The Challenge of Fostering a Talking for Understanding Talk Culture in a Middle School Math Class

Praxis Project Proposal: Submitted in partial fulfillment of the requirements for the degree of Bachelor of Arts —- as part of the Community, Youth, and Education Studies Major at Clark University

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Abstract

This project explores the way a pre-algebra class develops a classroom talk culture that benefits all students' understanding. The study was conducted through observations and audio recordings in a pre-algebra classroom. This data was then analyzed to notice similarities, differences, and patterns in the ways that students speak. The findings indicate that students are able to utilize talking as a tool to learn when a culture of talking to learn is established. This study revealed the value of student contributions in a classroom.

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Introduction

There is a starter on the board. It shows two different solutions to a problem from the day before. It says, "Here are 2 methods for finding the number of people at ten tables. Which is better and why?" The problem involves a hypothetical party–Beyonce's Album Release party to be exact–where the students have to figure out how many people could sit at a certain number of square tables pushed together. In this problem they were asked the day before to calculate the number of seats for 10 people, and two different methods for solving the problem emerged. At my group of desks, a student immediately started explaining his thinking to his seatmate sitting across from him. His seatmate was pretty unresponsive, but the initial student explained it to him nonetheless. He explained that the end tables had three seats each, while every other table had two. So, he added up the number of seats at each table in order to find out how many people could sit at all 10 tables. When he had finished explaining his thinking, the rest of the class was still working. Then, he began complaining about a group project he had in another class, telling me that he had to present. I asked why he had to present and the other people in his group couldn't, and he said "I did all the work. I always do all the work."

This sparked a thought in me, how do some students take on roles of leadership in group-settings? This vignette came from classroom observations I conducted in the fall of 2022. This instance led me to design my praxis project which is the basis for this study.

Classroom talk cultures vary based on a number of different qualities. A more traditional classroom talk culture may be based around a concept I call "talking for display." If student contributions are made with the sole purpose of getting the "right answer" instead of adding to the conversation, this is what I would call talking for display. However, a different classroom talk culture might value student contribution beyond talking for display. As a part of the CYES 250

course I took, I worked with Sarah Cramer, a pre-algebra teacher in the Worcester Public Schools. She was looking into a concept she called “talking for understanding.” She describes this concept as instances “[w]hen students pose a question to me or their classmates, rephrase someone else’s comment, or state their own formulation of a concept” (Cramer, 2022). The ultimate goal of her work as both a researcher and an educator was to create a classroom talk culture that centers talking for understanding as opposed to talking for display. During my time in her classroom I witnessed many instances of this “talking for understanding,” where students generated knowledge by asking questions and talking with each other.

When I started my own praxis work, I wondered if I should continue to work in a math classroom. However, I realized that talking for understanding is essential in math classes. On a range of math tests, Black and Hispanic students consistently score lower than their White counterparts (Tate, 1997). In a world that has increasing need for employees in technical, medical, and financial fields, a racial disparity in math education is a racial disparity in access to employment (Moses, 2002). The Algebra Project is a program with roots in the civil rights movement that is focused on addressing this disparity. It was “founded on the idea that the ongoing struggle for citizenship and equality for minority people is now linked to an issue of math and science literacy” (Moses, 2002). It addresses these issues of race in math education through curriculum development, teacher training, and support for parents and community members. The purpose of my project is to enlighten teachers to the way students learn algebra through talk, because math education is a right not a privilege.

The goal of my praxis work is to understand the value of a student-centered culture of talking for understanding in a classroom. I hope to understand the value that this talk culture provides to students. The knowledge students have in a class is a valuable thing. If students are in

a classroom that values the idea of "talking for display," the knowledge students can create may only be valued through the lens of correctness. I hope my praxis can add to a literature that math teachers can use to inform themselves about the value of talking for understanding in their classroom. I hope to expose the knowledge that is created when student contributions are present and valued in a classroom talk culture. The site for my research is a math classroom that allows for all different types of talk. I think it is important to do this work in a math classroom, because math is an essential part of education. Math education is essential for the struggle for citizenship. There is already a racial disparity in math education which makes improving math education even more essential.

My guiding questions in my work are: How do students talk about math? How is a classroom talk-culture established? Do members of a math class use repeated patterns of talking in order to enhance understanding and classroom culture?

By observing in a classroom, taking field notes, and surveying the students, I hope to be able to analyze the conversations and contributions to shine a light on the importance of talking for understanding in the classroom.

Literature Review:

The Algebra Project

Through reading Bob Moses, I have begun to understand the importance of my praxis work happening in a math classroom as opposed to a humanities classroom. The culture in our schooling is often "math phobic" in nature. Mathphobia is defined as "a feeling of anxiety that stops one from efficiently tackling mathematical problems (Kunwar 2020)." More broadly, this term refers to a cultural attitude towards math. Oftentimes, students will struggle through learning

math, and the adults in their life will echo the difficulty the student is facing with math. However, this math phobia has presented itself in such a way that very few students, specifically students of color, pursue careers in STEM. Historically, learning math was a privilege that only the wealthy could afford. By gaining the language to understand and speak about math, students are able to pursue careers that otherwise would be closed off from them and gain economic access that would otherwise be inaccessible to them. By highlighting the importance of math, Moses's theory only solidifies the importance of a math classroom where students feel a sense of agency over their learning. By fostering an environment of talking for understanding, ideally students will gain a deeper understanding of the curriculum.

Situating my Work in the Literature

The goal of my work is to add to the literature that already exists. My work is looking at the position of dialogic learning and talking for understanding in a math classroom. However an important aspect of my work is the lens of viewing math education as a civil right as is posed in the Algebra Project.

Conceptual Framing

Initiation-Response-Feedback Talk Pattern

In schooling that isn't centered around student contribution, talking in a classroom typically follows a formulaic pattern. The first step of this pattern, known as the initiation, involves the teacher posing a closed-question to a student or the class. Response is the following step, which happens when a student gives a short response to the question posed by a teacher. The final step is feedback. The feedback step is a short evaluation of the student's response, possibly

with brief feedback. This formula was coined as the Initiation-Response-Feedback, or IRF, pattern by John Sinclair and Malcom Coulthard in 1975 (Sinclair & Coulthard, 1975). There could also be an aspect of recitation in this pattern.

For a long time, this pattern was considered the most common talk pattern in a classroom. While this pattern works for certain types of classroom talk, it doesn't allow students to explain their thinking, grapple with each other's ideas, and learn from their incorrect answers. This talk-pattern impacts my work, because it is one of the talk patterns I am looking for in my transcripts. My aim is to evaluate the way students talk in a math classroom. I am curious if the Initiation-Response-Feedback is more present in the classroom than other forms of classroom talk. I will be looking for indicators of different patterns of talk in a math classroom. This type of research is less common in math classrooms. There is a lot of literature around discussion in classrooms, however, my research has a larger goal of exposing the way that dialogic teaching and Initiation-Response-Feedback patterns can co-exist in the classroom.

