Meaning Centered Mathematics Instruction:
Supporting Engagement and Conceptual Understanding in a Seventh-Grade Classroom

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An Action Research Project

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Abstract

This action research project examined how meaning-centered, mathematical tasks influence learner engagement and conceptual understanding in a seventh-grade mathematics classroom. The study was guided by the research question: How do meaning-centered mathematical tasks influence learner engagement and conceptual understanding in a seventh-grade mathematics classroom? Grounded in Constructivist theory, supported by sociocultural learning, the study explored instructional practices that emphasize collaboration, mathematical discourse, explanation, and conceptual reasoning. Using an action research framework, data were collected throughout a five-lesson instructional sequence using clicker quizzes, paper-based assessments, observation notes, and teacher reflection journals. Qualitative analysis was conducted using open coding and triangulation across data sources. Three major themes emerged from the analysis. First, students often demonstrated strong procedural fluency while showing less consistent conceptual understanding and mathematical justification. Second, structured, meaning-centered collaborative activities generally increased engagement and participation, particularly when paired with clear accountability structures and opportunities for discussion. Third, students demonstrated varying levels of success in using academic language to communicate mathematical reasoning, with many students providing stronger verbal explanations than written justifications. These findings suggest that meaning-centered mathematics instruction can support student engagement and conceptual understanding when learning experiences intentionally incorporate collaboration, discussion, reflection, and opportunities for mathematical explanation. The study highlights the importance of balancing procedural fluency with conceptual reasoning and supporting students in communicating mathematical thinking through both verbal and written discourse.

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Chapter 1 - Philosophy of Education

Education is a dynamic process in which students investigate ideas, ask meaningful questions, and connect classroom learning to their lived experiences and communities. It resonates with our capacity to imagine possibilities, create meaning from experience, and recognize their connection to the broader world around them. From this perspective, education becomes both a personal and social endeavor, guiding students to participate in the broader human story. Learning is not merely the transfer of knowledge but the diligent cultivation of meaning that stems from students' experiences, their reflections on those experiences, and the relationships that shape their learning. Every learner brings a phenomenological perspective shaped by their culture, history, and interests; and it is the role of a teacher to create an environment in which those unique perspectives can interact with one another, challenge assumptions, and deepen collective understanding. My educational phenomenology stems from the notion that prosperity rises when students actively engage in discerning the world around them. Therefore, teaching cannot be about control and conformity; rather, it is about guiding students as they navigate toward an understanding of themselves and the world, a sense of purpose in learning, and confidence in their ability to grow in an ongoing, ever-changing world.

I have come to understand education through long, thoughtful reflection on my journey. I previously viewed knowledge as established, concrete, and external, as something passed down from authority. However, through my formal education and lived experiences, I began to see that education, at its core, is an inquiry-driven and adaptive process. As I move away from rigid, structured belief systems into a deeper search for meaning, I continue to see education as collaborative discovery rather than instruction.

Navigating this belief has been particularly significant for me as a mathematics educator. Mathematics is often taught procedurally, yet it can also foster creativity and curiosity. I have witnessed students thrive once they realize it is a language of patterns and reasoning that extends beyond the classroom. My teaching philosophy will therefore focus on helping students reclaim math as a subject grounded in reasoning, curiosity, and sense-making rather than mere procedural completion. I want students to see it as a living discipline that goes beyond memorizing procedures or arriving at correct answers, one that encourages imagination, exploration, and confidence in their own abilities to reason through problems and make sense of the world around them.

My journey as a learner has included significant deconstruction. My early education was rooted in certainty and structure. I was taught that knowledge had strict boundaries, and learning was well-defined by obtaining the correct answers and reproducing them precisely. While this approach initially offered me direction and structure, it also stifled my ability to explore and question. When education relies solely on hierarchy, there is little space for developing creative thinking, curiosity about unfamiliar ideas, and open discussion with others. Through reflection, I saw that honest understanding is not passed down but must evolve from experience.

This revelation became a critical juncture in both my personal and professional life. As I advanced steadily through higher education and into teaching, I began to see that growth occurs when learners feel safe to explore, make mistakes, and adapt their thinking. Education relies on cultivating relationships in the classroom through listening, empathy, and mutual respect. This realization led me to shift from focusing on correctness and compliance to emphasizing active participation, openness to different perspectives, and the ability to adapt their thinking. When I invite students into shared experiences and exploration, they grow in their curiosity and confidence in ways that standardization cannot replicate or produce (a key aspect of self-determination theory).

I learned from these experiences that education is most influential when it mimics the complexities of life, helping students navigate its uncertainties, discover meaning, and connect ideas to their experiences. Teaching is no longer just about relaying information; for me, it is about cultivating an intellectually generous environment where each student's narrative is respected, and guidance is offered to foster a deeper understanding.

Core Beliefs About Teaching and Learning

Learning ignites interest when students share in an experience, are active in the process, and get to interact with the natural world. My classroom will encourage students to share ideas and refine their understanding. For example, I will have my students experiment with numbers, observe their patterns, and discover meaning through their engagement, rather than simply memorizing a process. When students are allowed to express themselves through active learning, they will begin to see themselves as capable thinkers who can solve problems creatively and collaborate effectively with others.

Learning, at its foundation, is about connection to the teacher, their peers, and the material being learned. When students feel seen, safe, and valued, they are more willing to take risks and contribute ideas. I make it a priority to engage my students by connecting instruction to their interests and lived experiences so their learning feels meaningful beyond the classroom. Standardized math often appears disconnected from the world they experience, so I use examples grounded in gaming strategy, sports statistics, track-and-field performance, and real-world financial decisions. When students begin to recognize mathematics within the things they already care about, they are more likely to view themselves as capable thinkers rather than passive participants merely trying to arrive at correct answers.

Reflection is a critical practice of learning since it allows students to pause, evaluate, and make sense of their exploration. When learners take time to process not only what they know but also how they came to understand it, they begin to see themselves as capable learners. In my classroom, I encourage this through structured dialogue, moments of self-assessment, and opportunities for students to analyze mistakes and reflect on their problem-solving strategies. Rather than viewing errors as failures, I want students to see them as opportunities for growth in reasoning and deeper understanding.

Purpose as an Educator

My primary purpose as an educator is to help students see themselves as capable problem-solvers and critical thinkers. I do not want them to pass math only; I want them to recognize mathematics in the world around them and understand that they are capable of making sense of it. I want to reveal to my students that mathematics is dynamic, creatively applied, and deeply connected to the world around them. My goal for every student as they leave my class is to become more confident in problem-solving, more curious about unfamiliar ideas, and more willing to view mistakes as part of the learning process.

