HOW DISCOURSE AND COLLABORATION CAN BE USED IN MATHEMATICS CLASSROOMS TO PROMOTE ENGAGEMENT AND LEARNING

By

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CHAPTER ONE

Introduction

Overview

In the fall of 2016, I stepped foot into my first day as a mathematics teacher. The classroom was filled with rows of seventh grade students waiting to hear what the class was about and what materials they would need. Since that day, I have personally and professionally evolved in my teaching style and how I have students interact in my classroom. One thing that has been predominantly more clear over time, is that math classes have a stigma. Year after year, I will hear students sharing how they are not a "math person", or family members will come into conferences sharing how they were not really good at math. So many people view math as an area of no talent for themselves.

As math teachers, we need to stop that narrative. It is crucial that we find ways to promote engagement and learning within our classrooms where students feel motivated about mathematics. In the last few years as an educator, I have attended many professional development sessions regarding mathematics education. During these sessions, I noticed that there are some topics that always seem to be explored: collaboration and discourse. I hope I can help other math teachers promote quality math instruction by having the opportunity to explore my research question: *How can math teachers promote engagement and learning through collaboration and discourse in the secondary mathematics classroom?*

Within this chapter I will be reviewing my past experiences as a student studying math. I will also detail the short history of instructional strategies that I have used. Finally, I will discuss challenges I have had, changes I have made, and how these things have influenced my desire to explore collaboration and discourse in secondary mathematics further.

Personal Experience

During elementary school through high school, I did not engage in a lot of collaboration and discourse within math. A typical math class included the teacher giving instruction, students writing notes, students working on homework and practicing skills the teacher just covered . The teacher would stay at their desk, and students were free to come up and ask questions if they were stuck. This was the reality for the majority of my math classes until my pre-calculus course in eleventh grade. In this course, the teacher expected us to talk, and often had us work in pairs.

Pre-calculus was different because at the beginning of class, we would write down which questions gave us problems on the homework. The teacher would then have students come up to the board to share their solutions and explain the problems. Students were encouraged to explain their thinking. In order to be able to teach someone else how to do a problem, you have to be very secure in your understanding of the concept. Through this practice, I was able to see the benefits of speaking about math. During this course, we were also involved in different projects where we worked in pairs. In one of these projects, we had to use equations of parabolas, circles, ellipses, lines, and more to create a spring scenery. During this project, we had to work together with our partner in

order to be successful. I was completely engaged in mathematics through collaboration and discourse. These are moments I hope to create in my classroom. My research on collaboration and discourse will help find ways to ensure engagement and achievement in the math classroom through the use of creating opportunities for students to work together and talk about math.

I spent many days in math classes during my time in public education, but the times where I worked together, talked about math with others, and had to be engaged in problem solving are the moments that I remember most vividly. The days spent taking notes and working on homework did not create lasting connections to the skills and concepts we were taught.

Professional Experience

Once I started teaching, it felt as if everyone was telling me about the benefits of equitable group work and having students talk about math. I tried to include these elements in my classroom right away, and it was incredibly difficult to manage as a new teacher. Whenever I tried to have students work together, it felt like a classroom management disaster. Students were talking off task, students were walking around the classroom, and it did not feel like students were engaged or learning about math. Because of those experiences, I tended to rely on teacher-directed instruction just like my teachers growing up had done. I would continuously hear how students were bored, or how they did not have fun in class. It was during this time that I realized that I was adding to the stigma of mathematics. Students were still not feeling successful in class, and they were

not looking forward to being in math because they were not engaged. Since they were not engaged, they were not learning.

At this point, I knew I needed to make changes to my classroom routines and structures. I had been teaching for two years, and I was heading into my third year of teaching. I started reviewing notes I had taken from various professional development sessions I had attended, and knew I needed to add more collaboration into my classroom. If students are collaborating, they naturally start engaging in more conversations about math as well. I started being more mindful about the group work I incorporated into my math grade 7+ investigations classes. This is a class of seventh-grade students who are more advanced in their mathematical understanding. It includes gifted on-grade level seventh grade students , as well as students that are in the accelerated mathematics classes as seventh graders. Investigations classes are a student's second math course of the day, and do not have the pressure of standardized assessments being attached to the course. It is very untraditional in the sense that it is designed to include no notes, homework, or tests within that class. While teaching this class, I began regularly using rubrics for grading, assigning roles for groups, and implementing quality tasks worthy of group work. With these changes, I found much more success in my classroom. Students were staying on task, persisting with challenging tasks, and relying on each other to help reach solutions.

However , in my on-grade level math courses, I struggled to include collaboration and discourse. In this course, I feel a lot of pressure to cover all of the standards which, I hope, will help my students achieve on their standardized tests. The model I have used is

a more traditional model for instruction. I give notes and direct instruction the standards, students practice the standards, and they are formatively assessed on the standards. As a beginning teacher, I thought that this routine of notes, practice, quiz, then test at the end of unit was the quickest way for students to learn new material. However, from studying my data, students have not retained these skills or made connections among the topics I have covered.

Roots of the Idea

In January of 2019, I knew I needed to include more collaboration and student discourse into my on-grade level classes, so I scheduled a meeting with my district's middle school math coach. With her knowledge and support over the years, I have grown in the classroom as a teacher with her knowledge and support, and in these conversations the roots of my capstone started to take hold. We talked about all the different ways teachers can get students engaged and motivated to learn math. At this time, I started reading two great texts that helped me develop my research interest, *Motivated: Designing Math Classrooms where Students Want to Join in* by Ilana Horn (2017) and *Necessary Conditions: Teaching Secondary Math with Academic Safety, Quality Tasks, and Effective Facilitation* by Geoff Krall (2018). These two texts have helped guide me during the capstone journey.

The intent of my research is to discover why students are more successful when they are able to collaborate and talk about math, as well as finding the best ways to incorporate collaboration into secondary math classrooms. This research will include the obstacles students face when working collaboratively, what expectations and routines

need to be in place to effectively facilitate collaboration and discourse, as well as what strategies are proven to work well in the classroom. The research will help to develop unit guides for the Minnesota seventh grade standards for my on-grade level course that I teach.

This research and project are going to benefit my current and future students who will be engaged in new learning tasks that will help promote engagement and learning. This research will assist other secondary mathematics teachers. They will be able to look at this research and find ways to utilize collaboration and discourse in their own classrooms. This research project will also help to create 21st-century learners who will be change agents in their communities. The citizens of tomorrow will be better suited when it comes to working with other people, and need to share ideas and knowledge with each other. The skills that students learn in my classroom about collaborating and speaking can transfer into other disciplines and arenas outside of school.

