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# Promoting Student To Student Discourse In Mathematics Classrooms

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# PROMOTING STUDENT TO STUDENT DISCOURSE IN MATHEMATICS CLASSROOMS

By

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# CHAPTER ONE

# INTRODUCTION

## Introduction

I have loved mathematics since my pre algebra class in middle school. During this class I learned of the thrill that can come from solving tough problems and I have been hooked ever since. However, once I entered my college level math courses, I learned that there was so much missing from my own high school mathematics learning experience. The classes I took growing up taught me definitions and formulas to memorize. The courses were lecture based, where we listened and then proceeded to practice the formula on our own.Very seldom did we have to struggle or collaborate with others on how to solve a problem. When I got stuck, I knew my teacher would tell me exactly where I went wrong. I was never taught to discuss my thinking, why the procedures worked, or how they connected to previous material. I just believed my teacher had all of the answers.

Once I found myself in college level mathematics courses, I was expected to collaborate with others to solve problems without knowing a formula or procedure to follow. This was a foreign concept to me and I struggled immensely. I went through a period believing I was bad at math, when in reality, I was never given the opportunity to discuss problems with other students and I was uncomfortable with it. I feel as though my secondary mathematics education required surface-level thinking that was teacher driven. This is something that I want to avoid for my own students. I feel that students should be working through problems together while learning how to justify their ideas and make connections to previous mathematical concepts. We are taught to have student centered

classrooms and to use Bloom's Taxonomy to get students to move towards higher levels of thinking, but how often do math teachers get there? Often math teachers, some more than others, fall back into the trap of telling students the formula to save time and then send them off to individually practice implementing that formula several times to help them "learn" it. My experience has led me to this question: *How can I promote student to student discourse in mathematics classrooms?* In this chapter, I will discuss my background, classroom observations, a brief overview of the capstone project, and the significance of this capstone project. First, I will discuss my background.

**Background**

I grew up and attended school in a northern suburb of the twin cities in Minnesota. I went to a smaller district in the area where my graduating class was around 300. I am someone who has always really enjoyed school. I always did my homework and took several honors and Advanced Placement courses. However, with that being said, I do not remember much of my learning experiences from k-12. I remember that I thought math was interesting and that I was good at it, but I do not remember anything that was especially fun or engaging. Oftentimes it was a lecture followed by individual work time where I quietly talked with friends and worked on my own assignment. This is not always a bad thing if the lecture is given in a way that incorporates student's ideas and is followed by structured work time or an engaging activity that is meaningful for students. In other content areas, like language arts, for example, students are asked to be expressive and create their own products/papers that will all look very different from one another. I do not recall ever being asked to express my thinking in a meaningful way in math class until calculus. Even in science class, students may be given a procedure to

follow but they are allowed to investigate different variables and are put into lab groups to do so.

My perspective on what math class could be changed when I was in college. I took an Advanced Probability and Mathematical Statistics course as a junior and I realized that math class could be explorative. My professor would assign us tasks and we would work together to see the experimental statistics play out. Sometimes we worked as an entire class and other times in small groups. One day he even had us test if we could tell the difference between different brands of bottled water. He made class engaging and fun. He gave us connections to the material that I still remember today.

The second class that changed how I view a math course was my methods class for teaching secondary mathematics. At times, the professor would treat us as if we were her secondary math students and she would have us do different activities. The activities we were doing were not about getting the correct answer, but instead about explaining our different ways of thinking. By talking to one another we would see that there were several ways to solve every single problem she gave us. We worked with Desmos, an online graphing application (Desmos, 2021). We explored geometry with compasses and a website called GeoGebra (GeoGebra, 2021). We engaged in problems that required us to use problem-solving techniques. Many of these activities we did together in groups or we discussed our thinking with one another. These various activities are something I would like to implement with my own students to get them talking to one another about the mathematics they are doing. My college experience really opened up my eyes to the possibilities of what a math class can look like. In the next section, I will discuss some of

the experiences I had during my time observing other teachers at work in their classrooms and in my own experience in my classroom.

**Classroom Observations and Experiences**

As an education student, I was required to spend many hours observing and working with other teachers in their classroom during my clinicals in various schools. I was able to observe teachers who were using instructional methods that I now implement with my own students. I was also able to observe teachers who demonstrated some teaching strategies that were, in my opinion, examples of what not to do in my own classroom. For example, some positive things I was able to see during one of my clinicals in a 6th grade math class in Minneapolis was that students were sitting at tables to help facilitate group discussions. The class was very student-centered with kids going up to the board explaining problems. Almost every group felt comfortable talking to one another and working together to see the math in various ways. One experience that was not so positive was when I was with a teacher who did not have very high expectations of the students, especially students in the lower level class. She told me "we just have to get through the first hour and then we are good for the day". This was striking to me because her first hour had more lower level students she felt it was something she had to "get through." This class was always off task and she had a hard time keeping them focused during her lecture style classroom. I never once saw students working together or talking about math with each other. The kids knew she did not believe in their abilities and it showed in the effort they gave and the overall classroom environment. These two very drastic examples showed me the significant difference that can come from believing in

students, having strong relationships, and creating an environment that promotes student to student discourse in the classroom.

In my own classroom this past year, I struggled with finding ways to encourage student to student discourse. We experienced challenging times in our school with moving between distance and hybrid learning several times. When we were all distance learning, I was able to find success getting kids to respond in the chat of our google meets or explaining their ideas by unmuting. But this usually occurred AFTER they have already thought about the problem on their own. I was not able to successfully find ways to get them to work through the entire problem solving process together while not being in the same physical space. This project focuses on activities teachers can use to promote student to student discourse in various settings; in person, hybrid, and distance learning models. Now I will provide a brief overview of my capstone project.

**Project Overview**

After reviewing literature relevant to answering the question: *How can I promote student to student discourse in mathematics classrooms?,* I have created unit activity guides for a high school geometry course that incorporates activities and various instructional strategies to promote student to student discourse. The units are based on the Minnesota academic teaching standards for mathematics, focusing on 9th through 12th grade geometry (Minnesota Department of Education, 2008). I will be implementing the guides primarily with 10th grade geometry students. Although I am designing the activities for a geometry class, the activities included in the guides can be adapted to fit other math courses as well. The purpose of the activities included in the guides is to get students discussing various approaches to solving problems in mathematics. Now that I

have given a brief description of the project, I will discuss why this project is important to the field of mathematics education.

**Project Significance**

In finishing this project, I am hoping to contribute to the professional conversation surrounding student to student discourse in mathematics classrooms. Within the last year, the classroom environment has changed drastically due to the Covid-19 pandemic and creating these opportunities for discourse are more important than ever before. According to the National Council of Mathematics Teachers (2014), some of the main goals of mathematics education are: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (National Council for Teachers of Mathematics [NCTM], 2014). Adaptive reasoning is the idea that students can think logically and discuss/justify their ideas. Student to student discourse has many benefits that reach far beyond the math classroom. Some of these benefits include students learning to clearly communicate their ideas, looking at situations from multiple perspectives, and working collaboratively with others towards a common goal. This project will provide other math teachers with a resource they can use in their classrooms while trying to promote student to student discourse. Finally, I will summarize the main points of this chapter.

