said.

Example: “Would you like to add something to what he just said?”

Explication: prompt students to analyze and develop their ideas.

Example: “Why do you think that? What steps did you take to get that?”

Wait Time: the teacher waits to call on a student to give the students time to think.

*Some moves and examples adopted from Classroom Discussions textbook.
See annotated bibliography.

Rules

1. Wrong answers no longer exist – we have only opportunities and learning moments.
2. It’s ok to question each other.
3. ASK when you feel fuzzy.
4. Be patient and willing to help.
5. Always TRY!!!
Appendix C: Student Surveys & Results

Pre-Inquiry Survey

In math class, I like to (check all that are true):
Listen to the teacher teach
Raise my hand to answer questions
Listen to others during class discussions
Participate in class discussions
Work independently at my seat
Work with a partner or group
Use the SmartBoard

Answer these questions by circling Yes or No:
I feel comfortable participating in class  Yes  No
I usually understand the math  Yes  No
I ask questions when I don’t understand  Yes  No
There is someone to help me when I need it  Yes  No

My favorite topic in math is...
Adding & Subtracting
Multiplication & Division
Measurement
Shapes
Fraction

What is the first thought that comes into your head when you’re called on in class?

-----------------------------------------------
Pre-Inquiry Survey Results

Math Class Inquiry Survey #1 Data

2/24/11

Questions with Choices

“In math class I like to…”

![Bar chart showing survey results for various activities in math class.

- Listen to the teacher teach: Most students prefer this activity, with 13 choosing yes.
- Raise hand to answer questions: Fewer students prefer this activity, with 6 choosing sometimes.
- Listen to others in discussion: This activity is preferred by 11 students.
- Participate in discussion: 7 students prefer this activity.
- Work independently at seat: 1 blank.
- Work with partner or group: 8 students choose yes, and 1 chooses sometimes.
- Use SmartBoard: 11 students choose yes, and 8 choose sometimes.

"I feel comfortable participating in class" and "I usually understand the math" are shown with corresponding counts.

"I always understand" and "There is someone to..." are also shown with corresponding counts.

"I ask questions when I don't understand" and "There is someone to..." are also shown with corresponding counts.
Open-Ended – I have generalized data into charts.

My favorite topic in math is…

![Bar chart showing frequency of topics: Multiplication, Division, Polygons, All, Other.]

What is the first thought that comes into your head when you’re called on in math?

![Bar chart showing frequency of responses: Negative, Positive, Answer, Other.]
Post-Inquiry Survey

What is your favorite way to learn in math class?
Listen to the teacher teach
Have class discussions
Work independently at my seat
Work with a partner or group

What is something you like about class discussions?

What is something you would like to change about class discussions?

Answer these questions by circling Yes or No. In class discussions...
I feel comfortable participating and explaining how I did something Yes No
I usually understand when others explain something Yes No
I ask questions when I don’t understand Yes No

On a 1-3-5 scale (like a show of fingers), do you feel confident that you are able to do the problems in math class, either on your own or with a teacher’s help?
Circle: 1 3 5

What is the first thought that comes into your head when you’re called on in class?

_________________________________________________________________________
Post-Inquiry Survey Results

Math Class Inquiry Survey #1 Data

2/24/11

Questions with Choices

My favorite way to learn in math class is…

How confident do you feel that you are able to do the problems in math class, either on your own or with a teacher’s help?
Appendix D: Data on Student Participation & Discussion Time

This data was collected from the three different videos that I analyzed in Studiocode.

Student Participation

2/10/11: At this discussion I asked questions about measurement and the students volunteered to answer. Multiple students raised their hands, and the following numbers reflect the students I chose to call on.

14 students total. 4 students twice, 5 students three times, 1 student four times.

2/24/11: During this discussion, I used the Smartboard to project different quadrilaterals and the students made observations on their similarities and differences, then we filled out a chart about quadrilaterals.

13 students total. 3 students twice, 1 student 4 times.

3/22/11: This discussion was a recap of the activities for measuring area that the students did during class. I did more explaining than in the other two discussions to make sure that the students understood the concept.