Commitment to the Classroom

The foundation of my classroom is respect, curiosity, and community. I strive to ensure that learning is accessible through visuals, collaborative work, and multiple representations that support different ways of thinking and learning. Every person brings a valuable perspective enriched by their experiences and identities. I encourage my students to support their peers and to view struggle as a natural part of growth. When students begin to see the meaning and worth in their ideas, they are more likely to develop persistence in problem-solving and take ownership of their learning. Ultimately, my classroom should be a place where curiosity and compassion come together, allowing learning to reflect the complex and continually evolving world beyond the classroom.

Connecting Philosophy to Pedagogical Theory

Holding these beliefs and commitments informs how I navigate my teaching and how I perceive my role as a mathematics teacher. They serve as reminders that learning is a collaborative effort built on trusting relationships, curiosity about the world, and persistence in the face of challenges. This philosophy is closely related to Constructivist and Sociocultural theories, focusing on how students can cultivate understanding through their lived experiences and social interactions.

Guiding Pedagogical Theory

Education: The Forest of Learning

Like a forest cultivated by rain, soil, and sunlight, students thrive when they are actively engaged with their learning environment and supported through meaningful community connections. Every student learns differently and is shaped by their experiences, the community they belong to, and their prior knowledge. Constructivists believe that learning is a process in which people develop new layers of understanding on top of their existing knowledge (Ormrod, 2019). As Paulo Freire (1970/1993) wrote, education should be a dialogue that empowers students to determine their own growth and development. In my classroom, it means cultivating a space where curiosity and collaboration can flourish, just like trees reaching for the light and growing stronger together.

The theories that guide my pedagogy reflect my own growth as both a learner and a teacher. Each theory contributes to my understanding of how students learn and grow, and reminds me that teaching is not about control but cultivation.

Definition of the Guiding Theories

Constructivism: Planting Understanding

As trees prosper in different soils, learners evolve their understanding when they connect new ideas to what they already know. Constructivism centers on building knowledge through experience, reflection, and adaptation. Jean Piaget (1952) emphasized that students reshape their thinking as they encounter new ideas and revise their understanding through experience. L.S. Vygotsky (1978) asserts that students learn best within a space beyond what they can accomplish independently, which he termed the Zone of Proximal Development. In my classroom, this means maintaining high expectations while providing the scaffolding and support students need to productively struggle through challenging ideas and gradually develop confidence in their own reasoning (Ormrod, 2019).

Within the boundaries of my classroom, Constructivism will be a living system of exploration. As Wiggins and McTighe (2005) advise, instruction should move beyond procedures meant merely for memorization and instead center on essential questions that offer students purpose and direction in their learning. When mathematics is presented through problem-solving, pattern exploration, and multiple solution strategies, students have opportunities to reason creatively and develop a deeper conceptual understanding.

Sociocultural Theory: Growth in Community

All learners face challenges, and during periods of struggle, new ideas can emerge that help others grow and flourish. Sociocultural theory emphasizes that learning is a social process rooted in communal experiences. Vygotsky (1978) stresses that culture and language are not merely additions to learning, but the means through which we form our thinking. Ormrod (2019) suggests that when students share their ideas and refine their reasoning together, they deepen their understanding and construct meaning together. Four Arrows and Deloria Jr. (2019) further develop this idea by describing education as an interdependent system in which all participants contribute to the learning process. From this perspective, the classroom environment is not merely an assortment of individuals, but rather, a symbiotic ecosystem where learners help one another grow and flourish.

Culturally Responsive Teaching: Nourishing Diverse Roots

Culturally Responsive Teaching (CRT) emphasizes that students learn most effectively when instruction connects to their cultural experiences and identities. Geneva Gay (2018) defines CRT as "using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them" (p. 36). Ladson-Billings (2009) refers to it as "a pedagogy that empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes" (p. 20). In mathematics, this may involve examining the effects of redlining on housing patterns, analyzing environmental inequities within communities, or investigating disparities connected to income, resources, and access to opportunity. When students can critically examine the realities shaping their communities through mathematics, learning becomes more personally meaningful and connected to the world they experience.

Linking the Theories Together

Together, these theories create a framework for my understanding of teaching and learning. Constructivism provides the foundation for emphasizing that students build understanding through inquiry, reflection, and meaningful experiences. Sociocultural theory extends this perspective in recognition that learning is shaped through language, culture, and participation within a community. Culturally Responsive Teaching further reinforces this framework by ensuring instruction honors students' intersectional identities and draws from their lived experiences. Together, these perspectives help me cultivate a classroom where students actively construct their understanding, learn from each other, and see their own experiences reflected in the learning process.

Effective teaching requires a balance between instructional structure, inquiry, collaboration, and reflection. To create this balance, lessons should be intentionally designed around meaningful experiences that encourage students to collaborate with peers and connect mathematics to their own understanding and lived experiences. This approach aligns with Wiggins and McTighe's (2005) backward design framework, which begins with the desired learning outcomes and then designs instruction and assessment to support those goals. In establishing a clear purpose for learning, students are better able to engage deeply with mathematical ideas and develop lasting understanding. This perspective also reflects Ormrod's (2019) emphasis on the relationship between social interaction, cognition, and long-term learning.

These guiding frameworks inform the design of my action research project, in which I will explore collaboration using culturally relevant examples to broaden students' understanding of mathematics. By employing a Constructivist approach, I will analyze how students discover meaning by challenging ideas, processing data, and drawing connections between mathematics and real-world situations.

The principles of Constructivism, Sociocultural Learning, and Culturally Responsive Teaching are closely aligned with the InTASC Standards for professional practice, particularly those focused on learner development, instructional strategies, and professional reflection. These standards illustrate how theory is applied in daily teaching, a topic I will explore in the next section.

Connection to InTASC Standards

Teaching is not merely about knowing theories; it is about applying them in and out of the classroom. The InTASC Standards offer practical ideas to help students reach their full potential and receive the support they need. My approach to teaching aligns with my theory of learning, as I design lessons before class, teach them during class, and reflect on them afterward.

Standard 1: Learner Development

Learner development aligns with my focus on understanding how students develop mathematical meaning at different stages. This standard guides my use of multiple representations, collaborative problem-solving, and opportunities for students to explain their reasoning in ways that reflect their readiness and prior experiences. This focus directly aligns with my action research in examining how instructional planning promotes deeper understanding and engagement.

Standard 3: Learning Environments

Learning environments inform my commitment to cultivating a classroom environment grounded in collaboration, respect, and productive struggle. Establishing these norms is integral to mathematical discussion, comparison of multiple solution strategies, and peer-supported learning. I hope to establish a culture in which students feel safe taking intellectual risks. This standard is closely connected to my research interest in how collaborative learning structures guide students toward meaning-making.

Standard 8: Instructional Strategies

Instructional strategies align with my use of visual models, collaborative discourse, and real-world mathematical investigations. Students may compare solution strategies, justify their reasoning, analyze misconceptions, and connect mathematics to contexts such as budgeting decisions, housing patterns, local issues, or other mathematical investigations connected to students' lived experiences. These strategies are intentionally implemented to support students in developing understanding rather than relying on memorized procedures, thereby reinforcing the constructivist and culturally responsive grounding of my teaching.