Conclusion

In math, it is important that we have our students make connections, be engaged, work collaboratively, and speak about math with others. These are ways that teachers can help remove the stigma that math is an area of no talent for some people. In my research, I will be identifying how secondary mathematics teachers can utilize collaboration and discourse to promote engagement and learning within their classrooms. This is a change from the type of instruction so many of us experienced when learning math. I myself spent many years in the classroom taking notes, doing homework, and then taking a quiz or test to assess my knowledge. Math was very teacher directed. Today, through

collaboration and discourse, math can become very student-directed where students are taking control of their learning, while the teacher serves as facilitator.

In Chapter Two, I will be synthesizing and elaborating on what the literature says about collaboration and discourse within the secondary math classrooms. Within the next chapter, I will be reviewing a lot of literature and making connections about what the authors say about various topics. I will be looking at how we define student engagement in the classroom, the different social risks students face in the math classroom, various routines to promote mathematical discourse, and how to foster collaboration amongst peers. In Chapter Three, I will be providing a description for my capstone project. For my project, I will be creating a resource to accompany my seventh grade math standards, that includes various learning tasks where students are working collaboratively and talking about math.

CHAPTER TWO

Literature Review

Overview

As educators, we are always looking for ways to engage our students in the content that we are teaching. In mathematics education, one way to help promote learning in the classroom is through mathematical discourse (Seeley, 2018). Students can be engaged in mathematical conversations using many different strategies, which leads to the question, *how can math teachers promote engagement and learning through collaboration and discourse in the secondary mathematics classroom?*

In this chapter, I give an overview of the literature surrounding this research question. First, I begin by defining student engagement and what it looks like in the classroom. Next, I share about the social risk and the student's status in a classroom that can hinder and promote student engagement. Then I discuss different routines and strategies for incorporating more mathematical conversations in whole-group and small-group scenarios. The last section of this chapter will focus on implementing group work into the classroom through group-worthy tasks. All of these topics help to see an overarching view of the benefits of using collaboration and discourse to increase the level of engagement and learning in their classroom. These sections also give practical ways to implement these strategies into the secondary mathematics classroom.

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

heavily influenced by many factors, such as policies and practices of the school and family or peer interactions (Skinner, Kindermann, Connell, & Wellborn, 2009). This means that teacher actions can have a significant influence on the level of engagement within the classroom. Teachers should be striving to have high levels of engagement and motivation because engagement affects levels of academic achievement (Lei et al., 2018). Specifically, engagement improves academic achievement of students who have had low grades and engagement lowers the levels of student dissatisfaction (Lei et al., 2018).

When students are engaged in tasks, there are many positive outcomes. Skinner and Belmont (1993) shared the following:

> select tasks at the border of their competencies, initiate action when given the opportunity, and exert intense effort and concentration in the implementation of learning tasks; they show generally positive emotions during ongoing action, including enthusiasm, optimism, curiosity, and interest. (p. 572).

Henningsen and Stein (1997) believed that engagement in mathematics classrooms is when students are actively involved in rich and worthwhile mathematical tasks . Teachers can have students work on rich mathematical tasks through utilizing student discourse and collaboration within the classroom.

Social Risk

Students often avoid participating in discussions and sharing their thinking because that puts themselves socially at risk (Horn, 2017). If teachers want to support and sustain mathematical conversations and collaboration in their classrooms, they need to take social risk into consideration. Social risk is defined as a threat to one's status in a

community (Horn, 2017). For example, students may choose not to participate because a wrong answer could result in being laughed at by their peers. This section will focus on further defining social risk, and how it affects the math classroom. It is important for teachers to create a sense of belongingness in their classrooms and foster mathematical mindsets in their students to promote a learning environment where students feel they can share their ideas and thoughts without feeling like their social status is at risk (Horn, 2017).

In mathematics, there is an increased level of social risk because it has become a subject that has been culturally thought of as a measure of someone's smartness (Horn, 2017). This means that your academic status is at risk, as well as your overall intelligence. Students have preconceived notions about their abilities as mathematicians, and these notions affect students' willingness to interact with their teacher, other students, and the content of mathematics (Krall, 2018). Students are often thinking about the participation risks and benefits. For example, if a student participates they risk being wrong in front of their peers but the benefit is pleasing the teacher. For many students, they have decided that it is not worth participating. There needs to be a shift in the classroom culture, so students can feel comfortable sharing their thinking because Horn (2017) stated that in order to make mathematical learning meaningful, it "involves exploration, false starts, and confusion on the way to deeper understanding" (p. 5).

Belongingness. Academic settings can leave some students feeling like they are untalented and incompetent (Horn, 2017). Some students may feel fine about school in general, but math leaves them feeling confused and filled with dread . Some students

enjoy math, but do not think they fit into the stereotype of a "math person" (Horn, 2017). Math has a way of alienating students. Horn (2017) said, "teachers who create a sense of belongingness can overcome these forms of alienation" (p. 29). Belongingness can be defined as, "when students experience frequent, pleasant interactions with the sense that others are concerned about who they are and for their well-being" (Horn, 2017, p. 29).

Krall (2018) also stressed the importance of caring for students in his book *Necessary Conditions: Teaching Secondary Math with Academic Safety, Quality Tasks, and Effective Communication*. In the chapter about academic safety, he discussed the differences between passive and active caring for students. Passive caring is defined as "nonspecific attitudes of care from teachers" (p. 43). Active caring is defined as "a two-way relationship independent of student's academic dispositions" (Krall, 2018, p. 43). If we want students to feel a true sense of belonging, and feel open to sharing their thoughts we need to aim for active caring. Horn (2017) shared that belongingness can be created through authentic connections. Creating authentic connections means seeing students for who they are. This includes their strengths, their weaknesses, their challenges, accepting all students, and working with them to find ways to help them grow (Horn, 2017). Booker and Lim (as cited in Horn, 2017) shared that belongingness is critical to student levels of engagement and their academic success in school (p. 30).

One thing teachers can do to help promote belongingness is to build relationships with students. At the secondary level, teachers can meet with over one hundred students a day so building a relationship with every student can be difficult. When you are actively caring about students, you are working towards getting to know and building

relationships with all students as individuals (Krall, 2017). This caring can be shown by learning about student passions, encouraging each student to participate, reaching out to specific students, offering specific praise, caring about how the student is doing outside of math, and asking about the specifics of their life (Krall, 2017).

Research shows that there is a strong correlation between strong teacher-student relationships and desirable academic outcomes (Horn, 2017). The earlier in the year you can start developing these relationships, the better. Teachers need to know their students' mathematical abilities, as well as how they are outside of the classroom. One way to promote students sharing about themselves is by sharing your own passions and interests (Horn, 2017). It is important to create meaningful connections and to be yourself. When you show students that you care about them as a whole person, it gives them the confidence to take risks (Horn, 2017).

Mathematical mindsets. In the secondary level, many students are walking into school with the identity. They either identify as a smart kid or one of the not so smart kids (Krall, 2018). Students have had years of experience and messages about math that have shaped them when they enter middle school and high school level math courses. Carol Dweck (2006) referred to this as a fixed mindset. There are two different mindsets, fixed and growth. Those with a growth mindset believe that smartness can increase with hard work and those with a fixed mindset believe that even though they can learn new things, their intelligence is fixed and cannot change (Boaler, 2016). The research showed that people have the ability to learn math and it is not fixed, but fluid (Horn, 2017).