Dialogic Learning

The ultimate goal for a more dialogic classroom would position the students as co-creators in the classroom. Robin Alexander defines dialogic teaching and proposes how to identify it when it is present in classroom talk. He details a set of indicators of dialogic learning. Unlike the IRF style of classroom talk, dialogic learning allows for students to "harness the power of talk to engage interest, stimulate thinking, advance understanding, expand ideas, and build and evaluate arguments, empowering students for lifelong learning and democratic engagement" (Alexander, 2020). This idea of dialogic teaching is one of the core theories that have guided my question in

my praxis project. This type of classroom allows students to be active participants in their learning.

Another important aspect of classroom talk is the interaction between students to talk through the curriculum they are learning. When students are able to speak with one another about curriculum they are able to build upon each other's understanding and expand their general understanding of a topic. Resnick (2018), another theorist that has studied dialogic teaching as an alternative to the IRF format, has explained why a classroom talk culture where all students are able to participate with one another is more beneficial than just one or two students engaging in dialogic learning. She says that "[t]he key component is the learning power generated by two or more minds working on the same problem together." This speaks to the communal aspect of dialogic teaching.

Sarah Michaels and Cathy O'Connor (2012), are leaders in the field of Dialogic Learning. They identify the markers of academically productive talk. This is not to say that talk is only valuable if it is "academically productive." However they specify that this academically productive talk breaks away from the conventional patterns of recitation. They identify some talk moves used by both teachers and students in Dialogic Learning. I looked for these talk moves in order to identify academically productive talk in dialogic learning.

Talking for Understanding

From these ideas of classroom talk culture, Sarah Cramer, a pre-algebra teacher in the Worcester Public Schools coined the term "talking for understanding (2022)." Cramer defines talking for understanding as the moments "[w]hen students pose a question to [the teacher] or their classmates, rephrase someone else's comment, or state their own formulation of a concept."

This theory seems reminiscent of the dialogic teaching that both Alexander and Resnick engaged with. Although these concepts are similar, I think an important difference lies in the positionality of the theorist it is coming from. While Alexander and Resnick are both respected theorists on education, Sarah Cramer was a current teacher herself when she developed her framework. She developed this theory with her students and classroom in mind. Also, Cramer's work is based in a math classroom which changes the importance and perspective of her theory talking for understanding in relation to my work. Her theories are specific to the lens my work is through. Her inspiration for this work came from her school encouraging her to incorporate writing for understanding in her math classroom. However, she wondered if she could incorporate talking for understanding as well to allow her class to value more discussion in her math classroom.

At its core, my work investigates how students talk. My goal is to examine the ways that students talk about math to engage with the curriculum with the goal to gain a deeper understanding; this is where Talking for Understanding comes in. Through my conceptualization, the definition of talking for understanding is students talking with one another in order to generate their own knowledge for a deeper understanding for themselves and their classmates. My research is looking to see if students engage in such talk for understanding in their math class.

An essential part of talking for understanding is what happens when students aren't talking. Talking for understanding is pointless if they are not speaking to an active listener that is receptive to hearing others' contributions. Both speakers and hearers should gain a new level of understanding from the exchange. This dynamic can look many different ways. One student can take on the helper role while another may be the one being helped. This can also look like the sharing of ideas and working through a problem by thinking out loud together.

Classroom Talk Culture

While building my conceptual framework, the most important aspect of my work was classroom talk and a classroom talk culture. My definition of a classroom talk culture is simply the recurring ways that students and teachers talk in a classroom. More specifically, I think the classroom talk culture is defined by which patterns and conventions are expected by all citizens of a classroom. For example, some classrooms may follow what I call a "traditional" classroom talk culture that relies on the IRF pattern of talk. However, every classroom has different expectations which leads to different talk cultures. I believe that the classroom talk culture is guided by the teacher and further developed by the students in the class. In the publication *Socializing Intelligence Through Academic Talk and Dialogue* by Resnick et. al. (2015), they have a statement that I believe encompasses my idea of a dialogic classroom talk culture:

> Overall, the teacher's goal is to sustain a teacher-led but student-owned process of shared reasoning that ultimately results in a more fully developed, evidence-backed conclusion, solution, or explanation. (Resik, 2015, p. 15)

My research is based on the idea of a classroom talk culture that consistently uses talking for understanding in a productive way.

A classroom talk culture is defined by who establishes it. If a teacher lays out ground rules for classroom talk without considering the students' perspective, that changes the culture and attitudes around conversations in the classroom. Some of these rules may include who speaks when, how students signal that they want to speak, and how students listen to each other's contributions. If the classroom culture encourages students to be active listeners to one another, this will change the culture around talk in the classroom. If they believe that their classmates are listening, this may impact how students speak when in class.

Methodology

Methodology

In my work, I am positioned as an ethnographer. There is no practitioner action research happening. I am observing and describing the standard customs of the classroom I am observing in. As an ethnographer I am observing a classroom and collecting data on the ways that students talk with one another without intervention. I will also be engaging students in conversations about the ways they talk in their math classroom in order to fully capture their perspective on their learning.

The approach I am taking to my practitioner inquiry work is a method of action research that is called Insider-Outsider Action Research (Vickers, 2005). This method of research requires an activist stance that one can take when conducting research in a space one may not be a part of. Since I am working in a classroom environment that I otherwise would not be a member of, I acknowledge my position as an outsider. I would not be undertaking this work if I did not believe my work could make a positive contribution to the classroom environment. By choosing to act as an ethnographer to this site, I hope to avoid being exploitative in my practices. These practices include starting informal discussions with my subjects to encourage them to think deeper about the way they speak as a member of their math class. I also conducted multiple surveys which encouraged self-examination from my subjects to evaluate their role in their classroom talk culture.

Praxis Site

My praxis site was a pre-algebra classroom at a Worcester Public School in Main South. It is a public school in Worcester that serves grades 7 to 12, and it is connected to an elementary school which serves grades preK-6. There are 527 students enrolled at this secondary school. The student to teacher ratio is 14.5 to 1, however the Worcester Public schools announced that their maximum class size is 30 students. The majority of the student body, 73.1%, self-identify as Hispanic. Additionally, a majority of the school, 82.5%, selected that English was not their first language. Finally, 93% of the students are identified as high need, which means they are "designated as either low income (prior to 2015, and from 2022 to present), economically disadvantaged (from 2015 to 2021), English Language Learner (ELL)/former ELL, or a student with disabilities."