Conclusion: Theory in Action

Merging these theories in light of the InTASC Standards guides my goal of cultivating a classroom where students explain their reasoning, learn from mistakes, collaborate with peers, and connect mathematics to their lived experiences.

Summary

My philosophy of education emphasizes that learning is an organic, dynamic process. The process begins within the community and evolves through curiosity and reflection. Guided by the theories of Constructivism, Sociocultural, and Culturally Responsive Teaching, education is both collective and personal, where students flourish when they are part of a community of learners. Teaching is not about control but about cultivation, centered on creating environments where students can investigate problems, challenge assumptions, and connect mathematical ideas to real-world situations drawn from their experiences.

These guiding principles inform my Action Research Project, which explores how implementing culturally responsive and collaborative approaches can enhance middle school students' understanding of mathematical reasoning. Through these approaches, my goal is to demonstrate how real-world contexts can improve comprehension and engagement in the mathematical classroom.

Finally, the InTASC Standards provide a guiding professional framework for integrating these ideas into practice. Constructivism aligns with the Learner and Learning Standards by emphasizing inquiry, discovery, and growth. Sociocultural Theory aligns well with the Instructional Practice standards through its emphasis on shared learning, feedback, and interaction. CRT supports Professional Responsibility standards, urging me to collaborate, teach with equity, and engage in reflective practice. These frameworks guide how I translate my educational beliefs into classroom practice.

Chapter 1 lays the groundwork for my identity as an educator: one who values connection, relevance, and growth, and utilizes reflection to foster these values. I strive to create a learning environment where students feel safe and are free to tackle challenges, discover meaning, and recognize themselves as capable learners. Like a flourishing forest that fosters balance and diversity, learning will thrive in spaces cultivated to allow students to reach their full potential.

Chapter 2 - Literature Review

This chapter synthesizes the literature informing the theoretical and instructional foundations of the pedagogy for this action research project. The purpose of this study is to analyze how task design, discourse facilitation, and constructivist-informed pedagogical practices affect students' conceptual understanding of equivalent expressions in a 7th-grade mathematics classroom. Given the demand for rigorous reasoning about operational structures and symbolic meaning, the focus is on observing how instructional decisions cultivate students' mathematical thinking.

The scholarly research reviewed in this chapter integrates a diverse array of interconnected threads, providing a multifaceted foundation for examining the learning process. Constructivist and sociocultural perspectives offer a framework for understanding how students build mathematical reasoning by talking through ideas, explaining their thinking, and reflecting on why strategies work. Research on both task and cognitive demand investigates how the interaction between the structure and implementation of mathematical tasks affects students' reasoning and depth of understanding. Research on classroom discourse and teacher practices examines how students explain procedures, justify their reasoning, and discuss strategies in ways that support conceptual development. Finally, sociopolitical perspectives on mathematical education highlight the significance of identity, access, and equitable support in shaping students' experiences with mathematics.

Ultimately, this bibliography of scholarship reinforces the foundation of this research: students develop stronger conceptual understanding when tasks require careful thinking, when discussion is structured around mathematical reasoning, and when instruction is intentionally planned around clear learning goals. The following annotated bibliography synthesizes the key research that informs the design and analysis of this project.

Annotated Bibliography

Boaler, J. (1998). Open and Closed Mathematics: Student Experiences and Understandings. *Journal for Research in Mathematics Education*, *29*(1), 41–62. https://doi.org/10.2307/749717

The author contrasts two distinct classroom approaches to teaching mathematics to examine how they influence students' mathematical thinking. One school is the traditional, textbook-oriented Amber Hill, and the other, Phoenix Park, is an open, project-based school. Utilizing ethnographic case studies, Boaler tracked students from both schools for three years, observing 80-100 lessons at each school, interviewing teachers and students, and examining assessments to understand their learning development. The study focused on how students chose strategies, interpreted context, and applied mathematical concepts to realistic situations to solve mathematical tasks. The article leans on the idea of situated learning, which holds that people learn mathematics in different ways depending on context. Boaler draws on critiques of rule-based teaching, demonstrating how a focus on procedure may hinder students' understanding of mathematical applications. Boaler concluded that the traditional approach of Amber Hill produced diligent students; however, they relied heavily on memorizing rules and cues instead of thinking critically about math, whereas Phoenix Park students developed stronger abilities in approaching unfamiliar problems, explaining their reasoning, and adapting to new situations more easily, regardless of working in noisy, unstructured environments. These findings demonstrate that project-based learning improved assessment performance and increased confidence in applying math outside the school setting.

This article provides valuable insights into how different teaching methods influence students' learning and understanding of mathematics. Its main strengths are its comprehensive research design, attention to real-world mathematical applications, and use of student interviews to show how students experienced the instruction. However, because the study examines only two schools and does not account for external variables such as teacher quality or broader contextual influences, the findings should be interpreted with caution when applied to other educational settings. Boaler also noted that the highly open structure at Phoenix Park did not work equally well for all students. Although many students developed stronger conceptual understanding and problem-solving abilities, some students preferred textbook-based instruction and struggled with the independence required by open-ended tasks. Boaler observed lower levels of visible on-task behavior at Phoenix Park than at Amber Hill, suggesting that open-ended approaches may require additional structures and accountability measures to support consistent participation for all learners. In conclusion, this article prompts me to consider how to strike an appropriate balance by implementing open-ended tasks that encourage reasoning while still providing adequate structure and routine to support all students.

Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational Psychologist*, *31*(3), 175–190. https://doi.org/10.1207/s15326985ep3103&4_3

Cobb and Yackel examine and advance an interpretive framework that integrates constructivist, emergent, and sociocultural perspectives to study learning and teaching in mathematics classrooms. Cobb and Yackel argued that constructivism focuses on individual cognitive processes, whereas sociocultural theories emphasize social interaction and cultural tools as crucial for learning. They suggest that emergent perspectives link these views by examining collaboratively developed classroom norms, individual reasoning, and social interactions within instructional sequences. By leaning into empirical classroom-based work, these researchers demonstrate how shared classroom norms, teachers' expectations, and students' explanations develop in ways that influence purpose in mathematics. They explain that research and teaching benefit from affirming both the collective and individual aspects of learning, particularly in mathematical understanding. This article from Cobb and Yackel adds meaningful clarity to ongoing discussions regarding the relationship between social interaction and individual cognition in mathematical education.

The emergent perspective can guide educators in understanding why classroom norms (e.g., participation, explanation, and justification) are essential to the development of mathematical reasoning. The authors reinforce their argument by using detailed classroom examples to demonstrate how teacher expectations and students' interactions co-evolve over time. It is a dense, theoretical article that may limit access for practitioners seeking expedient strategies. However, Cobb and Yackel offer a foundational conceptual framework that has considerably influenced research on mathematical instruction. This article is effective for my professional development as a mathematics instructor, as it reinforces my commitment to balancing individual understanding with collaborative classroom structures that foster communal meaning.