**Chapter One Summary**

In traditional mathematics classrooms, students are asked to listen to a lecture, take notes, and reproduce the math using routine procedures and various memorized facts. In today's world, the ability to think critically and work with others is becoming more and more important. In this chapter, I first discussed my own learning background

in highschool and college as it relates to this project. Then, I discussed some of the things I was able to observe in other classrooms and some things that I have been doing on my own as a first year teacher. I provided a brief overview of the capstone project, and finally, I discussed the significance of completing this project to the professional education community. The next chapter is a review of literature that is relevant to answering the question: *How can I promote student to student discourse in mathematics classrooms?*

# CHAPTER TWO

# LITERATURE REVIEW

## Introduction

The question being asked for this capstone is: *How can I promote student to student discourse in mathematics classrooms?* The purpose of this research is to inform my capstone project. My project is to create unit activity guides for a high school geometry course that incorporate various group, partner, and whole class activities that promote student to student discourse. The units will be based on the Minnesota academic teaching standards for mathematics, focusing on 9-12 geometry (Minnesota Department of Education, 2008). The activities included in the guides will be able to be incorporated into different lessons with the intent of getting students talking about their mathematical ideas. They will be developed for use in various types of learning models; in-person, hybrid, and distance learning.

Chapter Two will be a review of the literature relevant to answering this research question. Discussed first will be a review of student engagement in the classroom. This will include the research behind a positive learning environment, social pressures that exist surrounding mathematics learning, and increasing student engagement with student-centered classrooms. Next, will be a review of the role of mathematical discourse in the classroom. This will include the importance of mathematical discourse between peers, the benefits of using multiple types of discourse in a class, and how discourse can help facilitate productive struggle in learning. Finally, there will be a review of current best practices surrounding implementing discourse in the classroom. This will tie the two sections together by discussing what activities are currently being done to encourage both

student engagement and discourse within any of the learning models; in-person, hybrid, or distance. This first section will begin by reviewing student engagement and what it means to have a safe and positive classroom environment, where student to student discourse can flourish.

**Student Engagement**

Student engagement can be defined as students being actively involved in their learning tasks and activities (Lei, Cui, & Zhou, 2018). Engagement in a classroom is influenced by a variety of factors including school policies, school community, and peer interactions (National Council for Teachers of Mathematics [NCTM], 2014). Teachers also have a direct effect on the engagement levels of students. High levels of student engagement leads to more motivation to succeed, which in turn leads to higher levels of academic achievement (Lei et al., 2018). Increasing student engagement starts with creating a safe and positive learning environment for students. According to Maslow, without the basic need of safety and security being met, students will be unable to focus on much else (Huitt, 2007). This section will first examine what it means to have a positive classroom environment diving into the characteristics of a welcoming environment. Then it will look at social risks that exist in math that may inhibit student engagement. Lastly, it will look at a few different approaches to creating a positive environment that will increase overall student engagement while minimizing social risk. These are just some of the many classroom models out there, and they can be adapted to better fit different teachers' preferences. It is important to understand factors that may positively or negatively affect student motivation and discourse in the classroom, one of them being the environment.

***Definitions and Characteristics of a Positive Learning Environment***

Depending on the source, the idea of a positive learning environment is defined/characterized in a number of ways. Maslow (1943) developed the hierarchy of needs where one can only begin to address the higher level needs when the previous lower level need has been met. Starting from the most basic level and moving to higher level needs, Maslow's hierarchy includes the following:

- Biological/Physiological: breathing, food, water, shelter, sleep
- Safety: physical safety, access to resources, family, health, property, freedom from fear
- Love/belonging: friendship, family, group relationships, peer relationships
- Esteem: self esteem, confidence, achievement, respect for and by others, recognition
- Self Actualization: realizing one's potential, creativity, problem solving ability, acceptance of facts, lack of prejudice, pursue inner talents (Huitt, 2007)

This hierarchy is often used in education when discussing building rapport with students so that they feel safe and secure BEFORE they can start to dig into the content and learn. It is a more general theory that can be applied to classroom practices.

Whereas, there are more focused classroom specific definitions out there. One definition is given by Young, who defined a positive classroom environment as having these characteristics: students feel a sense of belonging, trust others, and feel encouraged to tackle challenges, take risks, and ask questions (2014). The environment provides relevant content, clear goals and feedback, social opportunities, and various strategies to help students be successful (Young, 2014). Young focuses on characteristics of a positive

learning environment, assuming biological and safety needs have already been met. Then there is MacSuga, Simonsen, & Briere's definition of what a positive classroom environment looks like. They write, ". . . (a) delivering explicit and engaging academic instruction, (b) implementing empirically supported classroom management strategies, and (c) building relationships with students and their families" (2012, p. 1). Combining parts of these three theories/definitions, for the purpose of this project, I will define a positive learning environment as one where students feel safe and accepted in, have a sense of community, have space for discourse, and feel they can take risks and ask questions. The environment of the classroom can have major impacts on how students learn and their belief in their own ability to succeed.

***Social Pressures inside a Math Class***

Students often have a love or hate relationship with mathematics, especially in traditional mathematics classrooms. From a young age, students are given the impression from either their teachers, parents, or peers that they either are good or bad at math (Bennett, 2010). They grow up hearing comments from adults saying things like "I was never good at math" or "some people just get math." Even in the most engaging classrooms, if students have a preconceived notion that they are bad at math it can be difficult to create student to student discourse. The key is getting all learners engaged by first building student–teacher relationships and creating a belief that everyone can learn math. After the relationship has been built, teachers can use discourse to help students see themselves as part of the mathematical community (Clements & Joswick, 2018).

According to Bennett, from an early age students are under the impression that some people are good at math and others are not (2010). This idea can come from a

variety of sources. This notion can have detrimental effects on a student's success as they move through their math education. Walking into a math classroom, even a student-centered classroom, an observer can usually see the kids who dominate the conversation and exude confidence in their abilities compared to the students who are just trying to make it through the class. Bennett referenced this to Canfield and Well's poker chip theory. Bennet writes,

> ". . . some students experience more success; these are the ones with more chips, so to speak, and thus come to class willing to take more intellectual risks, such as voluntarily participating in discussions. Essentially, they can afford to lose some chips. Other students, who have not experienced as much success and who have fewer poker chips, are less likely to take such risks unless they are ensured success." (Bennett, 2010 p. 79)

In order to remedy this phenomenon that so often occurs in K-12 math courses, teachers need to find a way to reduce the social risk and give all learners a meaningful voice, giving them the notion of having more chips so to speak.

Building relationships is key to students feeling open to discussing in the classroom. Assuming that physiological and safety needs are being met, the focus shifts to belonging and self actualization (Huitt, 2007). By developing a relationship with students, they will see that you care about not only their math success but also their success outside of the classroom. Research shows there is a strong correlation between strong teacher-student relationships and academic outcomes (Horn, 2017). One way to encourage students to share about themselves is by being open and sharing your own values, interests, and passions (Horn, 2017). When the teacher is themself, the students in

turn can be themselves. This will help create meaningful relationships where students can be more open to sharing in class (Horn, 2017). The next hurdle is getting students to share their mathematical ideas with their peers by creating a classroom community.