4 students total. 1 student twice.

Discussion Time

Discussion times during 3 classes:

2/10/11: 24 minutes, one 7-minute discussion & one 17-minute discussion

2/24/11: 18 minutes, one discussion

3/22/11: 15 minutes, one 8-minute discussion & one 10-minute discussion
Appendix E: Teacher Interview Notes

Interview #1:

Curt Himmelberger, 3rd grade PTS (long-term substitute) Easterly Parkway Elementary

Context: middle level of three 3rd grade math classes

1. What does a typical day in your math class look like?

*Warm up problems (book or mental math), carpet for intro of the day’s material (short lesson), worksheet/activity, do activity w/ partner, reconvene at end (Investigations discovery stuff).*

2. Do you ever/how often do you have class discussions in your math class? If you do, how are they structured?

*Primary discussions at end of class, discuss what they were trying to figure out, strategies they used to solve the problem. Facilitated by Curt 75%, ask how you solved & call on different students to explain. 25% of the time Curt is pretending to be confused at intro or conclusion & kids discuss to “help out.”*

3. What benefits do you see from using student work samples to teach, or from having a student explain his or her problem solving process to the class?

*Because of investigations, this is not as common. Definitely in language arts as models, not opposed to it in math. Hope that students are learning from each others’ explanations. Helps students explain their thinking more.*

4. How often do you use re-voicing and wait time in your math class?

*Uses re-voicing most to restate something incomprehensible that another student said & help student figure out what they’re trying to say. Wait time wait for ½ the class to have their hands raised, could do it differently or use another strategy to get more participation.*
Interview #2:

Judy Weaver, 5th grade teacher Easterly Parkway Elementary

Context: lower level of two 5th grade math classes

1. What does a typical day in your math class look like?

*Go over homework, review of recent concepts, activity &/or lesson, work period (guided practice),
assignment (2 days/ week computers for math facts, 10 mins)*

2. Do you ever/how often do you have class discussions in your math class? If you do, how are they structured?

*Investigations is heavy on discussion. With the low group, be careful how much we’re discussing because a lot of the kids take that time to draw, sit back or do nothing. They’re not attentive, it really depends on how attentive your class is with those discussions. Also found to really connect it to everyday life. Don’t like math, don’t see why they need math & it’s not something they feel that they really need to be good at to be happy & successful. Discuss the everyday function of what they’re learning. (kids making $ → chart)
DOING is more important than listening for this group.*

3. What benefits do you see from using student work samples to teach, or from having a student explain his or her problem solving process to the class?

*High group – different ways to do it, understand different ways. Low group has trouble figuring out one way. Investigations is encouraging. Can be too much discussion, confusing, lose students. Theoretically, use student work to explain test scores.*

4. How often do you use re-voicing and wait time in your math class?

*Does restate – ex: explaining mean more clearly. Does this a lot with the low group, calls it “wake-up” time. Many passive kids, not attending, call on different people to wake them up – I caught you off guard, I’m coming right back to you. Don’t know math facts. “You can do this, you know this, take your time.”*
Interview #3:
Matt Ammerman, 6th grade teacher Park Forest Middle School
Context: lowest level of 6th grade math classes (C Track)
1. What does a typical day in your math class look like?
   Online program Brainchild tied to PA standards. Matt, Jess & Chrissy (Learning Support teacher). Project
   problem to do in notebook, warm up. 3 stations: calendar math w/Jess, homework station w/Matt, new
   concept with Chrissy. 4 kids in a group, timer 10-12 min stations. Used to parallel teach, but kids become
   disengaged. Write down hw, preview, maybe start.

2. Do you ever/how often do you have class discussions in your math class? If you do, how are they
   structured?
   As a group with these kids it’s very difficult to have a discussion. Pull from 5-6 elementary, bottom kids
   from each school. Difficult to keep engaged. Do in small groups.