The emergent perspectives guide me to understand that students working together to compare strategies, explain reasoning, and solve mathematical tasks collaboratively should not be assumed but intentionally cultivated. This vision is inspirational for how I design discussion and collaborative problem-solving in mathematics. This article urges me to examine how I can create lessons that respect students' individuality while also fostering a unified understanding of mathematical concepts.

Godino, J. D., Batanero, C., & Font, V. (2007). The Onto-semiotic Approach to Research in Mathematics Education. *ZDM*, *39*(1–2), 127–135. https://doi.org/10.1007/s11858-006-0004-1

The authors discuss a theoretical model, the Onto-Semiotic Approach (OSA), in this article. It is designed to help researchers understand what makes people learn and apply mathematics. The authors elaborate on why mathematics teaching must adopt a framework that links ideas across fields such as philosophy, psychology, and semiotics. The authors developed their model by drawing on prior research and outlining three stages: beginning with ideas about personal and institutional meaning, then introducing concepts from ontology and semiotics, and finally proposing tools for analyzing teaching and learning in the classroom. Cobb and Yackel organize these ideas into components, including classroom context, instructional processes, mathematical objects, and practices, to guide researchers' further study of mathematical activity. Cobb and Yackel established their framework in OSA, which conceptualizes mathematics as a system of objects, practices, and relationships and explains how participants cultivate mathematical meaning through activity, communication, and interpretation. OSA also describes various types of mathematical objects, such as arguments, concepts, procedures, and symbols, and resolves how these objects relate through semiotic functions; that is, the connections between signs and meaning. The authors surmise that mathematical education requires a unified, interdisciplinary framework to understand how mathematical processing evolves in both individuals and institutions. They emphasize that OSA provides tools for monitoring classroom activity, understanding why students struggle, and contrasting various instructional methods. They also suggest “didactical suitability” as a way to measure the quality of a teaching process by examining cognitive, ecological, emotional, and interactive appropriateness. In conclusion, they recommend that advancements in mathematical education move away from a narrow theoretical perspective toward a more integrated, global perspective.

This article is influential in shaping how I think about students finding meaning in mathematics, specifically the idea that mathematical concepts are not merely things to memorize but objects that foster deeper meaning through classroom engagement. I resonate with the authors' ability to connect various perspectives into a single framework. The strength of this article lies in its presentation of a robust, interdisciplinary framework for research in mathematical education. Additionally, the authors successfully integrate diverse theoretical paradigms while emphasizing the relationship between meaning, practice, and mathematical objects. However, the framework is primarily theoretical and lacks robust classroom-based applications or examples, limiting its accessibility to practitioners. This gap underscores the significance of action-based classroom research, such as the present study, that seeks to translate conceptual frameworks into active instructional practice and to analyze their influence in real secondary mathematical classrooms.

Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education, 44*(1), 37–68. https://doi.org/10.5951/jresematheduc.44.1.0037

The author argues that mathematics education extends beyond the transmission of content, as power, identity, and society actively structure classroom experiences. Gutiérrez emphasizes that teachers and researchers need to consider how access, culture, language, and racism influence who succeeds in mathematics. She calls it the "sociopolitical turn," meaning that mathematical education is connected to justice and is not politically neutral. The article surveys various critical theories to explain better how social structures and classroom dynamics affect student identity and opportunity. Rather than gathering her own data, Gutiérrez's article is a meta-analysis that examines several research studies, theories, and ideas, bringing together concepts from critical theory, critical race theory (CRT), post-structuralism, and LatCrit to illustrate their connections to mathematical education. The article is rooted in sociopolitical theories that connect identity, knowledge, and power, and describes how social forces shape mathematical learning. She also contests the notion that mathematical success is universally neutral. Gutiérrez claims that traditional approaches to equity are overly focused on achievement gaps, therefore neglecting the systemic issues like racism, deficit thinking, and shallow ideas of there being "good math students." She encourages teachers to recognize that their classrooms foster students' identities and concludes that the field needs to embrace sociopolitical perspectives to address inequity and support marginalized students. Neglecting this shift will only keep math education reproducing social injustices.

This article reframes mathematical education as a sociopolitical space, demonstrating how power, identity, and access significantly impact who feels a sense of belonging and authority within mathematical learning environments. Gutiérrez argues that teachers should intentionally examine whose voices are represented in mathematics classrooms, challenge deficit perspectives about students' abilities, and create learning opportunities that value students' cultural knowledge and lived experiences. Since the article is primarily a theoretical synthesis rather than an empirical classroom study, it offers deep conceptual guidance but few practical instructional models. This framing underscores the importance of classroom-based research that examines how teachers implement the sociopolitical framework in specific instructional settings.

Hiebert, J., & Grouws, D. A. (2007). The Effects of Classroom Mathematics Teaching on Students' Learning. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (2nd ed., pp. 371–404). Information Age Publishing.

This article examines how mathematics instruction influences student learning, particularly the distinction between procedural fluency and teaching conceptual understanding. Hiebert and Grouws synthesize research demonstrating that classroom practices shape the types of learning students develop. Instruction that emphasizes reasoning, conceptual connections, and productive struggle supports conceptual understanding, while instruction that emphasizes modeling, feedback, and practice supports procedural fluency. Drawing on studies such as Fuson & Briars (1990) and Hiebert & Wearne (1993), the authors argue that effective teaching aligns with instructional methods with clearly defined goals. They characterize teaching as "classroom interactions among teachers and students around content directed toward facilitating students' achievement of learning goals" (p. 372) and emphasize the need for a stronger research base to support instructional decision-making.

The article is essential for my development as a math teacher because it emphasizes that the structure of lesson planning directly correlates with the learning style students can achieve. The significant strengths of this article lie in its concise descriptions of the differences between conceptual and procedural teaching and in the evidence it draws on from various impactful studies. While the article offers a well-supported synthesis of research on conceptual and procedural teaching, the focus is primarily on instructional characteristics rather than on the broader sociopolitical factors that may also foster student learning.