The specific classroom I am working in was an eighth grade pre-algebra classroom. In the specific classroom I worked in, there were twenty students. The gender makeup of the classroom included 45% girls and 55% boys. The class included thirteen English language learners (65%). 75% of the class identified to some extent with the label "Hispanic, Latino, or Spanish," 40% of the class identified some extent with the label "Black or African American, and one student identified to a certain extent with the label "Asian or Pacific Islander." Students were allowed to choose all the labels that they identify with, so some of these percentages add up to more than 100%. Two students have Individualized Educational Plans for a variety of reasons. The school I am working in tries to avoid a "tracking" system that separates "honors" students. However, in the 2022-2023 school year, the eighth grade class was separated by their perceived level compared to their peers into an honors track and a non-honors track. The class I am in is not the honors track.

Positionality

My positionality impacts my work, because it ultimately positions me as an outsider in my site. I am a white, English speaking, non-Spanish speaking woman who goes to Clark University. Additionally I grew up in an upper-middle class household going to a well-funded school. While a majority of my participants do not hold the same privilege as I do, I think specifically my linguistic privilege is extremely prevalent. The school I did my praxis work in has 82.5% of their students identify as current or former English Language Learners (ELL). Since I looked at the importance of talking in a classroom, language is an important aspect of that. As a student whose first language is English, I never struggled to take up space in classroom conversations. My goal was to put my student's experiences as ELLs at the forefront of my understanding.

My epistemological stance of the world has been shaped by the privileges granted to me and the work I have done. I hold a number of unconscious biases in spite of my intellectual understanding.. One of these unconscious biases positions English as the "right"" language even though I live and work in areas where there is a large diversity of language. So, everyday I have to do the work to unlearn the biases that were socialized into me. Another important part of my theoretical framework is my view of how social action takes place. When I first got into social justice work, I thought the only way to gain success was to tear down the oppressive systems from the top. Although that is the ultimate goal, the disappointments of failure forced me to re-evaluate the way work is done. Social justice work is done everyday in classrooms when teachers oppose the systems in education that oppress and exploit their students. My work does not tear down any of the pillars of systemic oppression; however it provides a different lens on the way we educate our students.

Participants

My research was conducted in an eighth-grade classroom. Therefore my subjects are the students (between the ages of 13 and 14) and the teacher. However, due to different enrollment ages for schools, I could not manage to find out the exact age of every subject. My goal was to include the entire class, 20 students, as subjects. Since many students and their guardians opted not to consent to my work, I ended up having 10 participants in total, 9 students and 1 teacher, who returned my consent form. I would have liked to include the whole class in my research as opposed to a smaller select group of students because I would like to understand the talk culture of the whole class. However this necessary change of plans limited the number of conversations and student contributions I was actually able to collect as data. Still, I was able to include recordings of large group discussions, small group discussions, and individual student contributions to the class. My research also includes the classroom teacher as one of my subjects. She is included in my audio recordings and I took field notes about her actions while observing the classroom as a whole.

Below I have included a brief description of each of my participants. All names used are pseudonyms:

Pseudonym[1]	**Brief Description**
Teacher	This is the classroom teacher. She identifies as a white woman and primarily speaks English. She is learning Spanish, and she includes all written directions in Spanish and English. She was educated at Worcester Polytechnical Institute and Clark University, and this is her fourth year

[1] All names used are pseudonyms. The pseudonyms are used in order to humanize my participants in all of my references to them. These are not meant to denote race or gender biases.

Pseudonym[1]	**Brief Description**
	teaching. She prioritizes student participation and contribution in her classroom.
Taylor	Taylor is a student. They[2] speak both English and Spanish in the classroom, but they primarily speak Spanish. They are quiet and rarely participate in classroom discussions. From my observation notes I wrote, "Taylor often has their head down on the desk, the teacher has talked to them about it multiple times."
Whitney	Whitney is a student. They speak both English and Spanish in the classroom. Usually they will speak to their individual classmates in Spanish, but they will talk to the teacher and the broader class in English. They are quiet, but if asked or called on, they will participate in the class. From my observation notes I wrote, "In the group work, Whitney seems to take a leadership role."
Bowie	Bowie is a student. They primarily speak Spanish, but they know some math terms in English. They do not participate much in whole-class or small-group discussions. On my survey, they only answered one of the questions.
Elton	Elton is a student. They speak both English and Spanish in the classroom. They are a bit quieter than their other classmates, but they will participate when called on. From my observation notes I wrote, "Elton seems hesitant to participate, but they often participate anyway."
Jimi	Jimi is a student. They primarily speak Spanish. They often don't participate in larger class discussions, but they participate often in small group discussions. From my observation notes, I wrote "This whole group (which included Jimi) is speaking Spanish in their group."
Rihanna	Rihanna is a student. They primarily speak English, although they seem to be

[2] Gender neutral pronouns are used for all participants

Pseudonym[1]	Brief Description
	able to understand some spanish. They often participate in both the small-group and larger class discussions. I have noticed multiple occasions where they help their fellow students. From my observation notes I wrote, "Rihanna is explaining their thinking to multiple classmates at once."
Elvis	Elvis is a student. They speak both English and Spanish. They are often absent from class. When they are there, they very rarely participate. I noticed them asking for help on one occasion. From my observation notes, I wrote, "Elvis walked over to Whitney's desk to ask for help."
Ashe	Ashe is a student. They speak both English and Spanish, but they seem to speak Spanish with fellow students and English with the teacher. They rarely participate in larger class discussions, and they seem to talk more socially when in small-groups. From my observation notes, I wrote, "Ashe has been talked to multiple times about being off-topic and distracting others."
Dolly	Dolly is a student. They speak both English and Spanish, but they primarily speak English. They are very active in small-group discussions, and I often see them helping the other people in the group. From my observation notes, I wrote, "Dolly has helped their own group and another group in the activity."

Data Collection

I chose to use a variety of qualitative and quantitative research methods to investigate my questions. I believe these methods are important to understand the ways that students talk. I used transcripts from audio-recorded classes so I could eventually analyze the different kinds of talk happening in the classroom. I used field notes to situate the transcripts in the curriculum and

classroom context. Finally, I used an anonymous survey to understand the students' perspective on their classroom talk culture.

When in the class observing, I took field notes in a physical notebook. These field notes took place only when I was physically in the classroom. I took notes on the subject's actions and discussions as it relates to their curriculum. This included who answered questions, the ways that students explained their thinking, and how students engaged with each other's answers.

With a hand-held digital recorder, I recorded the conversations occurring in the classroom. I transcribed parts of these conversations related to math. I would listen to my audio recordings and take note of multiple patterns of talk I heard from both the teacher and the students. The patterns that seemed consistent were the ones I would transcribe in order to use them in my data analysis. I also transcribed the conversations I had with the students where I encouraged them to think deeper about their learning and talking.

In order to capture the students' perspective on the talk culture in the classroom, I conducted a survey. The survey was distributed through their google classroom, but I clarified that it was not a necessary part of their class grade. The survey was conducted in English and Spanish to allow my Spanish-speaking participants the necessary understanding to fill it out. The survey was anonymous.