There are a few different ways to create a classroom community. One way is having classroom jobs. By giving students jobs within the room, even lower level learners who have not had a history of success in math can come to class knowing they will be a part of the class's overall success/functioning (Newell and Orton, 2018). Another way all learners' ideas can be valued in class is by creating a classroom standard where multiple strategies and perspectives are used to solve problems. This is one of NCTM's five strands of mathematical proficiency (National Council for Teachers of Mathematics [NCTM], 2014). By seeing different perspectives of problems and having students work together, math class can become a more positive, collaborative environment. According to Boaler, students should approach math with a positive mathematical mindset: a mindset in which they know that math is a subject of growth, and they know their role as mathematicians is to adapt and think about new ideas (2018).

Try to remind kids that growth can sometimes be difficult. Early on, students are instilled with the idea that math is only about following rules and procedures, which should not be the case (Lemley, Ivy, Franz, & Oppenheimer, 2019). Teachers want students to see math as useful and worthwhile. Another part of this is that students will see themselves and their ability to do mathematics in a positive way. As teachers, we want to get students thinking positively about failing and trying again, as well as learning in general (Watanabe-Crockett, 2020). This mindset can be fostered through the way the classroom is modeled.

### *Classroom Models That Increase Student Engagement*

The environment students are learning in is crucial in terms of student engagement (Anderson, 2018 ). For this reason, there are a few different classroom models to use while creating a positive learning environment that will reduce the social risk students feel around mathematics. This environment will increase student engagement and discourse. Within the classroom, there are roles that can be taken on by both teacher and student to help facilitate class. Traditional teacher-centered classes tend to present information in a way that focuses on memorization and leaves little room for creativity or innovation (Shah, Majoka, & Khan, 2019). Teachers are often looked at as the giver of information and students become the receivers in this model. This leaves little room for student to student discourse if the classroom follows this lecture/note style structure.

A newer approach called a student-centered classroom can help facilitate learning with a more hands on approach. A student-centered classroom is defined as a classroom that places the responsibility of learning back in the hands of the students, which creates autonomous and independent learners (Keiler, 2018). The success behind student-centered classrooms comes from, "...implementing learner-centered instructional-approach like inquiry methods, group work and active-learning strategies" (Shah et al., 2019, p. 143) . This allows for students to actively be involved with the everyday functions of the classroom. They become the driving force behind their learning. Teachers within this model become more of an academic support, guiding student's progress and learning (Shah et al., 2019). As part of this, students should be seen analyzing, reflecting, reasoning, and communicating day to day in class (Brookhart,

2010). By creating a student-centered classroom, the sense of classroom community increases as well as the overall motivation. Students begin to feel like they play an active role in their own learning. A student-centered classroom might take the form of a problem-based learning environment (Flynn, 2017).

Problem-based learning is a specific form of student-centered learning. It is defined as experiential learning through hands on problem solving (Wood & Sellers, 1996). Flynn described a way of using problems in the math classroom that grabs students' attention because it follows the same structure as captivating storytellers do (2017). This method involves some sort of attention-getter at the beginning, a main section of material, and a solution or conclusion at the end. Flynn discusses an approach to teaching found in a post titled, *The Three Acts of a Mathematical Story*, by Dan Meyer (2017). The three acts of the mathematical story are: 1) The teacher begins with an image or short video to pique student interest, 2) The teacher frames the problem at hand and students gather information and decide what information will be needed to solve their problem, and 3) Students communicate and present their results to the rest of the class (Flynn, 2017). By using this three step story technique class is framed in a similar way each day and it becomes a routine. In this model the focus is on one central problem. The central problem requires data collection or some sort of evidence gathering. This could be used in a mathematics classroom to encourage discourse for experimental topics like probability, statistics, or even discovering formulas. Now that there are a few different classroom models to increase student engagement, there also needs to be discussion on how social pressures and math anxiety can affect the way students discuss even in student-centered classrooms.

***Student Engagement- Summary***

Student engagement is the idea of getting students actively involved in class. Engagement has a direct impact on student achievement. There are many different aspects that go into student engagement, whether that be the classroom environment, role of the student, teacher-student relationship, or student's beliefs about their own mathematical ability. In the classroom, students can be seen being engaged in a variety of ways. In some classrooms, it might be a student-centered approach or more specifically problem-based learning. Students might be seen working collaboratively in groups to complete problems and justify their thinking and ideas. Increasing student engagement will in turn increase student to student discourse, which will allow more students to achieve in the classroom (Coleman, 2020). When it comes to the project I am creating, this can help inform what student engagement looks like and what teachers and students should be doing during class time. When teaching student discourse, educators need to know what to look for from their students; they need to know how to create an environment that invites all learners into the conversation.

With the next section, I want to gain more of an understanding of why mathematical discourse is so important in a classroom. What are the benefits of using multiple types of discourse? How can discourse help students struggle in a productive manner on their way towards learning? This section will examine these ideas and questions.

**Mathematical Discourse in the Classroom**

The ability to communicate your ideas clearly to others is a lifelong skill that everyone will need to learn. This skill will have a lasting impact on students. In the first

section, the focus will be on why discourse, specifically in the math classroom, is so important. This will include the definition of discourse and what that looks like in math. The second section will focus on the two main types of discourse and common benefits of both. The final section will talk about how student to student discourse can assist students to struggle in a productive manner, which promotes learning.

***Importance of Mathematical Discourse***

Student discourse is a huge topic in education. Discourse can mean a variety of things but for the purpose of this paper we will use the NCTM definition which considers discourse "to be mathematical communication that occurs in a classroom. Effective discourse happens when students articulate their own ideas and seriously consider their peers' mathematical perspectives as a way to construct mathematical understandings" (Front Matter, 2010, p.7). As discussed in the previous section, creating an environment for discourse is step one. Coleman references a quote that states, "'The people who do the talking in any lesson are the ones doing the learning"' (Coleman, 2020 p.59). Discourse is important in mathematics because there is a difference between watching a problem being solved and solving a problem. Discussing ideas outloud gives students a chance to communicate their own thinking, hear multiple perspectives, find gaps in learning, and ask questions of both their peers and teacher.

In mathematics courses, discourse has been proven to benefit the overall achievement of all learners in the classroom, no matter the ability level. A study was done in 1996 at various elementary schools with 2nd and 3rd graders in math classrooms (Wood & Sellers, 1996). The study compared three types of instruction models; students that were in problem-based learning classrooms for two years, students in problem-based

learning classrooms for one year, and students in more traditional textbook based classrooms for two years. In the study, the problem based classrooms focused on mathematical discourse and hands-on engagement; the traditional textbook style instruction focused more on formulas and practice work. The results that Wood and Sellers found were significant. They showed that on standardized tests students in the two year problem-based classrooms scored significantly higher in both computation and conceptual understanding (1996). The students were also asked to report their beliefs and ideas about reasons for success in mathematics. The major finding here was that students in the problem-based classrooms reported that they not only believed mathematical learning was important, but they also valued finding their own or multiple ways to solve problems. Student discourse and active learning has a direct correlation between achievement and a positive mindset in mathematics. Getting students to talk is not the only factor that can affect students' success in the classroom.