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), 524–549. https://doi.org/10.2307/749690

These authors analyze how various classroom factors can benefit or hinder students' ability to demonstrate high-level mathematical thinking. The authors observed 144 mathematical tasks across multiple middle school classrooms by sitting in on lessons, taking notes, and documenting classroom events. They also generated accurate classroom "portraits" to illustrate how the tasks unfolded in real time. The authors incorporated a framework detailing how a mathematical task progresses through various stages and how these stages influence cognitive demand. They also relied on research examining how mathematical tasks change in cognitive demand during application, how students process and represent mathematical ideas, and how classroom management and teacher choices can either reinforce productive struggle or reduce tasks to procedural work. The study concluded that sustaining mathematical thinking is challenging since teachers frequently simplify tasks during instruction. They found that students were more likely to engage in high-level mathematical thinking when teachers built on prior knowledge, provided appropriate scaffolding, modeled expectations, allowed sufficient time for exploration, and emphasized explanation and reasoning rather than answer production. They also identified several factors that reduced the cognitive demand of mathematical tasks, including overly directive teacher guidance, the removal of challenging portions of tasks, insufficient support for productive struggle, and allowing students to disengage from meaningful mathematical reasoning. This article influences my teaching because it details precisely how students lose motivation or resort to low-level work, even when tasks are more challenging. The study demonstrates that challenging mathematical tasks require intentional teacher facilitation. Rather than simplifying tasks when students struggle, I need to support students through questioning, discussion, and scaffolding that helps them persist in meaningful mathematical reasoning. It also serves as a reminder to clarify expectations, build on prior understanding, and require explanations rather than quick answers. Some of the strengths of this article are the number of real classroom observations and a detailed breakdown of why tasks transform during the lesson. However, its limitations are that it focuses on a small set of schools and often frames its suggestions at a theoretical level, such as promoting conceptual understanding and productive struggle, without offering detailed examples or step-by-step processes for implementing them in daily lesson planning. Overall, this article will help me design my lessons so that students can process more in-depth information rather than resorting to simplified procedures.

Lampert, M. (1990). When the Problem Is Not the Question and the Solution Is Not the Answer: Mathematical Knowing and Teaching. *American Educational Research Journal*, *27*(1), 29–63. https://doi.org/10.3102/00028312027001029

This work demonstrates how teachers can reform traditional mathematics instruction to reflect authentic mathematical practices. Lampert argues that this shift required altering classroom roles, restructuring discourse, and revising expectations for student reasoning and problem-solving. Rather than passive recipients of procedures, students are positioned as active meaning-makers who construct and refine mathematical understanding through discussion and inquiry. Lampert closely analyzed fifth-grade mathematics lessons to determine how students cultivate mathematical thinking when they are inspired to form opinions, test hypotheses, and publicly revise their reasoning. She draws inspiration from the philosophies of Polya and Lakatos, who highlight the iterative nature of mathematical exploration, including revision, justification, refutation, and conscious guessing. Applying classroom argumentation analysis, Lampert examines transcripts of fifth-grade mathematics lessons to analyze how students engage with, challenge, and clarify mathematical ideas through discourse. She records how the teacher intentionally designs questions, withholds immediate evaluation, and encourages students to justify their reasoning, gradually shifting intellectual authority from the teacher to the students. Lampert discovered that students learn to participate in authentic mathematical practices when they feel inspired to clarify assumptions, explore various strategies, justify their thinking with sound arguments, and use multiple representations. Lampert's study indicates that mathematical learning expands when students experience mathematics as revisable, ambiguous, and conversational rather than as a collection of fixed rules validated by the teacher. In these classrooms, students are encouraged to propose ideas, test conjectures, question one another's reasoning, and revise their thinking based on evidence and discussion. Mathematical authority gradually shifts from the teacher to the classroom community, allowing students to develop a deeper sense of ownership of their learning and reasoning. This article substantially affects my perception of mathematical teaching, as it emphasizes the importance of shifting from an answer-seeking to a reason-centered classroom norm. Lampert's research emphasizes the strengths of discussion, hypothesis testing, and collaborative problem-solving. It supports my goal of creating a classroom in which students explain their reasoning, evaluate multiple solution strategies, and revise their thinking through discussion rather than simply seeking teacher approval. A major strength of the article is its classroom-based examples of intellectual generosity, which encourage students to respectfully consider alternative ideas, learn from mistakes, and build on one another's reasoning. These examples provide a practical model for fostering meaningful mathematical discourse. However, since the article focuses closely on one classroom context, the findings may not fully account for how discourse-based instruction operates across different school settings or within the student bodies of those settings. Yet it offers a strong argument for authentic activities within the math classroom. This article reinforces my belief that students need to be actively engaged in mathematical reasoning rather than passively receiving procedures.

Simon, M. A. (1995). Reconstructing Mathematics Pedagogy from a Constructivist Perspective. *Journal for Research in Mathematics Education*, *26*(2), 114–145. https://doi.org/10.2307/749205

This author argues that constructivism influences how teachers perceive teaching mathematics. Simon argues that students develop mathematical understanding by constructing their own ideas through experience and interaction. To support this process, he proposes the Mathematics Teaching Cycle, a framework that connects learning goals, hypotheses about student thinking, instructional tasks, and ongoing assessment. Through a teaching experiment with prospective elementary teachers, Simon demonstrates that effective instruction requires teachers to continually adapt lessons based on evidence of student thinking rather than relying on fixed plans. He illustrates that teachers cannot plan; rather, they must develop activities that challenge and reform students' thinking. He also acknowledges that the role of a teacher in a constructivist classroom is ambitious and demands a clear understanding of math, students, and instructional planning. This article is highly impactful for my teaching because it emphasizes the importance of understanding how students process information before designing lessons. I appreciate the way Simon described the Mathematical Teaching Cycle as a flexible tool. The article's strength lies in its application of constructivist theory to mathematics pedagogy, making it particularly useful for experienced practitioners. However, the article does not fully address the instructional supports, time constraints, or required professional development needed for effective implementation, which limits the effectiveness of the Mathematical Teaching Cycle across various classroom contexts. Regardless, it inspires me to create lessons that will challenge students while also helping them succeed.

Stein, M. K., Grover, B. W., & Henningsen, M. (1996). Building Student Capacity for Mathematical Thinking and Reasoning: An Analysis of Mathematical Tasks Used in Reform Classrooms. *American Educational Research Journal*, *33*(2), 455–488.