3. What benefits do you see from using student work samples to teach, or from having a student explain his
   or her problem solving process to the class?
   Once in a while, on an atypical day, kids do review problems on the board. Small dry erase boards.

4. How often do you use re-voicing and wait time in your math class?
   Re-voicing yes, a lot! Repetition is very helpful for directions & math concepts ex long division. Also if they
   don’t talk loud enough. Wait time: come back to you because kids say I don’t know.
## Appendix F: Trajectory Charts

<table>
<thead>
<tr>
<th>A. Questioning</th>
<th>B. Explaining mathematical ideas</th>
<th>C. Source of mathematical ideas</th>
<th>D. Responsibility for learning</th>
<th>Thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0: Traditional, teacher-directed classroom with brief answer responses from students.</td>
<td>Students provide short answers and only respond to the teacher.</td>
<td>Teacher explains the work, only.</td>
<td>Students present student responses, answer questions, and provide explanations.</td>
<td>Teacher is the only questioner.</td>
</tr>
<tr>
<td>Question forms</td>
<td>Mission for evaluation.</td>
<td>Also initiating direction of lesson.</td>
<td>Students improve the source of ideas.</td>
<td>Students are responsible for learning and think.</td>
</tr>
<tr>
<td>Task forms</td>
<td>Mission for evaluation.</td>
<td>Also initiating direction of lesson.</td>
<td>Students improve the source of ideas.</td>
<td>Students are responsible for learning and think.</td>
</tr>
</tbody>
</table>

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Table 1: Overview of Skill over Levels 0-3: The classroom community grows to support students and each in central or leading roles.
### Responsibility for Learning: C. Source of Mathematical Ideas

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Teacher begins to pose student mathematical thinking. Teacher plays central role in the math-talk community.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</table>

### Responsibility for Learning: D. Explanatory Mathematical

<table>
<thead>
<tr>
<th>Level 2</th>
<th>Teacher modeling and helping students build new roles. Some co-teaching and co-learning begins.</th>
</tr>
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<tbody>
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<td></td>
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</table>

### Responsibility for Learning: E. Explorative Mathematical

<table>
<thead>
<tr>
<th>Level 3</th>
<th>Students begin to identify mathematical objects. Students begin to make connections.</th>
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<tbody>
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### Thinking

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Teacher asks questions to draw student thinking. Teacher begins to ask questions.</th>
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<tbody>
<tr>
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</table>

### Thinking

<table>
<thead>
<tr>
<th>Level 2</th>
<th>Teacher helps students to develop ideas. Teacher helps students to make connections.</th>
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</thead>
<tbody>
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<td></td>
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</tr>
</tbody>
</table>
The content of many math lessons is to be students' work. Students listen to understand ideas. Students interact with ideas as they develop and justify their answers. Students describe more complete explanations. Students ask questions and listen to the discussions. Student-to-student talk is student-driven, not dependent on the teacher. The teacher's questions still may guide the discussion. The student expresses ideas to co-learners. The teacher assists but now in more participatory and moderating role (coach and assessor).

This textbook focuses on 5 common talk moves for discussions and how they can be applied in the classroom. These moves are re-voicing, repeating, reasoning, adding on, and waiting. I am using these five moves to facilitate the discussions with my class. The beginning of the book provides an overview of these moves and how they can be used together in the context of a mathematical discussion. It then explains each move in detail and discusses different talk formats. This gave me a fuller understanding of how each move aids student learning. There is a section on how to start using talk moves and discussions in a class, which helped me initiate this teaching strategy, and a chapter on troubleshooting that gives advice and possible solutions to common problems that arise in discussions. I have already encountered some of the obstacles that are mentioned in the book and I will be trying some of the suggested solutions throughout the course of my inquiry.


This website addresses the focus on getting a correct answer that is common in math classrooms. It asks and addresses many of the same questions I had at the start of my inquiry, such as how to engage students and ensure that they are learning the required materials. It looks at the teacher’s role in discourse and interventions that are helpful for facilitating discussions. There are a few approaches discussed which can be used as groundwork to different teaching and learning styles in the classroom. It also provides video clip examples of discourse in action.