Even the words teachers and students use in the classroom can promote or discourage discourse. Another study conducted by Wagner and Herbel-Eisenmann talked about the power of the words used often in math courses, specifically the word “just” (Wagner & Herbel-Eisenmann, 2008). The study was done to compare classroom discussions, one week a month, for four months. Conversations were recorded and analyzed. Throughout the study they found that the word “just” was used most often as a synonym for simply. Students described two ways that the word “just” can come across and its effect on the classroom conversation. The first way a student described, “It’s kind of like they [teachers] just use ‘just’ because they don’t want to explain why it is. They just say, ‘It’s just that’” (p. 143). The other description stated that when “just” is used as a

synonym for simply, it can be frustrating. Sometimes something that is simple for a teacher or certain student, is not simple for them (p. 144). Wagner and Herbel-Eisenmann found that the word "just" can often close down dialogue because it has an aggressive connotation. Being careful and encouraging with the types of words used in class by both students and teachers can have a huge impact on discourse. Teaching kids proper discourse methods will be discussed in the next section to help avoid words like "just". However, implementing discourse in the classroom can look very differently depending on the type of discourse incorporated. Each type comes with its own benefits.

***Types of Discourse and the Benefits***

There are two main ways that teachers plan to incorporate discourse during lessons. The first one is whole-group discourse which can be defined as the teacher leading a lecture or discussion and modeling how to complete problems while students follow along or take notes (Kanold, Kanold-McIntyre, Larson, Barnes, Schuhl, & Toncheff, 2018). In this strategy the teacher will call on students individually to share out, answer questions, or participate in class. Student participation often happens one at a time. The other main way teachers incorporate discourse is through small-group discourse. This can be defined as time when students collaborate with each other with specific directions, prompts, or problems to discuss (Kanold et al., 2018). This frequently takes on the form of either partner or small group work. Teachers need to incorporate a balance of the two to help engage their students.

There is a time for teacher talk and there is a time for students to productively struggle. Whole-group discourse can be beneficial at the start of class or at the start of a new topic. It can also be beneficial to close out activities or topics together to make sure

everyone is on the same page (Ghousseini, Lord, & Cardon, 2017). Small-group discourse can be used to have students work collaboratively. This type of discourse is beneficial to have students make sense of material with their peers. When students are working in small groups, the teacher has the opportunity to walk around and formatively assess understanding (Ghousseni et al., 2017). The teacher can easily give feedback and have more time to interact with students on a more personal level. The teacher is more of a guide and peers become an intellectual team, working towards the same goal. Using both whole-group and small-group discourse will help differentiate class and facilitate learning in a more meaningful way.

***Productive Struggle***

Giving students tasks that require discourse can enrich their overall mathematical experience. Coleman suggests that in other classes, such as English Language Arts, teachers expect their students to think and write like authors (Coleman, 2020). They analyze and write texts in a similar process that real-life authors do. Students are actively engaged in their learning. Why does this not occur in math classrooms? Coleman argues that teachers often expect students to learn what they are shown. She writes, “In math class, we often boil concepts down to their most basic sequence of steps so students can easily arrive at the right answer. We show students how to do a problem the right way and expect them to follow suit, without a lot of back and forth. This is a missed opportunity” (Coleman, 2020 p. 59). Students need to be given activities that hold them to high expectations and allow them to productively struggle.

Productive struggle is defined as the process towards effortful learning that requires perseverance and creative thinking (Gray, 2019). Students complete tasks that

push them to deepen their understanding. Rather than immediately helping students at the first sign of trouble, allow them to work through struggles independently or with their peers. These tasks need to be in Vygotsky's zone of proximal development (Levykh, 2008). Vygotsky came up with this concept in 1962 to criticize testing a students current level of achievement, and it is still relevant in today's modern education system. This zone is looked at as the sweet spot between a task being challenging but still doable for students. The difference between scaffolding and support. The zone might look different depending on the ability level of the student. Implementing activities that cultivate this sort of engagement, one that requires productive struggle, creates more of a meaningful learning experience. Any educator will say that meaningful learning experiences lead to learning that sticks with the students.

Creating activities and learning opportunities for students that push them to productively struggle is important, especially when implementing student to student discourse. Giving them tasks that are too simple may lead to the discourse being simply about the answer (Gresham & Shannon, 2017). When implementing group work, first, make sure the problem that is being asked of the students can be looked at in multiple ways. Refrain from giving them a formula and asking them to solve problems using it. Often when this happens, students work independently and just check their answers with their group. Instead, ask a problem that applies what students are learning towards something more abstract or pushes what they are learning to a deeper level (Newell & Orton, 2018). Kids should be discussing and questioning why their ideas or methods work. This teaches kids to communicate the process or results of their thinking with others, and learn to be clear and convincing in their verbal and written explanations.

Additionally, listening to others explain gives students opportunities to develop their own understanding.

Implementing a routine and expectation for discourse can help students know what is expected from them during whole or small group discussions. A mathematical routine is defined as "a short activity with a specific structure that allows students to engage in sense-making through discourse, reasoning, and justification" (Newell & Orton, 2018, p. 95). Different articles have different goals or routines that they encourage a teacher to use for discourse. Several of the articles have similar ideas but the one that stood out to me was one that discussed creating math talk communities (Wagganer, 2015).

Wagganer discusses steps to use while creating a routine for discourse in your classroom. She claims that to implement a routine for discourse it needs to be done step-by-step with frequent modeling and opportunities for practice. The first step is to go over why talking about math is important. That stems back to Boaler's mindsets for believing math is important (2018). Getting kids interested or invested in what they are learning is essential. Step two is to teach students how to listen and respond. Wagganer goes over this with her students in less serious ways, like a check-in question. She has students rephrase what their partner said to check for understanding, and she models this as well when students are talking directly to her (2015). Wagganer believes being an active listener can go a long way in discussion because kids feel heard and valued. The third step is to give students sentence stems. This can help all learners find a way to enter the conversation. Sentence stems can be huge in focusing ideas, and I plan on using these in some of the activities within the project. Building a routine can help students feel more

open to sharing their ideas because they know that it is an expectation of the classroom environment.

***Mathematical Discourse - Summary***

There are a number of reasons why mathematical discourse is so important in the math classroom. Discourse can raise engagement in the classroom which, in turn, can lead to higher achievement (Wood & Sellers, 1996).Words are very powerful. Being intentional with them and teaching students to do the same can help invite all learners to join in regardless of ability level. There are two main types of discourse in the classroom, whole-group and small-group, and it is important to use a balance of both while teaching. Mathematical discourse is only effective if the task requires deeper thinking. Just simply asking for an answer is not going to promote long-term retention. Instead make sure that students are able to engage in productive struggle, especially with their peers. Go over expectations for discourse so students know what is expected of them. This way they get in the habit of explaining and asking why.

In terms of the project, mathematical discourse should be the center of discussion at the beginning of any trimester/semester, and it should be modeled and referenced throughout the entirety of class. Students may not be aware of the effects discourse can have. It may be useful to also talk to students about how the brain works and to help them explain why there is an expectation for them to discuss their ideas with others. This final section will dive into current practices/activities that incorporate discourse. The practices included in this review are just some examples of activities already out there. With the current state of education being so fluid between learning models, this section will incorporate ideas from in-person and distance learning models.