Survey Questions:

1. Do you enjoy answering questions in class?
    a. Yes, in whole-class conversations and small group discussions
    b. Yes, in whole-class conversations only
    c. Yes, in small group discussions
    d. No

2. Do you feel like you help other people learn when you talk in class?
    a. Yes
    b. Yes, but only when I get the correct answer
    c. No, but it helps me learn
    d. No
3. What makes you want to participate when in math class?
    a. Written Answer
4. Do you think you learn more from talking or listening?
    a. Talking
    b. Listening
    c. Both
5. How often do you help your classmates?
    a. Scale from 1 (Never) to 5 (Often)

Another method of data collection that I used when in my site was short conversations immediately after student-conversations. I would do this to try to gain the students' perspective on their talk in their math classes. The specific questions I asked tended to vary based on the conversations I had observed before talking to the student. I would ask them questions such as "Why did you start this conversation with your classmate?" and "Did you learn anything from that conversation, if so, what?

Data Analysis

I analyzed my data by looking for certain components of classroom talk that define a classroom talk culture and dialogic learning. I attempted to ask basic questions to investigate my

data and understand if there was dialogic learning happening. Although it isn't a strict coding scheme, it was based on my observations as well as the students' perspective I got by talking to students after their class discussions.

The way I analyzed my data was to look for patterns of talk in the teacher's whole class instruction and see if those patterns were evident in student talk. This would help me see if the way the teacher talks actually establishes a culture of talk and what type of talk culture. Similar patterns would allow me to see connections in the ways different members of the class speak alike. This could show the types of talk that are common and promoted in the classroom talk culture. The patterns I noticed being used by the classroom teacher that I tracked in the student talk is below:

Name	**Explanation**
Positive Affirmations	An extended form of the IRF model where the feedback includes an encouraging statement that shows how they value
Rewording	An extended form of the IRF model where one student restates another student's contribution back to them
Challenging	When someone provides an idea and another person challenges their thinking and asks them to defend it

I used these talk patterns to look for similarities between conversations and occurrences. The patterns of talk or thinking that seem consistent between multiple conversations were used in my findings. For my findings, I used my data to establish a setting of the classroom I was working in. Different data led to different conclusions and reasonings, so I separated my findings into: Classroom Talk Culture, How Students Think about Talking, and Unexpected Challenges.

I also used the observation notes I took to inform the setting of my audio recordings. I used my other observation notes to inform the context around my transcribed audio recordings.

These forms of data collection were recorded each time I was at my praxis site. Therefore, all of this data was analyzed together and used to inform the other. I hope that by doing this, I can have the appropriate context to prevent making uninformed inferences.

In analyzing the anonymous survey I conducted, I looked for the opinions of students whether they confirmed the data from my transcripts or not. Whether the survey data was "helpful" for my transcript analysis or not, It was important to me that the students' voices were elevated in regards to their classroom talk culture. I used this in tandem with my other forms of data, as I believe they all contextualize each other and enable me to triangulate the findings of my data. Through doing this, I hope to include the students' perspective in my understanding of my work.

Findings

What happened

The theory of change that I followed had to do with engaging students actively in more conversations to create a classroom culture of talking for understanding. I didn't intervene with a lesson on talking in class and the value of participating. Instead, my intervention was more focused on one-on-one conversations and surveys where I asked the participants to think deeply about their math class participation. By not intervening to start with, I was able to understand the ways that students talked with or without being asked. I think this is an important part of understanding the classroom talk culture. I also asked the students their perspective, because I think this is an important part of understanding why students talk and what they gain from talking in a classroom.

An important part of my ethnography of this class was to talk directly to the students about the conversations they were having with one another. I did this to call attention to the instances where students were talking, and ask them to think deeper about their conversations. I transcribed these conversations

The classroom teacher followed standard educational practice, however she conducted some behaviors that I view as actively promoting a talk culture of talking for understanding and dialogic learning. My goal was to understand how a normal math classroom may develop a more dialogic talk culture.

When I started coming to the class, I started by observing the classroom talk culture that already existed. I noticed the teacher was the leader of the talk in the classroom. In whole group discussions, she would often be the one asking the questions and encouraging participation. In small groups, I noticed the students seeming unsure of how to talk to each other. I assume that this could be because students have not been encouraged to speak in past math classes, however I am not completely sure.

Throughout my interactions with the class, the teacher tried to encourage discussion in the classroom. I noticed a grouping of students who participated and a grouping of students who didn't participate. The students who participated would often answer questions without much elaboration. This was a more standard form of an IRF pattern with closed questions and closed answers. This was obvious, because when the question asked by the teacher didn't have a one word answer, usually no one raised their hand. Later in my time observing, the teacher began to encourage more talk in the conversation. As the class became more comfortable with each other, she would encourage more small-group work as opposed to whole group lecture. She would create incentives for students to participate. Additionally, she would put students in different

groupings to figure out how students worked together and talked when working with different classmates. As this happened, I noticed the grouping of students who participated more often grew.

I believe another important change throughout my time at my site can be credited to comfort in the classroom or a growth in confidence among the students. I noticed that some of the students who seemed more hesitant to contribute were asking more questions. In my observation notes, I noted that as the year continued, the students had more non-academic conversations with each other and the teacher. I attributed this to growing comfortability and confidence with their class relationships. The teacher's instruction and assistance was different based on the student. She knew her students and what they needed to become a more active member of their classroom talk. Beyond individual intervention, I noticed a shift in the talk culture of the entire class.

The student to student conversations were different from those led by the teacher. One way I noticed these conversations occurring was when the teacher would ask one student to ask another. At the beginning of the year this was usually the instigator of many student to student conversations. However, as the year went on, I noticed more students asking each other for help and offering help to one another. In small group settings, I saw a few different dynamics. One dynamic that often occurred positioned one student as the group's leader. Another dynamic was when the group acted more like each other's thought partners. As the year went on, I noticed more students talking to each other about math. In my observation notes, I made common notes about the conversations that students were having about math with each other and the teacher. One such occurrence was when the students were given an amount of work in a set time. I noticed that Elton and Jimi were speaking with each other. They were speaking in Spanish and they were "pointing to their worksheet while discussing." Afterwards, I approached Elton and asked what

they were discussing. Elton told me they were discussing the worksheet even though they had both already finished. This is just one example of a time when the students were voluntarily having informal discussions about math.

My interactions with the students had more to do with asking the students questions and encouraging them to think more deeply about the way they talk in class. At the beginning of my time in the classroom, I noticed that students seemed hesitant to talk to me. They would often answer questions quickly with one-word answers. However as I asked more and more questions, they were more open to answering my questions. From this I was able to gain a better understanding of the student's perspective. I also conducted a survey where the students were able to answer without having to talk face to face if they were uncomfortable. By the end of my time in the classroom, I noticed the students thinking more in-depth about how they talk to one-another.