This article stresses the importance of mathematical discourse in accordance with Vygotsky’s research. It discusses the use of language and social interaction to help students develop their thoughts and understand concepts more fully. One student quoted says that it is easier to understand something when a peer at their same level gives an explanation. I am using this research to guide my facilitation techniques. I will encourage students to help each other figure problems out and I will keep a record of the language that they use with each other. This data will show how our classroom community is developing and what trajectory level we are at for the domains of explaining mathematical thinking and responsibility for learning.

This case study focuses on one teacher who implemented discussions into her bilingual math class. The study focuses on how teachers can establish a classroom community that can make math education reform possible. The actions and goals of the teacher in this case study are similar to mine for this inquiry. Therefore, I am attempting to follow a similar course of action, adjusting my plan as necessary to work effectively with my group of students. This case study did not focus on talk moves, rather on a trajectory chart with four domains similar to the talk moves. These domains are: questioning, explaining mathematical thinking, source of mathematical ideas, and responsibility for learning. There are four levels of the trajectory, from 0-3, and each domain is described at each level. These descriptions detail the actions of the teacher and students at each level. I am using this chart to determine what level my class is at, and my goal is to achieve level 3-quality discussions.


I interviewed my PDS MTHED professor Andrea McCloskey about her ideas and experience with mathematical discourse. She explained the idea of positive disposition, in which students don’t have to necessarily like math but they can feel confident that they are able to solve problems. This is a goal of mine for my inquiry, and mathematical discourse is an avenue to work toward it. I asked Andrea what components or elements of a lesson would make a good discussion. She thought that allowing students to explore a brand new topic through using manipulatives and discourse might be successful if the students don’t feel pressure to get something right. I will be testing this theory as we begin a new topic in our current unit.


This article gives a lot of in-depth information and background about the general idea of discourse and how it is best practiced in a mathematical setting. It addresses the problems that are experienced in present-day mathematics education, and explains the two main types of discourse that build success with mathematical literacy. It highlights benefits for students both in school and later in life in the workforce. Teachers who are using mathematical discourse in their classrooms may find this beneficial to read, as it is a very detailed explanation and rationale for mathematical literacy.

This article is a comparison between how math is taught in United States classrooms and Chinese classrooms. The article looks at the amount of mathematical discourse that occurs in classrooms in each culture. The atmosphere of the Chinese classrooms is what the United States is trying to achieve through mathematical reform, and is a model for me in implementing discourse into my math class. Visual representations of the data collected from U.S. and Chinese classrooms are included, along with excerpts from typical lessons in each country. These are models for me of how to facilitate a discussion, and I will be organizing my data in a similar format of charts and graphs. I will be coding videos for some of the same variables that this study looked at, such as mathematical statements produced by students.


This article focuses on the teacher’s role in a classroom implementing mathematical discourse. It discusses how the success of the classroom community in applying mathematical discourse is a result of the messages the teacher sends during discussions. It details and gives rationales for the teacher’s many roles in this classroom structure, and addresses the misconception that the teacher “stands aside while the students discuss and solve it.” The two main roles of the teacher in discourse – conceptual and motivational – are detailed and examples are given. This article gives examples of highly successful discourse of less successful discourse. It also provides a chart of the levels of discourse, adapted from the trajectory chart found in the Hufferd-Ackles, Fuson, & Sherin case study.


During the process of implicating mathematical discourse in my classroom, I talked with and interviewed some other teachers of lower achieving level math classes at the intermediate and upper intermediate grades. My goal was to learn what they found to be successful with their groups and about their experiences with discourse in the classroom. The dialogues I have compiled show three very differently structured but very successful math environments that all use discourse, but in different ways and for different reasons.


This handbook is a guide to mathematical discourse and the use of language in the world of mathematics. Although it is a resource to a target audience of college-level educators, it is informational for any teacher trying to implement language into their math class. It focuses on problems that may occur when integrating language and mathematics, and describes behaviors and attitudes that the writer has seen in teachers while teaching a math class.