## Current Best Practices to Incorporate Discourse

Currently there are a lot of resources and activities out there that promote student to student discourse. In this section, I will discuss a few that are shorter activities that teachers use to get students talking about math. Most of the activities are for in-person learning. These activities are also not directly linked to geometry, but I will adapt some of these to incorporate them into my activity guides. All of the activities I will mention either have students talking to other students or students talking to the teacher. In either case students are doing the talking, because as Coleman said, the person who is doing the talking is also doing the learning (Coleman, 2020).

With the current state of education due to the Covid-19 pandemic, teachers have had to engage students in various classroom settings. My project will expand to all three learning models; in-person, hybrid, and distance learning. This section will also discuss current knowledge and best practices used to incorporate discourse through in-person and distance learning, because I found a gap in the resources to support hybrid learning.

### *Activities for In-Person Learning*

People have come up with several activities to use to help encourage mathematical discourse in a classroom setting. All of the activities included are short, 5-10 minutes in length. The purpose of implementing one of them while students are in person is to get kids thinking about justifying their mathematical ideas to either their teacher or peers. Here are just a few that are very commonly used:

- Number Talks - The teacher shows students a visual with some sort of problem that they need to work out mentally, then students will share their methods for their solution with the class (Krall, 2018). During these talks the teacher is more

of a facilitator. They annotate the image as the student is describing their method so that the other kids can see. This way students can notice the similarities and differences among the various responses. (Newell & Orton, 2018). Number talks show students different perspectives of looking at the problem and are not meant to be super challenging visuals.

- Which One Doesn't Belong - Students are shown four images that could include shapes, graphs, numbers, expressions, or equations and they are asked to share which one of the images does not belong. They have to have a justification as to why the one they picked does not belong so they can defend their thinking (Newell & Orton, 2018). Students look at the images independently, then share their responses with a partner, group, or whole class. When selecting the images it is important that any of the four could be seen as different from the other three items. There should not be only one right answer. Make students aware of this as well. This opens the conversation up for all students to share without the fear of being wrong in front of their peers (Newell & Orton, 2018).
- Think-Ink-Pair-Share - Students are given the opportunity to first think on their own. After, they pick up something to write with and get their ideas down on paper. This step allows them to solidify their own ideas before talking to someone else. Then they discuss with a classmate their ideas. They may have similar or different ideas. Or one student might need further clarification that their peer can offer them. Lastly, partnerships share out to the whole class. This is a collaboration strategy that can be used to get students to independently think about something, and then communicate it in a smaller setting to lessen anxiety,

before sharing it with the entire class (Krall, 2018). Often with activities like this again you want to give students a problem that has multiple entry points, so there is not only one correct answer.

- Notice/Wonder - This activity encourages kids to slow down. They write down things they notice about a problem, picture, or graph. Then they write down things they still may be wondering about. It encourages students to make sense of contexts and relationships before rushing to compute with numbers and keywords (Newell & Orton, 2018).
- Always/Sometimes/Never - Students classify statements as “always true”, “sometimes true”, or “never true”. If students are struggling with a statement, ask them if they can think of examples that make the statement true or false. This pushes them to connect their thinking to real life and puts the learning back onto them. This activity has students thinking like mathematicians because they are making conjectures and testing their hypotheses (Krall, 2018).

These different activities are meant to get students thinking about math and discussing their ideas with either the teacher or their peers. These activities are more easily done while students are in-person and can easily collaborate with others. There are activities that are specifically created for when students are not physically all in one classroom.

***Activities for Distance Learning***

As expected, because distance learning is not the traditional model of education society uses; there are a lot less activities and resources out there that promote discourse. Even within distance learning there are different models that can happen. Asynchronous instruction is when students are able to complete the task whenever. It does not require

learners to be logged into a meeting or doing the activity at the same time as their peers (Gedeborg, 2016). The other model is synchronous instruction which requires students to login at the same time for instruction. In both cases there are activities that a teacher can incorporate to encourage discourse between students. However, in both situations, asynchronous and synchronous, teachers often rely on technology to help facilitate the discussions. Here are some of the most common activities found:

- Online Discussion Boards - Online discussion boards offer students a place to discuss topics or problems back and forth with their classmates or teachers (Gedeborg, 2016). Students can post their own ideas and directly respond to others. This is convenient especially for asynchronous instruction because you are still able to get the exchanging of ideas and can intervene with clarifying questions or points to help students.
- Videos with Embedded Questions - Videos with questions embedded are also a great tool to use to help facilitate discussion (Gedeborg, 2016). This is used more between student and teacher but depending on the platform can be between students. Teachers can see their students' responses to questions or ask students to rephrase parts of the video in their own words. Students can also ask questions or see answers/explanations that their classmates gave for certain problems.
- Project Based Learning - Assigning group projects that are broken down into smaller parts/sections can help facilitate online collaboration and discussion (Gedeborg, 2016). This can be synchronous or asynchronous. This way students are able to discuss each part of the project thoroughly before moving on to the

next. It can help students get clarification from their peers or the teacher and give them a way to express their ideas.

- Collaborative Software - There are tons of online resources and software that have been developed to help facilitate synchronous instruction in a distance learning model. Resources like Kahoot, Peardeck, Google Meets, Zoom, Webex, Quizizz, JamBoard, and so much more. These all can be great ways to help facilitate learning when all students are distance learning.

***Current Best Practices to Incorporate Discourse - Summary***

There are common activities to use that promote both student to student discourse and student to teacher discourse in the classroom. The above mentioned activities are very short, but get kids talking and justifying their ideas. The activities also show them that problems can be solved in many different ways. The distance learning activities require support of technology, otherwise it is hard to facilitate discussion. I have found a gap in the research with little information out there on facilitating discourse in a hybrid learning model. This is an interesting topic that will come up in my project within the guides that incorporate specific activities to use in a hybrid classroom to bridge the gap between the students in the room and at home.

**Chapter Two Summary**

Integrating more discourse into the secondary mathematics classroom has many benefits for students, including increased engagement and mathematical understanding. Being mindful of social pressures is important because not every student will feel comfortable communicating their ideas. That is why it is necessary that teachers give thoughtful planning to establish a positive classroom environment where students are

actively involved in their learning. Once the classroom environment is conducive to student engagement then teachers can focus on planning opportunities for mathematical discourse. There are different types of discourse, whole-group and small-group. Both need to be used throughout class time. There are also certain tasks that are more appropriate for each type of discourse. Making sure the tasks you are asking students to do are challenging enough where they can experience productive struggle is important to help deepen their understanding of the mathematics they are being asked to do. These types of tasks help encourage discussion because they often have multiple approaches that can be used to solve them. Currently, there are activities that math teachers often use to incorporate discourse in their lessons. However, with the current state of education being fluid between the learning models, it is important to think about connecting students and facilitating discourse in all settings; in-person, hybrid, or distance.

My research question, *How can I promote student to student discourse in mathematics classrooms?* investigates how all of these topics connect to one another and directly impact students ability to openly discuss their ideas in math. In the next chapter, I will be sharing my capstone project that is going to implement a lot of the information synthesized in the literature review. I will be making activity guides that offer 5-30 minute activities to help promote student to student discourse in the classroom. This project will be a resource for secondary teachers, specifically geometry teachers, to use to help them purposefully plan for mathematical discourse in their lessons.