Important Patterns

Classroom Talk Culture

Positive Affirmations

The classroom talk culture was established by the teacher modeling a pattern of talking that the students echoed in their conversations. In my transcriptions I noticed that the classes used positive affirmations when talking to each other. I am defining this talk pattern 'positive affirmations' as an expanded form of Initiation-Response-Feedback. This pattern happens after the initial feedback move when the person in the conversation giving the feedback thanks, encourages, or compliments the other person's thinking. Although this move is a part of an IRF pattern, it creates a culture where contributions are publicly valued. This shows the people

involved in the conversation and anyone that overhears that talking in the classroom is valued by the other members of their classroom talk culture. The instance of this below happened when the teacher was talking to a small group that was struggling with their work. She came over to help them which led to a brief discussion about the math. This instance is below:

Name	Minute	Contribution	Talk Pattern
Teacher	46:17	So can any of you tell me how we might solve for x?	
Rihanna	46:29	You would have to put the rest of the numbers in instead of the letters	
Teacher	46:42	Yes, you've got this.	Positive Affirmations

This was just one of many instances where I saw the teacher provide a student she was helping with positive affirmations for their thoughts. This kind of talk is important to establishing a classroom talk culture. The expanded form of IRF that includes positive affirmations reassures learners of their ability to do the work they are doing. If students are given a positive reaction when contributing to a conversation, they may associate their contribution with positive emotions. This kind of talk teaches students to value their work. When teachers consistently model talk like this, it becomes a normalized part of the classroom talk culture. I saw a few instances throughout my time in their classroom where students used this same kind of talk with each other. In the instance below, one student was helping another with their work, and the helper continuously reaffirmed the other student's thinking. This instance is below:

Name	Minute	Contribution	Talk Pattern
Dolly	13:37	Um, so do you remember the formula to, uh, to find the slope from two points?	

Elvis and Dolly were looking at the same piece of paper. Elvis wrote the formula to find the slope on the paper.

Elvis	13:52	Is it that?	
Dolly	13:59	Yes, see, you know how to do this. So, plug the numbers into that.	Positive Affirmations

I noticed this instance where Dolly was helping Elvis. Dolly continuously reaffirmed Elvisand complimented them on their thinking. After the conversation I had a brief conversation with Elvis where I asked the question "Do you feel confident in your work?" They told me they did. The talk pattern here obviously mirrors the way that the teacher used positive affirmations. The similarity between these instances shows that the teacher has established this talk pattern in the culture of talking in the classroom.

Another time in the classroom when I noticed a talk pattern that I would label as a positive affirmation was during a conversation between Dolly and Rihanna. In this conversation, the students were working through a slope-intercept problem, and Dolly and Rihanna were working together. One of them wasn't obviously "helping" the other, instead they were working as a pair to work through the problems they were assigned.

Name	Minute	Contribution	Talk Pattern
Dolly	24:32	Oh (...) I think this is what it's asking for.	
Rihanna	24:41	Yeah. You're so good at this.	Positive Affirmations

I noticed in this exchange where one of the students wasn't completely assuming the role of a helper, that there was still evidence of positive affirmations. In my observation notes I noted "Dolly was excited to work together after this positive affirmation." Afterward, I didn't have the chance to ask either of the students about their perspective of the conversation, but I would have liked to ask how the positive affirmations changed Dolly's feelings about the conversation.

I noticed that the prevalence of this talk pattern was different each time I was in the classroom. From my experience, I viewed this talk pattern as an important component of the classroom talk culture. In the examples that I presented above, the positive affirmations acted as a third turn of IRF that was expanded beyond the standard feedback move. I saw different variations of positive affirmations, however I consistently saw this talk move used throughout the classroom.

Rewording

Another behavior that was continuously modeled by the teacher was rewording students' thinking to clarify their ideas. I am defining this term 'rewording' as the restating of someone else's response from the Initiation-Response-Feedback pattern. This makes this talk pattern an expanded form of IRF that includes an expanded feedback move. This could be done as a way of confirming or clarifying the other person's idea. No matter the motivation, this move publicizes the ideas again allowing for more people to gain a deeper understanding. I noticed multiple examples in whole-class and small-group discussions where a student would give a contribution, then another member of the class would restate what they were saying to the whole class. One of these examples is below:

Name	Minute	Contribution	Talk Pattern
Teacher	10:56	Can somebody besides [NAME] or [NAME], though I really appreciate you, What is Y-intercept? What does that mean?	

There was about a 30-second pause where no one answered. In my observation notes, I noted this "Teacher paused, no one volunteering to talk." Then Elton, a student who is usually more quiet, raised their hand. "Teacher nodded to Elton, indicating she should answer."

Elton	11:04	Um, on the diagram, (...) it's where the line meets the, um, y-axis.	
Teacher	11:09	Exactly, thank you Elton, You said it's where the line meets the, the line that you graph, meets up on the y-axis. So in this case where is this line gonna hit this y-axis?	Rewording

In my observation notes, I noticed people in the class saying something similar to this in 6 different conversations. This is an important part of establishing talk moves that are common in a classroom talk culture. The students took over this kind of talk, so it became a part of the classroom vernacular. The rest of this conversation follows an IRF pattern; however the addition of rewording requires a level of reflection that IRF without rewording does not encourage. When the students were working with one another, I saw multiple instances where students would use this rewording technique.

Name	Minute	Contribution	Talk Pattern
Taylor	23:49	So, um, if the problem says that the business has a flat rate, is that the spot where the line crosses the y-axis?	

Rihanna	24:07	Yeah, the flat rate would be the y-intercept, so on the graph it would be where the line hits the y-axis.	Rewording

This instance where the student is using the same rewording move that the teacher used was common throughout the classroom. By echoing the teacher when helping one another, students are subconsciously participating in a classroom talk culture initiated by the teacher.

To situate the relevance of this talk move in the classroom talk culture, I have pulled some quotes from my observation notes when I started to notice these patterns. Although not every conversation went beyond the standard IRF to include the expanded IRF pattern that I call 'rewording,' these observation notes display how relevant it was that I noted it as an interesting moment multiple times. From my observation notes, I wrote "they repeat back what someone else said a lot" and a few moments later I wrote "this happens a lot." Although I do not have an exact count for the amount of times that this move was used. From my time being in the classroom, this type of talk pattern was relevant enough that I perceived it as a part of the regular classroom talk culture.