In a study of seventh graders Blackwell, Trzesniewski, & Dweck (as cited in Boaler, 2016)) found students with a growth mindset outperformed the students with a fixed mindset (p. 6). Blackwell et al. (as cited in Boaler, 2016) argued that those with a fixed mindset stayed constant with their achievement, while those with the growth mindset had their achievement increase over a two-year study (p. 6). If we want to increase mathematical achievement, it is clear that we need to develop a growth mindset in students.

One thing teachers can do is share with students the benefits of making mistakes and struggling. Students and teachers need to be aware that every time you make a mistake, your brain sparks and grows and that your brain grows regardless of whether you knew you were making the mistake or not (Boaler, 2016). This is because during the time of the mistake, the brain is struggling and is challenging. When you are challenged, this is the time that the brain is growing the most (Boaler, 2016). It is important that we share this information with our students. This helps students see that mistakes are not bad, rather mistakes are opportunities for learning and help you grow (Boaler, 2016). Teachers need to design classrooms where students are encouraged to make mistakes.

It is not easy to change the way students think about mistakes. Throughout a student's life, right answers have typically been praised. Teachers need to celebrate mistakes. One way to do this is by highlighting your "favorite mistake" to students (Boaler, 2016). During this routine, the teacher will select student examples that show a conceptual mistake and showcase it in front of the class. The teacher will start a class discussion about where the mistake came from and why it is a mistake. During this time

it is important to reinforce that the mistake is good, because during this time the student was struggling and the brain was growing (Boaler, 2016).

This means that teachers need to have students engaged in tasks that allow for mistakes. Teachers need to consider social risk before they plan any activities that involve collaboration or discourse. If the classroom is a place where students do not feel like they belong, there is a risk that students will stay quiet and not speak about the math. In my experience, this includes students complaining, students off task while in groups, and just the same people talking and sharing answers. The classroom needs to be a place where students feel comfortable to make mistakes and have false starts. Students will be more apt to join in the discussions and routines when they have a sense of belonging.

In the upcoming section on mathematical discourse, I will share different strategies and routines that allow for students to share their thoughts. Many of these routines encourage false starts and struggle. Students will make mistakes, and through conversations and collaboration, students will be able to develop a deeper conceptual understanding (Horn, 2017).

Mathematical Discourse

One way to promote student learning and engagement is through student discourse. Mathematical discourse is defined as "the purposeful exchange of ideas through classroom discussion, as well as through forms of verbal, visual, and written communication" (National Council for Teachers of Mathematics [NCTM], 2014, p. 29). This can be done many different ways, such as in small groups or as a whole group discussion. There are many benefits to promoting discourse in the classroom such as

revealing misunderstandings, supporting learning, deepening meaning, encouraging language development, boosting memory, and aiding in the development of social skills (Walter, 2018). This section gives an overview of the importance of including discourse in mathematics classrooms as well as different routines to embed more mathematical conversations.

Whole-group vs. small-group discourse. Teachers have many different ways that they can engage their students in discourse. The two primary ways to plan the strategies and activities that engage students in conversations are whole-group and small-group discourse (Kanold, Kanold-McIntyre, Larson, Barnes, Schuhl, & Toncheff, 2018). Whole-group discourse can be defined as the teacher leading the discussion and modeling how to complete problems. The teacher will call on students one at a time to respond to questions and reflects student responses to other classmates (Kanold et al., 2018). They also defined small-group discourse as a time when students collaborate with each other for a set amount of time with specific directions or prompts for students to discuss and share information about an assigned mathematics task or discussion prompt (Kanold et al., 2018).

Teachers should be utilizing both small and whole-group discourse in their classrooms (Kanold et al., 2018). The goal as educators should be to create a balance between the types of communication students are engaged in. Whole group discourse is best used when you are introducing new learning (Kanold et al., 2018). It can be useful to allow students to observe first, and make comments and reflect together. Whole-group discourse is also important at the end of a mathematical task that students might have

done in small groups. It allows for the information to be summarized and students are able to make mathematical connections (Kanold et al., 2018). Whole-group discourse can also help prepare students to work in small groups. Ghousseini, Lord, and Cardon (2017) suggested using whole-group discourse as a way to model specific ways to talk about mathematics. Teachers can ask students to model responses to different questions. This helps students see what productive math talk should look like. It is not about evaluating if a question is right or wrong, rather it is about working together and coaching one another in a mathematical task (Ghousseni et al., 2017).

When students work in small groups, it helps students understand mathematics more independently (Ghousseni et al., 2017). Students are not being lectured by a teacher, rather they are working together with their peers to make sense of the mathematical task. When students are working in small groups it is a great time for the teacher to formatively check for understanding (Ghousseni et al., 2017). The teacher can walk around and monitor and guide student thinking about the different mathematical content students are using in the given task (Ghousseni et al., 2017). During this time it is also easier to provide feedback to all students in your class since they are situated in groups. Instead of having to check in with 30 or more students individually, you can check in with eight groups with four students per group (Kanold et al., 2018). To ensure success in small groups it is important to establish clear expectations and norms (Ghousseni et al., 2017). This gives students knowledge about what is expected of them. To help students work independently without teacher assistance, it is important to provide groups with resources to assist them. This could include material or conceptual resources

(Ghousseni et al., 2017). Material resources would include tools such as manipulatives to help students while exploring the mathematical task. Conceptual resources are the vocabulary and language students will need to know in order to complete the task. It is important that the teacher explains that vocabulary to the students. This could be done through warm-ups, making connections to previous activities, or working on sample problems together as a class (Ghousseni et al., 2017). When students have the necessary resources, they are able to engage in successful small-group discourse and make sense of mathematical concepts with each other.

Classroom environment. Whether the teacher chooses to have students engage in small-group or whole-group discourse, teachers are creating and supporting a classroom learning environment that values reasoning and sense-making from the student's point of view. It is important that the teacher creates an environment where all students feel part of this learning and supporting community. The National Council of Teachers of Mathematics stated "teachers, through the ways in which they orchestrate discourse, convey messages about whose knowledge and ways of thinking and knowing are valued, who is considered able to contribute, and who has status in the group" (as cited in Kanold et al., 2018, p. 40).

Within a class, there are some students who may choose not to talk, and there are many reasons for this. Some students are quiet because of their temperament, and they naturally prefer to intently listen to everything in class, but stay out of the conversation until they feel ready (Horn, 2017). These students do not participate often in whole-group discussions, but when they do, they contribute a lot to the conversation. Another reason a

student may choose to stay quiet in class is because of lack of confidence. They might share information in small-group conversations, but do not feel like they are confident to participate in a whole-class discussion at all (Horn, 2017). These students do not feel confident in their math abilities yet, and fear what their peers would think and how it can affect their social status (Horn, 2017).