https://doi.org/10.3102/00028312033002455

The authors analyze how mathematical tasks are implemented in reform-oriented classrooms to develop students' conceptual understanding, mathematical reasoning, and problem-solving abilities. The authors analyzed 144 classroom tasks from middle school classrooms in the QUASAR Project, a middle school mathematics reform initiative aimed at increasing students' conceptual understanding and reasoning through higher-level tasks. They observed how teachers incorporated these tasks into instructional materials and how teachers and students used them. The study collected data by taking field notes and video recordings during classroom observations. The researchers examined characteristics of mathematical tasks, including opportunities for multiple solution strategies, representations, and mathematical explanation. They also analyzed factors that influenced whether tasks maintained their cognitive demand during instruction, such as classroom norms, available time, teacher scaffolding, and instructional decisions. The authors conclude that the teachers were successful in choosing and planning high-level mathematical tasks aligned with reform goals to foster students' capacity to meet mathematical cognitive demands. However, many of these high-level tasks lost their cognitive demand during implementation. Tasks that initially required reasoning, exploration, and mathematical connections were sometimes reduced to routine procedures when instruction became overly directive or when opportunities for justification and discussion were removed. Approximately 42% of these high-level tasks were maintained during students' work time. Tasks tended to decrease in routine procedures when teachers were overly supportive, rushed instruction, or when students lacked the proper prior understanding. Still, these high-level tasks remained high when teachers allotted appropriate time, built upon students' prior knowledge, modeled high-level thinking, encouraged justification, and scaffolded without lowering expectations or challenges. This article helps me understand the significance of selecting and implementing mathematical tasks that foster high-level thinking and reasoning in students, emphasizing the need for tasks that encourage multiple modes of problem-solving, multiple representations, and explanations and justifications. It also highlights the challenges of sustaining the cognitive demands during implementation and offers insight into which factors help students think at a higher level. Having this understanding will guide me as I cultivate an instructional environment that advocates for deep mathematical thinking, learning, and problem-solving. The main strength of the article is its concise analysis of mathematical tasks and their implementation in reform-oriented classrooms, offering clear examples of what benefits or hinders student thinking. However, the researchers' findings are limited in generalizability, as the article focused only on classrooms that participated in the QUASAR project, targeting middle schools in economically disadvantaged communities, and the study could have benefited from extending it to high school classrooms as well. Future research should examine how novice teachers can learn to increase cognitive demand, a significant challenge in mathematics instruction.

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2008). Orchestrating Productive Mathematical Discussions: Five Practices for Helping Teachers Move Beyond Show and Tell. *Mathematical Thinking and Learning*, *10*(4), 313–340. https://doi.org/10.1080/10986060802229675

This article analyzes how teachers can facilitate more meaningful whole-class mathematical discourse by implementing the “Five Practices” framework to support student discussion, comparison of solution strategies, and deepening of conceptual understanding beyond procedural answer-sharing. The researchers identify consistent challenges that teachers face in inquiry-based lessons, especially in characterizing diverse students' strategies and guiding discussions toward significant mathematical concepts. The authors demonstrate these struggles through a clarified vignette (the Leaves and Caterpillars example) and offer detailed explanations of each practice, backed by classroom observations and existing research, to illustrate how teachers can perform each practice (anticipating, connecting, monitoring, selecting, and sequencing). The study's findings and logic are rooted in the theoretical framework of productive disciplinary engagement (Engle & Conant, 2002), highlighting the harmony between students' authority to contribute ideas and their accountability to the norms and practices of mathematical reasoning. The study also connects cognitively demanding tasks with classroom discussion by showing how teachers can help students make sense of challenging mathematical ideas while emphasizing why the Five Practices are essential and how they extend the mathematical coherence of class discourse. The study concludes that the Five Practices offer teachers, particularly newcomers, a feasible and decisive way to engage in meaningful mathematical discourse, support students’ mathematical thinking, and help them connect procedures to larger mathematical ideas. They argue that taking this approach reinforces teacher efficacy, advances coherent classroom discussions, and avoids the drawbacks of unstructured discovery or mere teacher-directed instruction. Ultimately, they say that widespread endorsement of these practices can gradually and sustainably advance mathematics instruction for all grade levels.

This article impacts me as a developing mathematics teacher since it provides a clear, engaging framework for cultivating deeper mathematical discourse, which is essential to my teaching both middle and high school students. The power of this article lies in its precise classroom vignette, which provides a solid classification of each practice and is grounded in theory that links teacher procedures and student development. One drawback is that the required pedagogical practice could be overwhelming without mentorship or collaborative planning. Future research could explore exactly how these practices function at the secondary mathematics level, particularly given that the authors derive their prominent examples from elementary and middle school contexts.

Walshaw, M., & Anthony, G. (2008). The Teacher's Role in Classroom Discourse: A Review of Recent Research into Mathematics Classrooms. *Review of Educational Research*, *78*(3), 516–551. https://doi.org/10.3102/0034654308320292

This article analyzes how teachers support productive mathematical discourse in classrooms, centered on discussion, explanation, and mathematical argumentation, to help students make sense of ideas. Walshaw and Anthony surveyed research from various mathematics classrooms to pinpoint what practices most benefit students' mathematical engagement and processing. Using several classroom studies, these researchers illustrate how teachers cultivate classroom norms, lead discourse, listen to students' processing, and support their students through explanations, justifications, and analyses of mathematical concepts. They focus on research that examines diverse learners, language development, and classrooms with varying expectations for engagement. The authors examined this data utilizing the structures of classroom discourse framed around four primary themes: participation rights and responsibilities, supporting and differentiating student thinking, using mathematical language to refine ideas, and promoting mathematical argumentation. The structure helped the authors compare how various teaching methods influence students' reasoning abilities and identity development in math. Ultimately, the authors concluded that effective mathematics teaching requires more than encouraging students to talk about math; teachers must also guide discussions to ensure that mathematical concepts are accurate, precise, meaningful, and relatable. They emphasize that teachers who scaffold instruction, encourage students to justify their reasoning, and actively listen to student thinking create more equitable learning environments. Still, they highlight that classroom discussion may inadvertently exclude some students, particularly language learners or those from marginalized groups, unless teachers intentionally avoid this by carefully planning for equitable participation through strategies such as sentence frames, structured turn-taking, small-group discussion protocols, and purposeful questioning. This article is essential to my development as an aspiring mathematics teacher because it reinforces the idea that teachers must intentionally integrate mathematical discussion into the classroom. One of the article's strengths is its precise organization of collaborative practices, and the several classroom examples it provides of how teachers' moves develop students' processing. While the article provides a strong synthesis of discourse-based mathematics instruction, many of the classroom examples come from elementary settings, leaving fewer illustrations of how these practices operate in secondary mathematics classrooms. In conclusion, researchers need to examine how teachers can frame classroom discourse to accommodate broader variations in mathematical understanding and confidence.

Watson, A., & Ohtani, M. (2015). Themes and Issues in Mathematics Education Concerning Task Design: Editorial Introduction. In M. Ohtani & A. Watson (Eds.), *Task Design In Mathematics Education* (pp. 3–15). Springer International Publishing. https://doi.org/10.1007/978-3-319-09629-2_1

This article examines major themes and issues regarding the design of mathematical tasks for the classroom. It focuses on why task design is essential for student learning, classroom culture, and teaching practices. The authors illustrate how tasks affect what students believe mathematics to be and how they participate in it. Another area it examines is research on task design, including student perspectives, teacher choice, curricular design, and math tools. This article serves as a synthesis of international research presented at an ICMI study conference. Watson and Ohtani surveyed the current literature, examined the contributions of various research groups, and organized themes into categories such as classroom practice, cultural influences, and cognitive perspectives. They also provided examples from the QUASAR, Freudenthal Institute, and Lesson Study research communities to demonstrate why researchers study task design across contexts. The authors utilize multiple theoretical perspectives to explain how mathematical tasks influence mathematical thinking, intermediate theories that relate tasks to classroom cooperation and teachers' choices, and domain-specific theories that aid in the creation of specific mathematical concepts. The authors review ideas such as variation theory, instrumental genesis, design science, and didactic situations to demonstrate the wide range of perspectives incorporated by task design research. Their findings were that effective task design must take into account mathematics and the learners. They highlight that tasks affect students' perceptions of mathematical exercises by either helping or hindering their ability to think deeply. Their emphasis is on teachers examining how they present tasks, how their students perceive them, and how tools can foster learning. They state that research needs to produce clear task descriptions so others can understand what researchers actually applied in those studies. Lastly, they identify significant future needs, such as acknowledging learner perspectives, understanding how task features influence activity, and how task design can uplift equity.