# CHAPTER THREE

# PROJECT DESCRIPTION

## Introduction

In my research, I explored different strategies to incorporate student to student discourse in the mathematics classroom. This chapter will provide a detailed description of the project. The project is a set of activity guides that teachers can implement into their secondary geometry courses to help encourage mathematical discourse between their students. The activities are able to be implemented in various classroom models; in-person, hybrid, and distance. The focus of several of the activities is to bridge the gap between students learning in various settings. The project also has an adaptability to other mathematics courses, but geometry is the central focus. This project, in addition to the literature review, is intended to help answer the question: *How can I promote student to student discourse in mathematics classrooms?*

The biggest takeaways from the research were the importance of a positive classroom environment and the impact discourse has on student mindset and achievement in mathematics. I will discuss how the research affected the project design and how I was able to take the main ideas into consideration while creating the activities. This chapter will first give an overview of the project. This includes an overview of the framework that was used to answer the research question. Next, the rationale for completing the project is discussed. This section provides the why behind the project. The third section covers the audience and setting in which the project was designed for. Finally, the fourth section discusses the project outline and timeline. This includes information on how the project can be implemented and how effectiveness is to be measured.

## Project Overview

The project is a set of ten activity guides. The guides are separated with the Minnesota academic standards for mathematics in mind based on each main topic in geometry (Minnesota Department of Education, 2008). The activities included can be used in a secondary geometry classroom to encourage student to student discourse. The students in the geometry class are of mixed ability levels and consist of 9th, 10th and 11th graders, but with a majority of them being in the 10th grade. The activity guides incorporate a range of 5-30 minute activities that teachers can implement before, during, or after a lesson to get students discussing their mathematical ideas. Due to the current pandemic, the school is currently back to a four-day in-person school schedule. The fifth day is asynchronous, which means students can complete the work assigned to them that day at any time. Within this model, students did still have a choice to remain in the distance learning format. This means that teachers are simultaneously teaching to students in their classroom and students at home logged in via Google meet. The guides were designed to include activities that can be used in all three learning formats; in-person, hybrid, and distance. Class periods are 67 minutes long. All of these various constraints affected how the guides came together. As the guides were created, the question: *How can I promote student to student discourse in mathematics classrooms?* was at the forefront of it.

### *Project Framework*

For this project the concept of backwards design and Understanding by Design (UbD) helped me create quality activity guides that are applicable in various geometry classrooms (Wiggins & McTighe, 2011). UbD is a way of intentionally thinking about

planning lessons to help students grow their understanding of the main ideas of a lesson or concept (Wiggin & McTighe, 2011). The main ideas come from the content level standards that are associated with the class. In UbD, there are three stages within the process: desired results, evidence, and finally the learning plan.

The three stages help guide the teacher in remembering the purpose of each activity or unit (Wiggin & McTighe, 2011). In the first stage of UbD, teachers need to identify the desired results. These are the overall goals of the unit or lesson. Teachers need to ask themselves what students need to know and what they should be able to do by the end of every day, unit, or activity. In stage two of backward design, teachers now need to decide what they will use as their evidence of learning. Educators need to consider how they are going to be able to determine if students have achieved the desired results that were set in stage one (Wiggin & McTighe, 2011). They also need to know what method they will use to do this i.e. formative or summative assessments. This can look very different depending on the learning model the school is in at the time, i.e. in-person, hybrid, or distance. In the third stage, specific lessons and activities are planned. This is where teachers consider how and when, or in what order, content should be taught to help achieve the desired results. Again, this stage can vary immensely depending on the learning model of the school at the time.

## Rationale

### *Why This Project?*

This project includes various activities that are designed to get students discussing their ideas in mathematics classrooms. Traditionally, in math classrooms, students have been asked to memorize routine procedures without really knowing how or why what

they are doing works. Classes typically are lecture based, where students repeatedly practice the same types of problems. With the current Covid-19 pandemic, schools have had to adapt very quickly to meet the needs of students. One thing that has been a struggle for lots of teachers is bridging the gap between the kids in different settings i.e. distance learners and kids in the classroom. The skill of being able to communicate your thoughts and collaborate with others is considered to be a valuable life skill. These guides provide various opportunities for students to practice these skills in all settings and hopefully give students strategies to take to other classes and their lives outside of school. As discussed in the literature review, discourse activities are generally more engaging for students than lectures and can have academic benefits (Wood and Sellers, 1996). With this in mind, it is important for teachers to spend class time building a positive classroom environment so that they can integrate activities and questions into class that can help students improve their discourse skills.

***Activity Guide Framework***

The activity guide framework for the project was inspired by Understanding by Design. As stated earlier on, UbD is a planning model that has three stages (Bowen, 2017; Wiggins & McTighe, 1998). In using this backward design approach, teachers set goals early on and then create lessons/materials based on those goals. This is very different from other design methods. One of which is the forward design approach, which typically involves teachers planning the lessons and activities first. Then they move on to planning assessments and making connections between the overall course goals (Bowen, 2017). A benefit of the UbD model is having a clear idea of what the goals are before planning begins (Bowen, 2017; Wiggins & McTighe, 1998). This helps teachers be

intentional with their lessons and activities. Bowen suggests, UbD gets rid of the chance of having students do certain activities just for the sake of doing them (Bowen, 2017). If an activity does not align with any of the pre-established goals, then it should not be used. Teachers are more intentional about what they are asking students to do.

During the first stage of UbD, there are suggested questions that the teacher should ask themself while diving into planning goals for a unit or chapter (Bowen, 2017). The questions suggested by Bowen are: *What should students hear, read, see, or explore? What content and skills should students master by the end?*, and *What are the big ideas and understandings that students should retain long after the course is completed?* (2017). These questions get teachers thinking intentionally about the goals of the class while making connections to the knowledge students need to be familiar with long after the course is complete.The first stage looks at the end goals for all learners before thinking about assessments or specific lesson activities.

Within the second stage of planning with UbD, the teacher thinks about assessments or learning experiences that students can do in order to demonstrate their learning (Wiggins & McTighe, 1998). Teachers should ask themselves these two questions during this stage: *How will I know if a student has reached the goal(s)?* and *What is considered to be acceptable evidence of student understanding?* (Bowen, 2017). It is important to consider a variety of assessments. Classes have a wide range of learners and ability levels all in one room, so an assessment that demonstrates what one student knows may not accurately reflect what others know. This is where differentiation is important, so that all learners have the opportunity to accurately demonstrate their learning.

Stage three is planning for instruction. This includes planning lessons and activities for students to partake in each day. Bowen suggested four questions to consider at this stage. The questions are: *What knowledge and skills will students need to know in order to reach the goals and achieve the desired results?*, *What activities will help students to obtain the necessary knowledge and skills?*, *What needs to be taught, and what is the best way to teach it in light of the goals?*, and *What materials and resources are needed in order to reach the established goals?* (Bowen, 2017). Utilizing each stage within Understanding by Design, encourages teachers to use the desired outcomes and course goals to drive everything else they plan to implement in the classroom.