On the contrary, there are also students who are very talkative in class. These students are always willing to speak up and share their thinking in class. They do a great job at modeling their thinking publically in front of their peers, but they also can dominate a class. This can make it challenging for other students to get a word in (Horn, 2017). Quieter students often need think time, and for talkative students, it can be difficult to give that quiet time and silence.

It is important to create a classroom culture and environment that promotes effective discourse where everybody contributes to the conversation. In the next section, there will be many different tasks and routines listed that help create an environment for discourse in the classroom. These routines help to promote conversations amongst talkative students and quiet students in a classroom.

Discourse routines. If a secondary mathematics teacher wants to promote more discourse in their classroom, there are many different routines that they could start establishing. 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). Some of these routines include discourse between students and peers, and other routines have discourse between teacher

and student. In each routine, students are talking which is essential to developing mathematical understanding.

- *Number Talks* - The teacher shows students an arithmetic or visual counting problem that they need to work out mentally, then students will share their methods for their solution with the class (Krall, 2018). During these conversations, the teacher will facilitate mathematical conversations with students so they are noticing the similarities and differences among the various responses. Using visuals for a number talk is a great entry point for students to begin number talks (Newell & Orton, 2018). Using visuals allow students to count the quantity of an item and share their strategies with others. The teacher will then annotate the image.
- *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. Students analyze and compare the images to 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, and students need to be aware of this as well. This opens up all students to share without the fear of being wrong in front of their peers (Newell & Orton, 2018).
- *Would You Rather* - Students are shown an image or statement that describes a dilemma and they make the choice of which one they would rather have and

justify it (Newell & Orton, 2018). Students are given individual think time first, and then share with each other. They listen to the arguments of those that agree and disagree with them. This routine can also be used in writing. Students have to justify their choice in writing. There is not one way of getting the "right answer", the focus is on their justification and reasoning for getting that answer.

- *Counting Circles* - In this routine, you need a starting number and a counting number. Students line up in a circle, and a volunteer will start counting by the counting number. For example, you could start at 17 and count by -3. The expectations are that students take their time, they do not comment on other people's answers, mistakes are ok, and if you notice a mistake you ask a question rather than correcting it (Horn, 2017). After going around the circle, the teacher will have the students stop. The teacher will have students predict what someone would say further down the line. Once they have a prediction they put their thumb up as a signal. She then has students share what number they predict and their strategy
- *Visual Patterns* - A pattern is presented to the students that range from simple to complex geometric figures. Students silently look at the pattern, and then discuss what they noticed with the pattern. Students explain how they say the pattern and see if they can write an equation for it. Students are creating mathematical generalizations and have to justify their responses (Horn, 2017).
- *Estimation* - Students are presented with an image and they make a series of estimations. They start with estimates that are too low, too high, and then estimate

that are just right (Newell & Orton, 2018). Students share their justifications for their estimates. Justifications can be from the visual and their own experiences to get a strong estimate. The actual amount is shared with the class and students evaluate how accurate their estimation was. Estimation 180 is a website that teachers can use as a resource to find lots of images for students to estimate. Using estimation is great for all students because it has students rely on intuition and reasoning skills, and it "levels the playing field for all learners" (Newell & Orton, 2018). Estimation activities warm up students brains for a lesson, increases number sense, and engages students (Krall, 2018).

- *Polygraph or Guess Who* - This is a learning activity that was inspired by the game "Guess Who". In "Guess Who", you select a person from a set of people and your partner asks questions to identify who your selected person was. For math, you can replace the people with mathematical concepts such as shapes and graphs, Desmos created an online version of this called Polygraph that a teacher can run in their classroom. Students log into the activity and are paired up with another person in the room. Within a pair, is a picker and a guesser. The picker selects one of 16 images on the screen. The guesser will ask a series of yes or no questions that the picker will need to answer. The guesser can eliminate images after gathering more information from the questions until they are able to accurately identify the mathematical object. This game is great when students have not yet learned the formal mathematical vocabulary for a unit (Krall, 2018).

The teacher can listen to responses and questions, and use student intuitions and student words to teach descriptions for mathematical concepts (Krall, 2018).

- *Always/Sometimes/Never* - Students classify statements as “always true”, “sometimes true”, or “never true”. This opportunity has students thinking like mathematicians because they are making conjectures and testing their hypotheses (Krall, 2018).

These various routines can help to promote discourse and mathematical conversations within the classroom for all students (Krall, 2018). Some of these activities are done as a whole group while others might be done with partners of small groups. In the next section, I will discuss how collaboration can be used as a way to engage students in equitable group work where students are working with each other and engaging in conversations to gain understanding about mathematical concepts.

Collaboration

One way to promote engagement and achievement in the secondary classroom is through collaboration (Corso et al., 2013). For this capstone, collaboration is defined as students working with their peers in a classroom (Corso et al., 2013). They are working on tasks that they would not be able to complete on their own. Collaboration is often called group work or teamwork. Collaboration allows for all students to participate in the classroom. Having students engaged in group work has many learning benefits for students socially and mathematically. Mathematically, these students have more opportunities to share their thinking, show a deeper understanding and retention of concepts, are more welcome to the ideas of others, feel less isolated and anxious about

mathematics, and can incorporate other ideas into their own strategies (Allen, 2012). There are many positive outcomes socially for these students too such as learning to communicate effectively, justifying their objective, working in a team environment, and respecting differences (Allen, 2012).

The first part of this section will discuss what makes a task group-worthy. Group-worthy tasks are open-ended, have multiple entry points, deal with intellectually important content, and require interdependence of others (Lotan, 2003). Facilitating group work and collaboration is also incredibly important in secondary math classrooms. The second part of this section will look at ways to structure the group-worthy tasks and ways to facilitate group work and collaboration in the classroom.

Group-worthy tasks. If a teacher is planning on incorporating group work into the classroom, it is important that they consider what types of tasks would support collaboration. A group-worthy task is one where students would be more successful working in a group than individually (Allen, 2012). The literature describes many qualities of these tasks. Lotan (2003) said that group work tasks must be open-ended, require complex problem solving, allow for multiple entry points, multiple opportunities to show intellectual competence, require interdependence on others, and individual accountability. In the article *Keys to Successful Group Work: Culture, Structure, Nurture* the author also listed characteristics of group-worthy tasks (Allen, 2012). The author stated that these tasks focus on the big ideas, accesses multiple abilities, are open-ended, require interdependence, and include individual accountability (Allen, 2012). Both Lotan and Allen list many similar features. The main overlapping features of the two authors

are that group-worthy tasks are open-ended, allow for multiple ways of thinking, require interdependence, and include individual accountability.