Challenging

Another talk pattern that seemed to be commonplace in this math classroom was challenging each others' thinking in order to expand the explanation. A common phrase used in the classroom is "What do you mean by that?" People would say this to each other often when students didn't give in-depth explanations of their answers. This would often happen outside of the format of an Initiation-Response-Feedback pattern. One member of the class would challenge the other to think deeper and explain their thinking. Although sometimes these moves could be seen as 'clarifying' what someone meant. However, no matter the motive of the talk move, it

challenges the other person to publicize their thinking in a different way so everyone can gain the best understanding of another person's thinking. In the instance below, the whole class was having a discussion about the Pythagorean theorem. The teacher put a triangle on the board where the value of a and c were known. She was asking the class how they could solve for b. The instance is below:

Name	Minute	Contribution	Talk Pattern
Teacher	17:34	Can anyone tell me how I can solve for b if the only formula we know is a squared plus b squared equals c squared?	
Taylor	17:49	You would just move the formula around.	
Teacher	17:56	What do you mean by that?	Challenging

In this example, The teacher asked Taylor what she meant by saying "move the formula around." By challenging Taylor to further explain her thinking, she forced Taylor to not only think further about the answer she gave, but Taylor was able to publicize her thought process.

In another exchange that I recognized as a challenging move happened between the Teacher and Dolly. Dolly had raised their hand and called over the teacher to ask for some assistance. Dolly had written the answer down and was pointing to it at the beginning of this exchange. This is the transcript:

Name	Minute	Contribution	Talk Pattern
Dolly	44:15	Is this the answer?	
Teacher	44:21	Why do you think that?	Challenging

Although this example didn't show the same wording of the phrase "What do you mean by that?," asking the question "Why do you think that?" acted in the same manner. It challenged Dolly to think more deeply about her contribution and find a new way to explain it.

When students were working in small groups I noticed that students would challenge one another and ask each other to defend their thinking. I even saw students modeling the teacher so much that they would use the exact same phrasing the teacher often uses. In the instance below, the students were engaged in a graphing activity in groups. They were given different types of linear formulas and they had to graph them.

Name	Minute	Contribution	Talk Pattern
Rihanna	23:25	Wait, I think we need to go down, because the slope is negative	
Dolly	23:37	What do you mean by that?	Challenging
Rihanna	23:56	Like, instead of going, um, instead of going up and over, we go down and over.	

When Dolly asked Rihanna what they meant, Rihanna paused, and they took a second to regroup and explain what they meant. The modeling of this phrasing from the teacher established a classroom talk culture where students are challenged to explain themselves multiple times and think deeper about their ideas.

This kind of move was more common when I was in the class later in the year. The teacher would often say this when students would give vague or confusing answers to her questions. Although this may have been "clarifying," Clarifying in this way could be seen as a way of challenging the students' contributions. In my observation notes, I wrote the phrase "What do you

mean by that?" in quotes repeatedly. This proved to me that this kind of talk move was prevalent enough that I felt the need to write this phrase repeatedly.

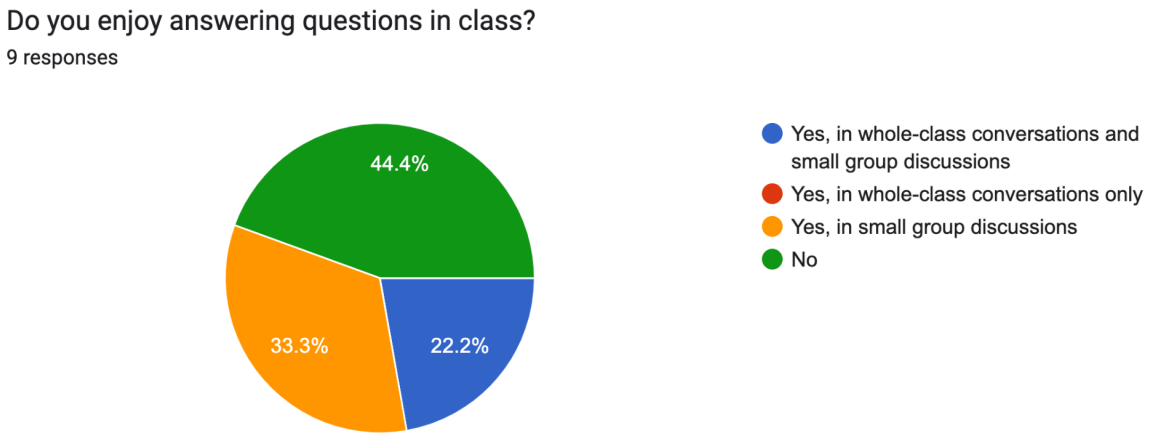
How the Students Think About Talking

An important part of understanding the way that talk occurs in the classroom is to ask the people that are speaking what they are thinking. A few times after students had conversations, I would approach one or both of them to ask them questions about the conversation they just had. One of the times I did this was after a conversation between Rihanna and a nonconsenting classmate. From my observation notes "The class was working on a "systems of equation" problem where they were asked to compare two companies selling the same product. They were tasked with determining the most cost-effective company to buy from. Rihanna approached a non-consenting classmate after they had completed their own work. Their classroom teacher didn't ask them to help or prompt them in any way that I saw. I could not collect data on this conversation, so, after the conversation ended, I approached Rihanna to ask them about the conversation." A section of this follow-up conversation is below:

Name	Minute	Contribution
Sarah	35:11	Ok, um, sorry, last question. Did you learn anything from helping [NAME]?
Rihanna	35:29	Um, I don't know. Um. I had to think a lot about how I solved it. (pause) Like, I couldn't just, I couldn't do it I had to move slower. So, yeah I had to think about it a lot. I guess talking to [NAME] about it made it easier to understand.

In this conversation, I tried to challenge Rihanna to think about the conversation they just had, and I unearthed something interesting. They said that they had to "move slower" when explaining their thinking to another classmate and this made it easier to understand the content. Although this is a single occurrence, I think this points to how when students help each other they can gain a deeper understanding, then both the person helping and the person being helped benefit.

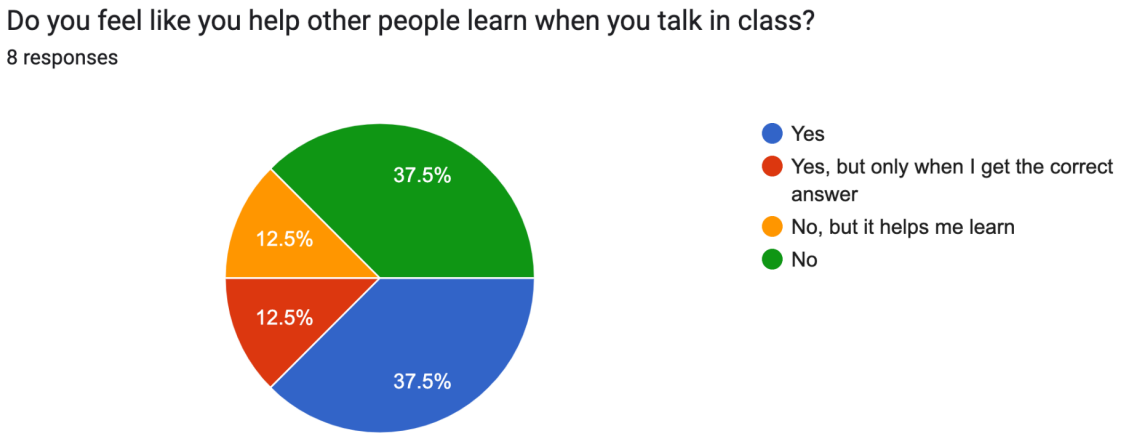
I conducted a survey where I asked my participants to think deeply about talking in their math class. In this survey, I asked the students whether they enjoyed answering questions in their math class. I asked this question to investigate why students talk in their math class. The results are below:



Almost half of the students that were in this survey answered "No." I think this points out something important about the classroom talk culture. If students don't enjoy talking in class, they won't. I must acknowledge the common hesitancy students, and especially students of color, have been made to feel in their math class. Whether or not the students enjoy talking, they may have just answered "no" because they do not enjoy math in general. Nevertheless, I think the high number of "no's" points to a hesitant classroom talk culture, since so many students would rather not speak in class. I also found it interesting that no one answered that they enjoyed talking most

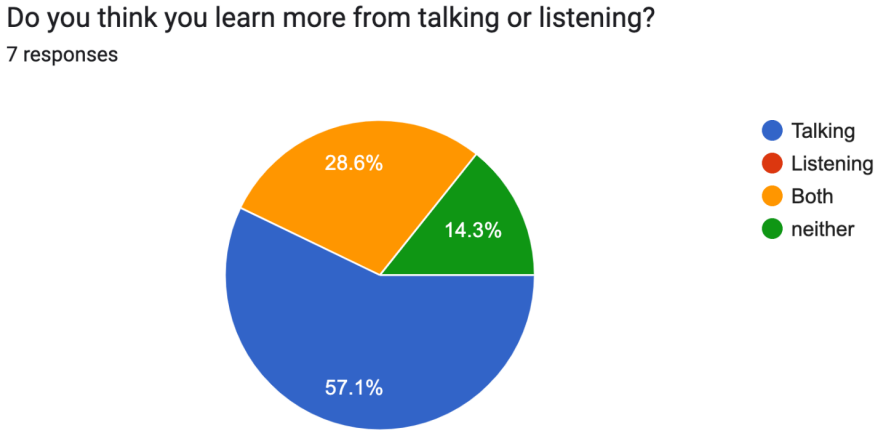
in the whole-class discussions. This may point to the students' motivation for talking. Students may enjoy helping one another, but they don't feel their talk is as effective in the whole-class discussions. I also must account for the way language impacts students talking. If students are in a small group that all speak Spanish, they may feel more comfortable answering than in the whole-class where their teacher and multiple classmates don't speak their language.

Another question in my survey was, "Do you feel like you help other people learn when you talk in class?" This can establish students' perspective on their own learning. If students feel as though they can help their classmates by talking in class, they may be more likely to participate. The results are below:



The answers were pretty split. I only had eight results to this question, because Bowie only answered the first question. Half of the people answered some form of "yes," and half of the people answered some form of "no." Surprisingly only one participant answered that they only feel like they help other people only if they get the answer right. I think this proves that there are many different motivations as to why students may talk to each other.

The next question in the survey asked the question, "Do you think you learn more from talking or listening?" I included this question to see whether students feel that they gain understanding when they talk about math. Only 7 participants responded to this question.



[3]

The results of this question were the most surprising to me. Despite the answers to the first question suggesting that the students don't enjoy talking when in their math class, this question shows that they do believe they learn from it. This can provide some answers for why students talk in their class even though they may not enjoy it. If students believe they are learning from talking, hopefully they are more engaged with the dialogic learning happening in their classroom.

Unexpected Challenges

An important part of understanding a classroom talk culture is understanding the classroom community. Although I spent a large amount of time in the classroom, I was still seen as an outsider by the class. Since I wasn't a member of the class, my perspective on their

[3] I allowed an 'Other…' option where students could write-in their own answers, the green section of the chart represents one of these write-in answers where the student wrote in "neither."

classroom talk culture was skewed by that. This can be both positive and negative. I had a more third-person perspective that the teacher may be too present in the classroom to get. However, I also lost some understanding that I could've gained about the classroom culture by being a full-time member of the class. I attempted to gain the students' perspective as much as possible in order to account for these misunderstandings. These gaps in my understanding became obvious in some of the one-on-one conversations I had with my participants. One of the instances below occurred when a student helped another. I thought the student was trying to challenge another in their thinking, but they actually didn't understand what the nonconsenting classmate was saying.

Name	**Minutes**	**Contribution**
Sarah	15:12	Can you tell me why you asked [NAME] what she meant when you were working on question 6?
Rihanna	15:37	Um, I don't know (looks at the paper) Uh, I didn't understand what she was saying in Spanish, I don't speak Spanish.

I wasn't super familiar with the nonconsenting classmate that they were working with, which may be why I misunderstood this exchange. My focus on the students that were consenting to my work was essential to get enough data for my work, however this also caused me to have an altered relationship with the nonconsenting students. If I were a teacher or student in the classroom, I would have a better understanding of the classroom talk culture which would make my data more extensive and accurate.

Another hurdle I faced was one I anticipated in my positionality statement. The classroom I was doing my praxis in was majority multilingual, both English and Spanish. I don't speak Spanish, so I was already separated from the class by a language barrier. Of my participants, all but one spoke Spanish. When working in small groups and helping one another, the students

spoke what they describe as Spanglish—a mix between speaking Spanish and English with words and slang from each. I was able to understand pieces of these conversations, however I couldn't gain a deeper understanding of these conversations. Jimi was my only participant that spoke little to no English in the classroom. From my observation notes I wrote "Jimi seems to consistently work with the same group of Spanish-speaking nonconsenting students." Throughout my data, I was only able to transcribe very few conversations where participant Jimi was speaking. The classroom teacher also does not speak Spanish fluently. This excludes a whole class of students like Jimi from participating in the whole classroom talk culture. When a certain class of students are excluded from the talk culture, the talk culture does not invite or value their contributions and they miss out on learning from their classmates.

Another setback that I faced was the times when students simply weren't using talking to learn. Many times when I was in the classroom, I was recording and observing moments when the students weren't using one of the talk patterns that I identified as common in the classroom. There were also many patterns that I noticed consistently that were just non-academic in nature. One time, when the students were working in small groups, I was observing a small group that didn't finish their work. This group included Bowie and participant 8. I wrote in my observation notes "8 and Bowie are discussing a video game." A few minutes later, the teacher tried to get them back on topic, but the students quickly went back to discussing non-math topics. Although this kind of talk was non-academic in nature this also speaks to the classroom talk culture. I think this is one of the facets of the classroom talk culture that the students are solely in control of. Non-academic talk is important to establishing community within a class. If Bowie and participant 8 were bonding over video games this may not have been academically productive, but

it was important to build their relationship with one another. Since I was only looking at academic talk, I had a blind spot for the important non-academic talk that happened.