This article is crucial for my development as a math teacher, as it emphasizes what to consider when designing tasks that foster students' growth and reminds me that even the little details of tasks, such as their description, layout, and representations, can influence how students take hold of the information. The authors clarify precisely why teachers need to balance practicality and theory to meet classroom needs. The article's primary strength is its clear organization of complex research into easy-to-understand themes. Yet, because it provides a comprehensive introduction, it does not offer enough specific examples that teachers can apply immediately. Regardless, it still encourages me to consider how I will approach choosing or designing tasks that allow students to discover and reason in meaningful ways.

Chapter 3 - Methodology

Introduction

Sagor (2000) defined action research as "a disciplined process of inquiry conducted by and for those taking the action," with the primary intention of the "actor" to improve and refine their actionable teaching practice (p. 3). Action research deviated from general methods by grounding the investigation in the study's context, positioning the actor at the intersection of inquiry and application, serving as both the investigator and the beneficiary of the results. The purpose was improvement, not abstraction, by helping me refine instructional practices within my own seventh-grade classroom.

Sagor (2000) articulated a recursive process of seven comprehensive phases: (1) selecting a focus, (2) clarifying theories, (3) identifying research questions, (4) collecting data, (5) analyzing data, (6) reporting results, and (7) taking informed action (pp. 3-4). A key aspect of this methodology is critical reflection on pedagogical decisions, paired with the intentional integration of various data streams to strengthen the credibility of the findings (p. 5). Rather than using complex statistical procedures, the data was analyzed by identifying patterns and trends to answer two primary questions: What story did the data tell, and why did it unfold that way? (p. 6).

My action research adhered to Sagor's frameworks by prioritizing student engagement and meaning development within a specific mathematical unit. This research was guided by Constructivism, Sociocultural Theory, and Culturally Responsive Teaching, which ultimately informed the design of a meaning-centered mathematical task and classroom discourse intrinsically linked to this research question: ***What impact did the incorporation of real-world, meaning-centered mathematical tasks have on student engagement and meaning-making***

during a five-lesson unit? In this study, real-world tasks included activities related to local agriculture, community contexts, and collaborative problem-solving situations designed to help students connect mathematical concepts to meaningful experiences.

Wu's (2023) self-study model informed my coding procedures and reflective analysis. The model emphasized connecting classroom practice to broader theoretical commitments and supported systematic examination of student work, observations, and reflections. These procedures helped ground the interpretation of the data within the study's theoretical framework.

Action research was the most effective methodology for this study, as the objective shifted from validating universal interventions to focusing on strategic pedagogical revisions in a particular classroom environment. The function, then, was to examine how intentionally designed tasks influenced student engagement and mathematical meaning-making. By systematically gathering and analyzing classroom evidence, this study aimed to weave together theory and practice to support ongoing instructional growth.

Participants and Setting

This study was conducted at Cheldelin Middle School, a public middle school located in a mid-sized city in Western Oregon's Willamette Valley. The school's diverse socioeconomic and cultural profile required intentional instructional design to make sure all students had equitable access to resources and materials. The school provided free lunch for every student, and the student body included students from diverse racial, linguistic, and socioeconomic backgrounds. To uphold ethical standards and protect confidentiality, all identifying names of the school and the students were replaced with pseudonyms.

The focal classroom for this research comprised 22 students in a 7th-grade mathematics course, aged 12 to 13. The racial and ethnic composition of this particular class was approximately 18 White students and four Latinx students. Furthermore, three students of the class were identified as Talented and Gifted (TAG), two were English language learners (ELLs), and four required specific support through IEPs or 504 plans. The class comprised individuals with diverse gender identities and family backgrounds. The classroom's compositional profile was relevant because culturally responsive, meaning-focused task design had to account for students' lived experiences and identities.

Academically, the students demonstrated diverse levels of instructional readiness. Based on formative assessments and prior unit experience, approximately 79% of students performed at or above 7th-grade expectations; while 21% of students required additional support, such as scaffolding, to participate fully in the grade-level task. Students brought diverse experiences and perspectives that emerged through classroom discussions, collaborative activities, and examples shared during instruction. Their collective lived experiences demonstrated the local economic landscape, particularly in the agricultural and service industries, providing a valuable context for applying abstract mathematical concepts to community scenarios. By grounding the five-lesson unit in local assets such as agriculture, community decision-making, and collaborative problem-solving situations familiar to the students, the instructional choices enabled authentic meaning-making through intentional math tasks. They effectively closed the gap between community-based knowledge and classroom discourse.

During the investigative period, I worked alongside this group of students for approximately 6 months, which allowed me to gain an understanding of classroom norms, patterns of student engagement, and their individual strengths and challenges. My primary assets gained in working with these students included growing relational trust, designing visually structured tasks, and facilitating collaborative discourse. Areas for continued development include more effectively differentiating instruction for students with significant mathematical anxiety and ensuring equitable participation in whole-class discourse.

The classroom context was structured around collaborative learning, with desks arranged in small groups to encourage peer interaction. Instruction followed a constructivist orientation, emphasizing students' reasoning, multiple representations, and discussion-based exploration of mathematical concepts. The five-lesson unit utilized during this study was intentionally designed to incorporate real-world, meaningful tasks aligned with this instructional approach. Students engaged in activities that required them to explain reasoning, compare solution strategies, participate in collaborative problem-solving, and justify mathematical conclusions through discussion and written reflection. Rather than emphasizing procedural completion alone, the lessons were designed to help students construct meaning through mathematical discourse, peer interaction, and conceptual exploration.

Data Collection & Analysis

Adhering to Sagor's (2000) framework regarding the cyclical nature of classroom-based research in authentic instructional contexts, this study utilized a range of naturally occurring data sources across a five-lesson instructional unit. The data sources included the unit plan and lesson plans, observation notes, exit tickets, teaching reflection journals, assessments, and feedback from the Clinical Teacher (CT) and University Supervisor (US). The lesson plans documented the intentional design and implementation of real-world, meaningful contexts for mathematical tasks. Observation notes captured patterns in how students participated in classroom discussion, worked collaboratively on mathematical tasks, and explained their reasoning while interacting with peers. These notes included informal checks for understanding and exit-ticket responses collected at the end of instruction. Reflection journals recorded the instructional decisions, adjustments made during the unit, and perceived student responses. Assessments also provided further evidence of conceptual understanding and reasoning. Collectively, these sources provided valuable insights into both instructional design and student learning.