Open-ended tasks often deal with real-life scenarios (Lotan, 2003). These genuine scenarios might include having students experiment, create models, solve authentic problems, and more. With the open-ended nature of these scenarios, there is not one correct way to get to a solution. There are multiple paths that could bring you to a solution. When there are multiple paths, it allows for more students to participate and contribute to the group's ability to solve the task at hand (Lotan, 2003). Each student is different, which allows for different problem-solving strategies to emerge in the conversations as a group. Including so many voices and approaches helps to change the social status of members in the classroom (Lotan, 2003). More students are able to demonstrate to their peers that they are intellectually capable.

Group roles. According to Willis (2010), a key element to group work is giving students an "achievable challenge" for the group where they need each other to succeed because of the complexity of the task (as cited in Lotan, 2013). In essence, this means that the task requires interdependence among members of a group. One way to ensure that all students are working together is by assigning roles to a group (Wood, Sheldon, Felton-Koestler, Oslund, Parks, Crespo, & Featherstone, 2019). Cohen (1994) shared that group roles help alleviate potential imbalances that can occur within a group (as cited in Allen, 2012). Groups will be comprised of many different students. Some of these students will have lower social status, and others will have higher social status. It is important that all students, regardless of status, are given an important role in the task

where the responsibilities are spread equally (Wood et al., 2019). This helps to encourage engagement from students that often do not participate and it helps to keep students from dominating and taking over the task (Allen, 2012).

The responsibilities in the roles ensure that work gets done, not about who is doing the work (Wood et al., 2019). Four commonly used roles used in secondary mathematics classrooms are the facilitator, resource manager, task manager, and recorder/reporter (Allen, 2012). The facilitator initiates the tasks and will check for understanding throughout the task. The resource manager manages the supplies needed for the task and will seek teacher assistance when it is needed. The task manager listens to the group and keeps the group on task and on track. The recorder/reporter will share the data with the class and will make sure their group agrees before they report. Since each of these roles focus on getting the work done, any student can find success in any of the roles (Wood et al., 2019). All of these roles work together to ensure that the group is able to work together and be successful in the "achievable challenge".

Individual accountability. Within a group work task, there also needs to be individual accountability (Wood et al., 2019). Assigning roles often keeps students accountable for their actions in a group. All students also need to be accountable for the content learned during a group task. One way to encourage individual accountability during is group work, is by establishing a classroom norm that no one is done until everyone understands (Wood et al., 2019). When groups come up with a solution, the group needs to ensure that all members understand and could explain the solution. When the teacher is talking to a group, they can ask several students about their mathematical

understanding. The teacher can also ask one person in the group to explain and justify the strategy that they used for the task. In order for the person selected to explain their strategy, the group has to ensure that everyone in the group understood the strategy (Wood et al., 2019).

Another strategy teachers can use is having students complete something individually after the group-worthy task, such as a report. The students needed to be engaged with the task and conversing about the mathematical concepts while they were collaborating together. Lotan (2003) shared that, "in the process of engaging in quality conversations about a concrete project, students develop mastery of the content and the ability to articulate its ideas" (p. 74).

A lot of consideration and planning is necessary to successfully have students collaborate and work together on group-worthy tasks. Teachers need to consider what kinds of tasks are appropriate for group worth as well as ways to keep students accountable while working in teams. When teachers properly plan and facilitate group-worthy tasks in teams of students, the students receive many learning benefits, socially and mathematically (Allen, 2012).

Conclusion

Integrating more collaboration and discourse into the secondary mathematics classroom has many benefits for students, including increased engagement and mathematical understanding. It is necessary that teachers give thoughtful planning to their classroom discourse routines and group work tasks. One thing to consider is the social risk associated with sharing and participating in class. An essential step to incorporating

more discourse and collaboration is creating a learning environment and classroom culture that respects false starts, mistakes, and misunderstandings (Horn, 2017). Creating that social environment helps students who might be concerned about losing social status feel more inclined to begin engaging in mathematical conversations (Horn, 2017). When students are having mathematical conversations, it increases student understanding of the concepts (Seeley, 2018). There are many different discourse routines that teachers can implement into their lessons to begin encouraging discourse. These routines can be done as a whole group or in small groups. Small groups can be utilized in the classroom many ways to help promote engagement and learning. Teachers can select group-worthy tasks that are open-ended, encourage multiple ways of thinking, require interdependence, and also have individual accountability. Collaboration and discussions amongst students increases engagement (Corso et al., 2013). My research question, *how can math teachers promote engagement and learning through collaboration and discourse in the secondary mathematics classroom* investigates how all of these topics work together to promote engagement and learning.

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. This project will be a curriculum resource to seventh grade math teachers using the Minnesota state standards. I will be creating lessons, discourse routines, and group-worthy tasks that correlate with the Minnesota state standards. This project will impact teachers, as well as the students that will be engaged in the lessons presented in the project.

CHAPTER THREE

Project Description

Introduction

In my research, I explored different discourse and collaboration strategies and routines to implement into the secondary mathematics classroom. My experience with students is that they experience a lot of social risk in the math classroom, which can inhibit students from wanting to talk and speak about math. Therefore, I wanted to explore, *How can math teachers promote engagement and learning through collaboration and discourse in the secondary mathematics classroom*, for my research question. Through the research, I found that students need to feel a sense of belonging in the classroom. The classroom environment is essential. Once students feel that they belong, they are more inclined to be engaged in mathematical conversations (Horn, 2017). Mathematical conversations increase student understanding (Seeley, 2018). These conversations can occur in small groups or as a whole group.

For my project, I developed curriculum into organized unit guides for the seventh grade math curriculum. These unit guides include different performance tasks to encourage discourse and collaboration to teach the seventh grade math standards. This curriculum focused on ways to incorporate more discourse and collaboration, it helps to promote understanding and engagement within the mathematics standards (Seeley, 2018). I utilized the Understanding by Design (UbD) approach to my curriculum design which was developed by Wiggins and McTighe (2011). In this chapter, I describe an overview of my project, the intended audience, and timeline of the project. Within this chapter, I

share the research that supports my project design structure and why I chose the method of UbD for my project design.

Project Description

My project consists of unit guides for each of the units for seventh-grade math covering the Minnesota state standards. The unit guide acts as a planning document for each of the units. For each unit, I have listed the content standards, understanding goals, essential questions, student objectives, performance tasks, and learning plans for the unit. The units consist of ratios and proportions, probability, integers, rational numbers, algebra, proportional relationships, geometry, percents, data and statistics, and transformations. The performance tasks and learning events focus on activities and routines that promote engagement and achievement through discourse and collaboration. Other tasks such as quizzes, tests, homework, etc. will not be included, because the unit guides only list the collaboration and discourse strategies and routines that are incorporated into that particular units.