## Audience and Setting

### *Setting*

The project setting is a public school in a north suburb of the Twin Cities in Minnesota. The school serves students in grades nine through twelve. Within the school, lesson plans fall primarily on the teachers and their Collaboration Team (CT). The school district is currently rolling out a new math curriculum called College Preparatory Mathematics (CPM), which has a lot of instructional strategies and problems already laid out for teachers. CPM is a spiraling curriculum that is being used with all math classes from middle school to high school in the district. A sprialing curriculum just means that topics keep recurring to promote long term retention and to help students make connections between concepts. The activity guides in this project were created to help facilitate discourse in the classroom in addition to the new curriculum. The activities are a tool, and are not designed to be used as an entire curriculum on their own. I will be

implementing the guides with a group of geometry students, most of whom are in the tenth grade.

### *Audience*

The intended audience for this project are my colleagues in the math department as well as my colleagues who are in my collaboration team (CT). I worked with my CT to get feedback on the goals of each of the ten guides. I also will ask them for feedback on the activities I included in the guides before the 2021-2022 school year. At the completion of the project, I intend to share much of what I have learned about teaching and promoting student to student discourse skills in the classroom with other teachers in my building. In the event that the project receives positive feedback from other math teachers and is deemed as being useful, I will be happy to share with more members of my school community i.e. the math department's Teaching and Learning Specialists.

## Project Outline, Timeline, and Assessment

### *Project Outline*

In the beginning stages, there needed to be time spent brainstorming goals and desired outcomes of each overall activity guide. Time was set aside to research techniques to engage various types of learners. This time was necessary in order to ensure that student needs would be met with the implementation of the activity guides. Getting students to talk about math can be a challenge, especially with classrooms of students at various ability levels in their math journey. As stated in my literature review, creating a community where all students feel safe to share ideas is important (Bennett, 2010). When designing the guides I knew that the activities included needed to have various entry points to allow all learners to feel important and empowered to share. Being intentional

about this will also help to garner as much participation as possible. The core planning of the activities began after this. To reiterate, the framework used was Understanding by Design. The guides include activities for any of the three major learning formats that schools are operating in now due to the Covid-19 pandemic. The next stage in the project is to implement the activities with the students. Finally, there will be time set aside to analyze how everything went.

***Timeline***

In the summer of 2021, I created the activity guides utilizing backwards design for a secondary geometry classroom. For stage one of UbD, I used my previous work with my Collaboration Team (CT) at Coon Rapids to identify the desired results for each of the ten guides. I adapted the previous year's goals, essential questions, and student objectives that corresponded with the content standards. After I completed the first stage, I began working on the second stage, assessment evidence, and the third stage, discourse activities with the learning model. I focused on researching and creating resources that promote both small-group and whole-group discourse in any learning model.

For each model I tried to focus on one or two ideas while deciding on what activities to include in the guides. For in-person activities, I focused on getting students creating or manipulating something with their hands and discussing it with their peers. During my literature review, I noticed a gap in resources that currently exist for hybrid learning. Hybrid is one of the most challenging models in my opinion to create a classroom community in, so I wanted to focus on bridging the gap between students in the room and students at home. For distance learning activities, I relied heavily on technology to help facilitate discourse between students in meaningful ways.

Researching, adapting, and creating these activities for the ten guides took about a month in total to complete. The plan is to implement the activities during the 21-22 school year.

***Assessment***

There are some ideas that come to mind with regards to assessing how well the project answers the research question: *How can I promote student to student discourse in mathematics classrooms?* The first way to assess the guides would be to ask students to reflect on their learning experiences after implementing an activity from the guides or after each unit as a whole. Reflections could be used in both verbal or written formats. Both formats come with different benefits. A written reflection gives students the ability to remain anonymous and be honest about their opinions. A verbal reflection seems less formal and can be done in a matter of minutes. The reflections, no matter the format, should ask students which learning activity or task they found helped them understand the concept and offered them the most memorable experience. The second reflection piece will be on when in the unit they felt they were most engaged. It might be interesting to also survey students at the beginning of the year, in the middle, and at the end to see how their mindset on mathematics has evolved during the course of the year.

**Chapter Three Summary**

This chapter provided a detailed overview of the project. The project is a set of ten activity guides that help facilitate mathematical discourse in the classroom. The overall focus of the guides is on incorporating student discourse whether it be in-person, hybrid, or distance learning. The guides will be implemented with a group of geometry students. As discussed, the work was guided by the model called Understanding by Design. The following question was driving the project design: *How can I promote*

*student to student discourse in mathematics classrooms?* The next chapter will conclude the project. This will include an explanation of what has been learned from my capstone project. As well as the implications and the limitations of the activity guides.

# CHAPTER FOUR

# CONCLUSION

## Introduction

Education, and specifically mathematics education, is constantly evolving as to what is considered best practice. In completing my project I wanted to accomplish two major goals; better my own teaching and also provide a resource to others in the field that could help them be more intentional with creating a space for discourse. The question that guided my research was: *How can I promote student to student discourse in mathematics classrooms?* I then proceeded to conduct an extensive literature review of various sources relevant to this exact question and all of the aspects that go into creating a space for discourse. Following the literature review, I put together my capstone project. The project consists of ten activity guides, each including three activities to be used throughout various topics in a high school geometry class. The guides include an activity for every learning model; in person, hybrid, and distance. All of the activities focus on improving geometry skills while simultaneously promoting discourse between students. The guides aim to help students build their discourse skills through participation in tasks and activities that require teamwork and multiple perspectives to problems.

This chapter will start with a description of all that I learned throughout the capstone project process which took place during May through July. I then will revisit the literature review I did and highlight specific parts that had a major influence in my capstone project. Next, I discuss the possible limitations of the project in helping to promote discourse in various classroom settings. The following section covers possible future research and projects that could be done to improve or enhance this one. The final

section will discuss how the project will be used and how the project benefits the teaching profession as a whole.

**Major Findings**

The process and amount of work that goes into a capstone paper and project is intensive and has taught me a great deal. First, I realized that even if you are not the best reader or writer you can still complete quality research. I have always excelled in math, while I found reading and writing to be more of a challenge. This process has taught me that the thing I often overlooked is the sheer amount of time that it takes to complete high quality research. As a first year teacher and student, time was not always on my side with this project. However, becoming a better teacher was what drove me to continue on with the process. I love being an educator. I have a passion for helping my students. All throughout the time spent researching and constructing the activity guides, I always wanted to keep in mind to include things that I would specifically want to use in my own classroom.

Another big takeaway from this project that I learned is that collaboration is one of the most important parts of creating something that you are proud of. I was not doing this by myself nor did I need to come up with every activity on my own. There were plenty of people in my corner helping me along the way. From professors, to classmates, to my content expert, everyone who listened to my ideas, read my paper and guides, or simply encouraged me to continue was extremely important to me in completing this capstone project. Being able to lean on others benefited my mental health and helped improve the end result of both my paper and project.

Overall, the biggest surprise to me was how difficult of a time I had completing the actual project. During the research, I found myself having all of these innovative ideas to use in my guides that would facilitate conversation across all learning models. However, once it came time to start creating the project, I really struggled with motivation and getting my ideas down on paper. Looking through UbD models and projects in the Digital Commons, I realized that making my own template would be easiest in creating the vision I wanted. Once I decided on making one activity per learning model, I found a rhythm and was able to start putting the guides together. I would not have been able to do this without the information I learned during my literature review about routines for discourse. This leads me to my next section, which discusses specific sections of the literature review that heavily influenced the creation of my project.