Conclusion

Summary

When I started this work, I was trying to understand the value of discussion when learning math. I did this by looking at the classroom talk culture around math that furthers student learning. I did this by looking at the patterns of how the teacher and students talk. I found consistent patterns in the ways that students talked, including patterns of positive affirmations, rewording, and challenging others to say more. This demonstrates a case where students seemed to have taken up elements of the teacher's talk, in enacting the talk culture when speaking in their math class.

I also looked at the students' opinions to understand why they speak during a math class. I got a variety of answers to this. Some students contribute to class discussion because they are prompted by the teacher to speak. Other students will talk during math class because they feel compelled to help their classmates. However the data shows that students in general recognize that they learn from talking. This is an important aspect of the classroom talk culture that shows students value the way they can learn from the culture of talking for understanding in the class.

Implications for Practice

The implication this project has for teachers points to the importance of teachers to be leaders of their classroom talk culture. What I found was that modeling talking for understanding encourages students to take up and use a similar discourse pattern. There is also an interesting

implication on the importance of student's explaining their thinking to one another. In the survey I conducted, 85.7% of students said that in some form, they learn from talking. Then in one of the conversations with Rihanna, I challenged them to think about how they learn from explaining their thinking. If students are challenged to explain their thinking, they too can learn from that.

Personally, there are many implications for me in my own practice as a future elementary school teacher. Many of the kids came to 8th grade with feelings about math and talking in math class already ingrained into them. If students have better teachers in their earlier education who have a better relationship with math and talking as a tool for learning, they may hold onto their interest in math class a little longer. If a strong talk culture was established in their earlier learning years, it would come more naturally to participate in it. In my own classroom, I hope math will be something the students look forward to. I plan to do this by establishing a positive, student-led classroom talk culture in my classroom, by establishing talking for understanding as a general classroom norm.

Limitations

One of the most prevalent limitations I faced in my research was due to my positionality. I was an outsider in the classroom community no matter how much I attempted to build relationships and connections with the students. As an outsider, there was a limit to how much I could understand the classroom culture. If I were to start over with this project, I think I would make it a youth participatory action research (YPAR) project. If the project was a YPAR, the students would have more control over the research, since they are full members of the class being researched. Another way my positionality limited me was linguistically. Since such a large majority of the class spoke Spanish, in the future, I would want to have a co-researcher who is

fluent in Spanish who could assist with the project. Although my positionality limited me, I think the most important part of this work is creating comfort and community with the students and teach]er. If I had spent more time in the classroom, I could've spent more time fostering this connection with the students. This was a fault of my own to not dedicate more time to this work. If I were to redo this project, I would've begun my work earlier. If I plan to do a project like this again in the future, my goal would to be to do this in my own classroom, so that I would be more of a presence in the classroom.

Another limitation I faced was the amount of consenting participants in the classroom. The class was made up of 20 students, and my hope was that all of the students would consent. However, only 9 of the students participated in my research. Due to this limitation, I couldn't take observation notes and transcriptions of many important conversations. These conversations may have led me to see the classroom talk culture differently or from different angles. Analyzing these conversations could probably help me see the talk in the classroom from different angles.

Theoretical Implications

Throughout my pursuit of dialogic learning in the site I was observing, I realized the complexity that talking in a classroom offers. Going into my work, I thought dialogic learning and the IRF pattern couldn't coexist in the same classroom talk culture. However, throughout my observations I realized that the same class that uses more dialogic methods of learning can also use expanded versions of IRF.

In the talk patterns I recognized, "challenging" might be considered more of a dialogic learning technique. However "Positive Affirmations" and "Rewording" take on more of an extended IRF model. Since these talk patterns often require initiation, response, and feedback

before the talk move of rewording or affirmations, these may live in a space of gray between dialogic learning and strict IRF models.

Methodological Implications

An important part of my methodology is the conversations I had with my participants after they were in discussion with each other. Although student voice is often an important part of data analysis, I wondered what value could be gained from seeking out student voice immediately after they spoke with one another. I started to do this as a necessary data-collecting method. Since I had such a small number of participants there were many conversations that I could not record. To try to account for missing these conversations, I would talk to a consenting member of the conversation afterwards and I would ask them about their perspective of the conversation.

I think I gained a unique insight on the student's perspective that helped me to better analyze the talk culture in the classroom. Although there are other methods of gaining the student's perspective in research, this method feels like it is the best way I could challenge my participants to truly think about the way they were talking in that exact moment.

Significance

I think the significance of my praxis work is tied back to the ideas that Bob Moses posits about math education being a civil right. Any work that emphasizes a math education that enhances student understanding or student access is a work of civil rights. In underfunded public schools with large minority populations like the one I did my praxis work in, math as a civil right is more essential, because math literacy has continuously been gatekept from Black and Hispanic students. Although my work may not be observing a completely revolutionary form of classroom talk that emphasizes math literacy, any work that encourages student voice and a wider

perspective of math education promotes the idea that math education can be an act of activism to fight against systemic oppression against non-white students.

Works Cited

Alexander, Robin. “Developing Dialogic Teaching: Genesis, Process, Trial.” *Research Papers in Education*, vol. 33, no. 5, 17 June 2018, pp. 1–38., doi:10.1080/02671522.2018.1481140.

Asterhan, Christa, Sherice Clarke, and Lauren Resnick. "Socializing intelligence through academic talk and dialogue." (2015): 1-480.

Cramer, Sarah. “Sarah Cramer Research Proposal up-to-Date 2022.” Google Docs, Cramer, 2022, https://docs.google.com/document/d/14dfAyY6i_SnWYk7EEBCaYSE0oVck_k8G5e_z52YYrc4/edit

Kunwar, Rajendra. "Mathematics phobia: Causes, symptoms and ways to overcome." *International Journal of creative research thoughts* 8.8 (2020): 818-822.

Michaels, Sarah, and Cathy O’Connor. "Talk science primer." *Cambridge, MA: TERC* (2012).

Moses, Robert, and Charles E. Cobb. *Radical equations: Civil rights from Mississippi to the Algebra Project*. Beacon Press, 2002.

Resnick, Lauren B., et al. "Next generation research in dialogic learning." *The Wiley handbook of teaching and learning* (2018): 323-338.

Tate, William F. "Race-Ethnicity, SES, Gender, and Language Proficiency Trends in Mathematics Achievement: An Update." *Journal for research in mathematics education* 28.6 (1997): 652-679.

Vickers, Margaret. "Action research to improve the human condition: An insider-outsider and a multi-methodology design for actionable knowledge outcomes." *International journal of action research* 1.2 (2005): 190-218.