For each unit, I have many performance tasks that support discourse and collaboration. There is at least one discourse routine per unit. As listed in Chapter Two, these routines include: number talks, always/sometimes/never, polygraph/guess who, estimation, visual patterns, counting circles, would you rather, and which one does not belong (Horn, 2017; Krall, 2018; Newell & Orton, 2018). These routines do not take up a whole class period. The performance tasks also include one to two group-worthy tasks where students are assigned group roles and work collaboratively with each other. These

investigations would take a whole class period or more for each unit. These are open-ended tasks that often deal with real-life scenarios.

Backwards Design Framework

Backwards design and Understanding by Design (UbD) helps to create high-quality units (Wiggins & McTighe, 2011). UbD is a way of thinking purposefully about planning curriculum and units to help develop and deepen student understanding through the use of "big ideas" (Wiggin & McTighe, 2011). The "big ideas" come from the content level standards that are unpacked. In UbD, there are three stages to the design process; desired results, evidence, and learning plan. The three stages give a unit purpose and priority (Wiggin & McTighe, 2011).

Before any learning activities are planned, teachers need to identify the desired results. This is the first stage of UbD. These are the goals. Teachers think about what students need to know and what they will be able to do. The second stage of backward design is determining acceptable evidence of learning. Teachers need to consider how they are going to be able to determine if students have achieved the desired results and met the content standards (Wiggin & McTighe, 2011). In the third stage learning experiences and instruction are planned. This is where teachers consider how content should be taught and the sequence of activities to help achieve the desired results.

Choice of Method

I chose to use Ubd because I wanted to ensure that my implementation of learning activities and routines went beyond "activity oriented teaching" (Wiggin & McTighe, 2011). I needed to ensure I was not just selecting activities to use for the sake of

discourse and collaboration. I needed to think about the desired results, evidence, and learning plans that would help to give meaning to the unit guides. For example, when considering the desired results of a unit, my PLC (Professional Learning Community) has to consider our established goals for the unit and what the long-term independent accomplishments we desire in a unit to help transfer student learning. My PLC consists of myself and one other math teacher who teaches the same on-grade level seventh grade class as myself. In our PLC we meet weekly to discuss our plans for a unit and reflect on how units have gone. We work together to ensure the students at our school are learning and growing in mathematics.

For this project, if I did not utilize backwards design, there is a risk that there would not be grounding factors to the learning activities. Students would not be able to make connections to an essential question to the unit. There also could be a risk that the discourse routines and collaboration activities would not have related to the seventh grade mathematics standards. Backwards design and Ubd ensured that the desired results and goals of a unit were always the priority.

Project Audience

The intended audience for my project is seventh grade students in my suburban middle school and the staff members within my PLC that teach seventh grade mathematics. The middle school is located in a northern Twin Cities suburb. It is a middle school that serves around 700 students where 53% are White, 16% Black, 11% Hispanic, 11% Asian, 1% Native American, and 8% identify as two or more ethnicities. At the school, 47% of the students qualify for free or reduced lunch and 15% receive

special education services (“Edgewood Middle School Fast Facts”, n.d.). This is the population of students that will be audience of the learning tasks and curriculum organized within the project. These students will be engaged with learning tasks and using the discourse and collaboration routines to promote their achievement and engagement within the mathematics classroom.

Another key audience is my PLC for the seventh-grade courses that we teach. My PLC consists of myself and one other teacher. As I developed the unit guides I was in close communication with my fellow PLC member. We teach the same course, so we wanted to agree on the important features of the unit guides such as the learning targets, essential questions, and what sorts of routines and activities were going to support engagement and collaboration in the classroom. We both will be able to utilize the unit guide throughout the year and have resources readily available for our classroom in the upcoming years.

I also hope that this resource can be helpful for other seventh-grade math teachers within Minnesota. This resource will list all of the seventh grade Minnesota mathematics standards with engaging learning activities that will promote discourse and collaboration. Teachers across the state would be able to take these activities and easily implement them into their classroom.

Project Timeline

In the summer of 2019, I created the unit guides utilizing backwards design for the seventh-grade mathematics curriculum. During this time I worked with the other member of my PLC to identify the desired results (stage 1) for each of the units. We

worked together to agree on the understanding goals, essential questions, and student objectives that correspond with the content standards for each of the units in seventh-grade math.

After we complete the first stage, I worked independently on the second stage - assessment evidence and the third stage - learning plan on creating and organizing the resources that promote discourse and collaboration. After I organized the performance tasks and learning plan I met again with my PLC member. We looked at the tasks and learning plan that I organized. During this time we made revisions of tasks so that we both felt comfortable and ready to teach with these activities and routines in the 2019-2020 school year and beyond. I helped to teach my coworker how to implement the discourse routines she is not familiar with in the classroom before the start of the year.

Project assessment. In the fall of 2019, we will start to implement the routines and activities throughout the year with our students. During our PLC meetings, we will plan the specifics of when we want to execute the planned tasks. At the end of a unit, we intend to reflect on how the tasks went and we will give students surveys that ask them to reflect on what learning tasks from the unit helped the most in learning new information. We will also ask the students about which tasks were the most engaging. When our PLC meets to study these surveys, we will discuss what the strengths were, and what changes we might want to make to the tasks to improve them for the upcoming year based on student survey data, assessment data, and our observations throughout the unit. Throughout the year we may incorporate more discourse and collaboration routines and edit the originally planned tasks. We want to ensure that we are always finding ways to

improve and create the best lessons to promote engagement and achievement in our math classes.

Conclusion

My project consists of 10 unit guides that go along with the seventh grade mathematics standards in Minnesota. I used UbD and backwards design to create these unit guides (Wiggins & McTighe, 2011). The guides have the key components of backwards design; the desired results, evidence, and learning plan. Through extensive research, the learning plan for each unit focuses on collaboration and discourse. Throughout each of these units, our PLC would incorporate many other lessons, but the priority of my project is on collaboration and discourse to encourage engagement and achievement. In the next chapter, I will explain what I have learned from my capstone project. This includes the implications as well as the limitations of my unit guides.

CHAPTER FOUR

Conclusion

Overview

My capstone project explores the question: *How can math teachers promote engagement and learning through collaboration and discourse in the secondary mathematics classroom?* This question was my motivation behind the creation and design for unit guides that complement the Minnesota 7th grade mathematics standards. Within this fourth chapter, I reflect on what I learned through the capstone process as a researcher, a writer, and a learner. In Chapter 4, I also revisit the literature review and how it supported the creation of the unit guides as well the connections I have made to the reviewed literature. This chapter addresses the possible implications and limitations of my project. Lastly, in Chapter 4 I will explain who in the world of education will benefit from my work and share my plan to communicate the results of this project.