**Revisiting the Literature Review**

Creating a routine for discourse is essential to helping all students feel safe and important in mathematics classrooms. This is an idea that came up frequently during my literature review. Bennett (2010) described the social pressures students feel in a classroom by comparing it to the pressures of a poker game (Bennett, 2010). Students who have historically been successful in school, specifically in math class, feel confident to share their ideas or have more "chips". Whereas, students who have not regularly experienced success in math classrooms, are less likely to risk their "chips" by not participating in small or whole group discussions. In my activity guides, I tried to keep Bennett's metaphor in the back of my mind by focusing on giving all learners a meaningful voice, essentially giving them the notion of having more chips. I did this by

using another idea that kept emerging in the literature review which was the importance of relationships and routines in the classroom.

Building relationships and implementing a routine for discourse can help students feel that they are a part of the classroom community. Horn (2017) discussed the connection between a strong student-teacher relationship and academic success. Horn also encouraged teachers to share about themselves to help invite students to do the same (Horn, 2017). In my activity guides, students are given ways to express their own interests, for example in the Class Traits v.s. Shape Traits activity, Logo Exploration, or the Similar Picture Drawing. Students can be creative and express themselves while learning more about their classmates and teacher alike. The other biggest influence from the literature review on my project was the routines for discourse. When used sparingly, these activities can be quick but effective ways for getting students to talk to one another. Activities of this nature that I included in the guides are ones like Which One Doesn't Belong (Newell & Orton, 2018; Parish, 2011), Think-Ink-Pair-Share (Krall, 2018), and Notice and Wonder (Newell & Orton, 2018).

As I was creating the activity guides, it very quickly became clear that I cannot simply use one activity or instructional strategy over and over. It is necessary to intertwine various strategies to help reach all types of learners and allow for multiple entry points into the lessons. Students should be able to experience various learning opportunities while in the classroom. Using the same routines can become boring if over done. As students are asked repeatedly to discuss their ideas, they may be more willing or engaged if the activities they are participating in require different levels of discussion or participation. My ten activity guides were influenced by many strategies I read about

during my literature review, not just one. The next section will discuss possible implications and limitations of the project that was created.

**Implications and Limitations**

My project does have both positive and negative implications on both teachers who use the guides and students who participate in the activities included. One positive implication is that students are getting worthwhile interactions with their peers. They are able to hear different perspectives, see different methods of solving problems, and ask clarifying questions of their classmates when needed. Another benefit is that students are making their own connections within concepts and between concepts and the real world in the various activities. An example of this is the real world shapes activity or wrapping paper game. Students are seeing where math can be useful in real life situations. A negative limitation of the guides would be that some of the activities require specific resources (for example, wrapping paper) or access to some sort of technology to help facilitate synchronous learning between students in various learning environments. Without the correct resources it would be difficult to implement some of the activities, especially the hybrid ones where I tried to focus on bridging the gap between students in the room and students at home.

A personal implication of my project that I faced during the creation of the guides was deciding whether or not to write them with activities that could be done during the COVID-19 pandemic. I had a difficult time deciding whether or not to include the various learning models specifically, or just include activities that could be implemented in any model. I am unaware of what the future holds for education and I do risk the guides losing relevance to future classrooms if hybrid and distance learning becomes a thing of

the past. However, I still decided to create activities specifically for each learning model because this pandemic is a serious issue we are still facing on a global scale and having resources to help future teachers is important. It could also be used if students are experiencing snow days or some sort of illness that causes them to miss class for an extended period of time. The next section will discuss the possibilities for future research and projects.

**Future Research and Projects**

This project leaves room for further research. I would be curious to see research with regards to how student to student discourse has affected academic achievement with the use of technology in the classroom. Students have a ton of information often at their fingertips with things like cell phones, Chromebooks, and iPads. Does this access to technology affect conversation? Do students still feel it is important to explain their reasoning or know the why behind the math when they can so easily look up formulas or answers to questions? I think seeing how technology, especially after such a strange year with the Covid-19 pandemic, will affect how students interact with one another in the classroom setting when/if they are all back to learning in person.

I also believe it would be interesting to conduct some sort of study to see how a student's perception of being a part of a classroom community changes when teachers create a routine for discourse. Bits of the literature I read discussed this idea, but I believe more in depth research is needed to fully understand why teaching students about discourse and creating an expectation of it in the classroom changes their perception of the community. Does the routine for discourse allow students to feel like their voice matters? Do routines for discourse bridge the gap between students of various learning

needs i.e. special education students or English Language learners? I would love to see more research being done with various groups of students and how discourse affects their learning as well. As for the scope of my project, I do think it will have an impact on the teaching profession, which I will discuss in the next section.

**Communication and Benefit to the Teaching Profession**

To begin, I want to share my project with as many people as possible. First and foremost, I want to communicate my project to my collaboration team (CT) at Coon Rapids High School. They all teach geometry as well so I am excited to see what activities they are interested in implementing in their own classrooms. I also want to share with them what I learned from this experience. Even just small things such as being mindful of words they use in the classroom like "just" or other words that can often close down dialogue because it has an aggressive connotation (Wagner & Herbel-Eisenmann, 2008). I am also planning on sharing with them the Understanding by Design (Ubd) planning model to hopefully encourage the math department to be more intentional and goal oriented in planning lessons and activities. Another exciting way I will be able to get my project out is the fact that as part of the Capstone Project course, my project will become a part of Hamline University's Digital Commons. Here, the guides will be accessible for other educators to read as well.

I believe the work I have done benefits the teaching profession in a few ways. First, it is helping me to become a better teacher for my own students in the years to come. I now have more tools and activities I am able to use as I teach. I can implement the guides in the classroom or adapt them to what I need to help encourage discourse. I

have a new way of thinking about teaching math that helps me demonstrate and teach students that math is not just about memorizing but instead it can be explorative and fun.

I feel as though my work benefits the teaching profession as it explores the importance of students expressing their ideas to one another and making sense of things with their peers. Discourse allows students to become the driving force behind their learning. This is something that can be used across all content areas. The activities present in my guides are specific to mathematics courses, but the idea and point of the activities is to get students talking and justifying their ideas. That is something that is valuable to all educators. The field of education is ever-changing, and I hope that my project can be a reminder to teachers to be intentional about the activities they use and mindful of getting students more involved in their learning.

**Chapter Four Summary**

The entirety of the capstone project has been one of the most challenging tasks I have ever taken part in during my academic career. In the end, I truly feel that the hard work has paid off. I have something tangible and useful that I can implement with my own students no matter the learning model. I have something that I am proud to have contributed to the field of mathematics education. I learned that creating quality materials takes time and dedication and to rely on others when help is needed. I was able to discover new activities and instructional strategies that I had never even heard of before this. In my literature review, I explored how student to student discourse can affect engagement in the classroom. This led me to create a ten part activity guide that spans all learning models. The second half of this chapter discussed the possible implications and limitations of the project, future research possibilities, communication, and the benefits

the project has to the teaching profession. Overall, I hope that my paper and project will benefit educators and students for years to come.

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