Learnings

Throughout my work on the capstone project, my learning can be separated into three different roles: a researcher, writer, and learner. In the beginning of my project I had to immerse myself in various literature and research. It can be a daunting task reading various articles and books. I began my research with two texts that acted as a foundation to my research. *Motivated: Designing Math Classrooms where Students Want to Join in* by Ilana Horn (2017) and *Necessary Conditions: Teaching Secondary Math with Academic Safety, Quality Tasks, and Effective Facilitation* by Geoff Krall (2018) were both crucial to my capstone research. These two texts, lead me to my other research. In

these texts, there was lots of information about social risk, discourse routines, the use of group roles, and more (Horn, 2017; Krall (2018). After initially reading the information in those books, I was able to get a better idea of what kind of literature I needed to research to find even more information about engagement, discourse, and collaboration. After I had collected many resources, I separated the literature into different categories. Some research was all about collaboration and group work, while other literature talked about mathematical and growth mindsets. I read the literature and categorized each of them, which helped tremendously when it came to writing my literature review.

The literature guided my writing. By finding the common themes, it was easier to write about all of the research that I had done. As someone with a background in math, I was very anxious to begin a project that would involve so much writing. However, it all felt quite natural since I did a good job of organizing my research. During the writing process, it was important to always keep thinking back to my research question: *How can math teachers promote engagement and learning through collaboration and discourse in the secondary mathematics classroom?* I would ask myself, does my research encompass everything that needs to be said? If not, I would go back into the role of a researcher. While writing, I would sometimes need to go back looking for resources and more information. The role of researchers and writing sometimes intermixed. During the researching and writing, I was learning and synthesizing so much new information.

The information I learned was very helpful when creating my capstone project, but has also helped me in my role as a secondary mathematics teacher. As an educator, I am always yearning to learn more and grow more in the profession. Immersing myself in

this literature has helped me tremendously in the classroom. During my time teaching, I have attended many professional development opportunities such as attending conferences and workshops. While I was doing my research for my capstone, I was expecting to find research that was similar to what I had learned in the various sessions I have attended over the years. To my surprise, I was learning a lot of brand new information. For example, I had not had much prior knowledge about social risk in the classroom. During this research I learned about different ways a teacher can make their students feel comfortable and ready to engage in discourse and collaboration.

Overall, this capstone process has been incredibly beneficial to me. My knowledge on collaboration and discourse in the mathematics classroom has increased tremendously. I now understand different ways to engage my students in mathematical conversations and how to better facilitate collaboration and group work amongst my students. In the next section, I revisit the literature review, and share what literature and research was the most helpful in completing my capstone project.

Revisiting the Literature Review

In Chapter 2, I review various literature that addressed engagement, collaboration, and discourse in the secondary mathematics classroom. All of the literature was very influential in helping to answer my research question, *how can math teachers promote engagement and learning through collaboration and discourse in the secondary mathematics classroom?* However, there were some texts that proved to be the most important to me as I was creating my project. When I was working on discourse routines for each unit, I often referred back to the books *Necessary Conditions: Teaching*

Secondary Math with Academic Safety, Quality Tasks, and Effective Facilitation by Krall (2018), *Motivated: Designing Math Classrooms Where Students Want to Join in* (Horn 2017), and the journal article *Classroom Routines: An Invitation for Discourse* (Newell & Orton, 2018). These particular texts provided great examples of discourse routines that I can implement in the classroom. In these texts I learned how to implement strategies such as Number Talks, Which One Doesn't Belong, Would You Rather, Counting Circles, Visual Patterns, Estimation, Desmos' Polygraphs, and Always/Sometimes/Never. These routines will become regular strategies I use in the classroom to promote students in conversation and discourse with each other about mathematics.

When I was working on the project, I was also looking at different group-worthy tasks to incorporate that would foster collaboration amongst peers. I found the work by Allen (2012) and Lotan (2003) the most important for that segment of my capstone. Both authors talk about what it means to have group worthy tasks and how you can facilitate the group-work. According to Allen (2012), a group-worthy task is one where students would be more successful working in a group than individually. Lotan (2003) shares that group-work must be open-ended and require complex problem solving, allow for multiple entry points, require multiple opportunities to show intellectual competence, require interdependence of others, and individual accountability. When I was selecting tasks, I would ask myself if the task fell under these two author's definitions and descriptions of group work. If it did not, I would not include it in the unit guide. I would refer back to Allen (2012) when I was thinking about what group roles would be beneficial for the

group-worthy tasks. He recommends using the roles of facilitator, resource manager, task manager, and recorder/reporter (Allen, 2012).

Through the literature review process of the capstone, I learned many valuable aspects that helped in the creation of my unit guides. Without the review, I do not believe that I would have been able to select and create such high quality tasks and routines that promote mathematical conversations through discourse and collaboration. The literature review process was a vital component of my capstone project and helped to guide my project. In the next section, I share how I came up with the design of my project.

Project Design

When designing my project, I used the Understanding by Design (Ubd) framework by Wiggins and McTighe (2011). I knew that I wanted to incorporate all three stages, desired results, assessment evidence, and learning plan, but I did not need to incorporate all the elements of each of the stages because I was creating unit guides, not an entire curriculum for each unit. For stage one, desired results, I chose to keep the established goals, essential questions, and skills. For stage two, assessment evidence, I broke up the evidence into performance tasks and discourse routines. The performance tasks are the group-worthy tasks for each unit, and the discourse routines are the activities that encourage mathematical conversations. In the third stage, learning plan, I list the performance tasks and discourse routines and how to implement them into the classrooms. My adapted template of the UbD framework works perfectly for my intentions for this project (Wiggins & McTighe, 2011). The project has many positive

implications for educators and students. In the next section, I share what some of those implications are.

Possible Implications

In my building, I work in a Professional Learning Community (PLC) with one other coworker. This unit guide is going to be very helpful to our team throughout the year. We will be able to take the resources that have been created and implement them into our curriculum. Students will be asked to talk about mathematics through discourse routines and they will be working together in groups collaboratively on tasks. In the past, our team has not been comfortable asking our students to engage in mathematical thinking in this way. This capstone project has given us more confidence to move forward and engage our students in discourse and collaboration. Our students will benefit greatly from this project.

Another goal I had for this project was to create a guide for other teachers across the state and beyond. While this guide focuses on seventh grade mathematics standards, other secondary mathematics teachers can benefit from the research. The research in the literature review provides teachers with many different ways to incorporate more mathematical discourse and collaboration into their own math classrooms. Teachers can discover the many different discourse routines that help to facilitate mathematical conversations as well as strategies for selecting and engaging students in group-worthy tasks. While these unit guides and research can be very helpful and useful for both teachers and students, there are some limitations of the project as well.

Project Limitations & Future Work

While I was working on this project, one limitation was time. I know that there are many more great discourse routines and group-worthy tasks that I would be great additions to these unit guides. However, during the time of my capstone courses, there was not enough time to include everything that is out there. Within upcoming school years, we will be continuing to edit and adapt the unit guide. If my PLC groups finds more resources, we will add them to the project. Or, if we find that an activity or routine could be improved, we will edit it to make sure the activity is more effective in the upcoming years. Student feedback and conversations with my PLC about these activities will be very important in ensuring that we are always adding more content and adapting it to best meet the needs of our students.

Another limitation of the project is that it is not able to be easily accessed by teachers outside of my immediate professional circle. My unit guides will be shared with the other seventh grade math teachers within my school district, but beyond that I am not sure how many teachers will find this resource that could be available for them. I intend to present my research as various math teacher conferences as well, but that is still a limited amount of educators.

Communication and Benefits

Communicating and sharing the unit guides with other teachers will be crucial in ensuring that as many teachers and students are able to benefit from the various discourse routines and group-worthy tasks selected for the seventh grade Minnesota math standards. At the beginning of the school year, I will be sharing these unit guides with the

other seventh grade math teachers in my district. I will also share this project with my district's math coach. I will encourage those that I share this project with to share it with any other secondary math teachers that they feel would benefit from the content.

This project will benefit a lot of teachers who might not have always been comfortable to ask students to work in groups and/or talk about mathematics through discourse. Specifically, it will benefit the seventh grade math teachers by providing them a variety of resources to encourage collaboration and discourse that correlate with the seventh grade math standards.

Summary

When I was completing this project, my main goal was to answer the question: *How can math teachers promote engagement and learning through collaboration and discourse in the secondary mathematics classroom?* Through my research and completion of this project, I was able to understand what sorts of discourse routines and group-worthy tasks can help to promote engagement and learning in the secondary mathematics classroom. From this research, I created unit guides that correlate with the seventh grade Minnesota mathematics standards. For each unit I list the established goals, essential question(s), skills, at least one performance/group-worthy tasks, and at least one discourse routine. There are a variety of different tasks to encourage collaboration and mathematical discussions amongst students. While this capstone project is now complete, I plan on adapting this unit guide as time goes on. I will use the feedback I receive from coworkers and students to edit different learning activities, as well as always looking to add more discourse routines and group-worthy tasks. Another goal I have is to keep the

unit guides up to date with the most relevant and useful resources. Completing this capstone has been a rewarding experience, and I look forward to using these activities with my students in the years to come and witness their engagement and learnings.

REFERENCES

Allen, K. C. (2012). Keys to Successful Group Work: Culture, Structure, Nurture. *The Mathematics Teacher,106*(4), 308-312. doi:10.5951/mathteacher.106.4.0308

Bennett, C. A. (2010). "It's hard getting kids to talk about math": Helping New Teachers Improve Mathematical Discourse. *Action in Teacher Education,32*(3), 79-89. doi:10.1080/01626620.2010.10463561

Boaler, J. (2016). *Mathematical mindsets: Unleashing students potential through creative math, inspiring messages, and innovative teaching*. San Francisco, CA: Jossey-Bass & Pfeiffer Imprints.

Corso, M., Bundick, M., Quaglia, R., & Haywood, D. (2013). Where Student, Teacher, and Content Meet: Student Engagement in the Secondary School Classroom. *American Secondary Education*, *41*(3), 50–61. Retrieved from https://search-ebscohost-com.ezproxy.hamline.edu/login.aspx?direct=true&db=keh&AN=89935759&site=ehost-live

Dweck, C. S. (2006). *Mindset*. New York, NY: Ballantine Books.

Edgewood Middle School Fast Facts (n.d.). Retrieved from https://www.moundsviewschools.org/Page/1139

Ghousseini, H., Lord, S., & Cardon, A. (2017). Supporting Math Talk in Small Groups. *Teaching Children Mathematics,23*(7), 422-428. doi:10.5951/teacchilmath.23.7.0422

Henningsen, M., & Stein, M. K. (1997). Mathematical Tasks and Student Cognition: Classroom-Based Factors That Support and Inhibit High-Level Mathematical Thinking and Reasoning. *Journal for Research in Mathematics Education,28*(5), 524. doi:10.2307/749690

Horn, I. S. (2017). *Motivated: Designing math classrooms where students want to join in*. Portsmouth, NH: Heinemann.

Kanold, T. D., Kanold-McIntyre, J., Larson, M. R., Barnes, B., Schuhl, S., & Toncheff, M. (2018). *Mathematics instruction and tasks in a PLC at work*. Bloomington, IN: Solution Tree Press.

Krall, G. (2018). *Necessary conditions: Teaching secondary math with academic safety, quality tasks, and effective facilitation*. Portland, ME: Stenhouse.

Lei, H., Cui, Y., & Zhou, W. (2018). Relationships between student engagement and academic achievement: A meta-analysis. *Social Behavior and Personality: An International Journal,46*(3), 517-528. doi:10.2224/sbp.7054

Lotan, R. A. (2003). *Group-Worthy Tasks,60*(6), 72-75. Retrieved from http://tafstem.pbworks.com/w/file/fetch/67621837/Group-worthy-tasks-Lotan.pdf

Newell, C., & Orton, C. (2018). Classroom Routines: An Invitation for Discourse. *Teaching Children Mathematics,25*(2), 94-102 doi:10.5951/teacchilmath.25.2.0094

Principles to actions: Ensuring mathematical success for all. (2014). Reston, VA: National Council of Teachers of Mathematics.

Rachel, L. A. (2003). Group-Worthy Tasks. *Educational Leadership,60*(6), 72-75.

Seeley, C., Dr. (2018, February 14). Rich Classroom Discourse: Benefits for Student Learning. Retrieved from https://medium.com/inspired-ideas-prek-12/rich-classroom-discourse-benefits-for-student-learning-964aae303974

Skinner, E.A., & Belmont, M.J. (1993). Motivation in the Classroom: Reciprocal Effects of Teacher Behavior and Student Engagement Across the School Year. *Journal of Educational Psychology, 85(4)* 571-581

Skinner, E.A., Kindermann, T.A. & Furrer, C.J. (2009). A Motivational Perspective on Engagement and Disaffection: Conceptualization and Assessment of Children's Behavioral and Emotional Participation in Academic Activities in the Classroom. *Educational and Psychological Measurement, 69(3),* 493-525

Walter, H. A. (2018). Beyond Turn and Talk: Creating Discourse. *Teaching Children Mathematics,25*(3), 180-185. doi:10.5951/teacchilmath.25.3.0180

Wiggins, Grant P., and Jay McTighe. *The Understanding by Design Guide to Creating High-Quality Units*. ASCD, 2011.

Wood, M. B., Sheldon, J., Felton-Koestler, M. D., Oslund, J., Parks, A. N., Crespo, S., & Featherstone, H. (2019). 8 Teaching Moves Supporting Equitable Participation. *Teaching Children Mathematics,25*(4), 218-223. doi:10.5951/teacchilmath.25.4.0218

APPENDIX A

Understanding By Design Unit Guide Template

Stage 1 - Desired Results

Established Goal(s):

Essential Question(s):	Skill: *Students will be able to...*

Stage 2 - Assessment Evidence

Performance Task(s):

Stage 3 - Learning Plan (Learning Activities)