The data analysis utilized traditional qualitative procedures congruent with Sagor (2000). I organized artifacts chronologically by lesson and grouped them by data type, and then reviewed them repeatedly to identify patterns related to engagement, participation, and meaning-making. Rather than relying on statistical analyses, I focused on identifying recurring trends and asking what story the data suggested and why.

Following Wu's (2023) self-study model, I used open coding to understand the data. I coded observation notes, exit tickets, assessments, and reflection journals line by line, assigning descriptive labels to data segments reflecting student discourse, conceptual reasoning, procedural completion, participation patterns, and task engagement. The related codes were grouped into broader themes that captured patterns in student engagement, conceptual understanding, procedural fluency, and academic language. These themes are examined in detail in Chapter 4.

I triangulated my findings across the 5-lesson unit, observation notes, exit tickets, reflections, assessments, and external feedback. In line with Sagor (2000), I revisited the theoretical framework from Chapters 1 and 2 to ensure that the emerging themes were consistent with my constructivist and culturally responsive commitments. As patterns emerged across various sources, confidence in the findings increased.

Ultimately, I shared my emerging themes with my CT and US. Their feedback helped refine the theme language and clarify the variations with engagement patterns, participation behaviors, and conceptual understanding, thereby strengthening the credibility of the analysis.

Researcher Positionality

As an evolving mathematics teacher, I engaged in this study, relying heavily on constructivist and culturally responsive approaches to teaching. Specifically, I valued student discussion, collaborative learning, the design of meaningful tasks, and opportunities for students to explain their reasoning. I believe that learning mathematics is not merely an acquisition of procedural knowledge, but a process of gaining meaning through discourse, collaboration, task design, identity, and access. This belief directly informed my research question, which examined how real-world, meaningful tasks affected student engagement and meaning-making.

As a White male teacher working with students with varied academic, social, and cultural needs, I reflected on how my identity and assumptions shaped my understanding of student engagement and instructional decision-making. This positionality required me to avoid interpreting quietness, hesitation, or incomplete written explanations as indicators of ability or interest. Instead, I viewed these patterns as data about how instructional structures, supports, and classroom expectations influenced participation. I recognized that students experienced mathematics differently based on their prior experiences, cultural backgrounds, language practices, and sense of belonging. This awareness guided my attention to patterns of participation, equity of voice, and the ways students interacted with tasks.

I entered this research as both an investigator and a teacher, dual roles that provided insight into instructional choices but could also introduce potential bias. Since I generated and implemented the unit, I view the engagement positively and plan to cultivate instructional intentions. To mitigate bias, I relied on a range of data sources and intentionally sought feedback from both my Clinical Teacher and University Supervisor. Their insights helped me distinguish between surface engagement and deep conceptual understanding.

Finally, my commitment to constructivist and culturally responsive theories informed my definition of “engagement” and “success.” Engagement was not merely compliance or being on task, but was active participation in mathematical discourse and reasoning. Understanding this perspective enabled me to interpret the findings transparently and to be attentive to how my values might have influenced the analysis. By acknowledging these positional factors, I align with the data's interpretation, both reflectively and conceptually.

Chapter 4 - Data Analysis

Introduction

This chapter presents the analysis of data collected during the five-lesson instructional unit on generating and analyzing equivalent expressions. Data sources included lesson plans, student work (such as clicker quiz responses, paper-based assessments, and exit tickets), and observation notes and journal reflections. Data were analyzed using the coding and triangulation procedures described in Chapter 3. Analysis of these data sources revealed several recurring patterns related to conceptual understanding, engagement, and mathematical communication. The findings presented in this chapter address the study's guiding research questions concerning these patterns during meaning-centered mathematics instruction.

Analysis of the collected data revealed several reliable patterns in students' learning. The findings are organized into three primary themes: (1) students demonstrated procedural fluency more consistently than conceptual understanding; (2) pupil engagement increased during structured and collaborative activities; and (3) students demonstrated varying abilities to use academic language in explaining their reasoning (see Table 1).

Table 1

Theme Summaries

Theme	Primary Data Sources	Key Findings
Procedural Fluency vs. Conceptual Understanding	Clicker quizzes, paper assessments, and reflections	Students demonstrated procedural success more consistently than conceptual explanation
Structured Collaboration and Engagement	Observation Notes, reflection journals	Students participated more actively during collaborative meaning-centered tasks
Academic Language and Mathematical Explanation	Paper assessments, observation notes	Students often struggled to fully explain reasoning using mathematical language

Note. Summary of the major themes that emerged across the analyzed data sources, guiding the organization of findings in this chapter.

Initial open coding of observation notes, assessments, and reflection journals generated recurring instructional and behavioral patterns. These patterns were organized into broader themes that guided the analysis presented throughout this chapter. Table 2 illustrates how initial codes were grouped into the broader themes that emerged during data analysis.

Table 2

Coding to Theme Development

Initial Codes	**Emerging Theme**
Procedural accuracy	Procedural Fluency vs Conceptual Understanding
Limited written explanation	Academic Language Development
Increased peer discussion	Structured Collaboration and Engagement
Uneven participation	Participation and Accountability
Collaborative reasoning	Increased Engagement Through Structured and Team-Based Activities
Difficulty explaining thinking	Academic Language and Mathematical Explanation

Note. Several initial codes overlapped and, for this chapter, were ultimately grouped into three broader analytical themes through qualitative coding procedures described in Chapter 3.

Strong Procedural Fluency but Inconsistent Conceptual Understanding

One of the most consistent findings across all data sources was the distinction between students' proficiency with mathematical procedures and their ability to demonstrate conceptual understanding. As the study progressed, this finding prompted me to reflect on whether my instruction was providing sufficient opportunities for students to explain, justify, and discuss their mathematical reasoning rather than simply produce correct answers. This distinction was particularly important since the instructional unit was designed around meaning-centered mathematical tasks intended to promote explanation, justification, and conceptual reasoning rather than procedural completion alone. Evidence from both clicker quiz data and written assessments indicated that approximately 78-82% of students correctly applied procedural skills, such as using the distributive property and combining like terms. The trend was observed consistently across multiple lessons and assessment formats. Table 3 summarizes the approximate difference between students' procedural accuracy and their ability to provide conceptual explanations across the analyzed assessment.

Table 3

Comparison of Procedural Accuracy and Conceptual Explanation

Skill Demonstrated	Approximate Percentage of Students
Correct procedural completion	78–82%
Clear conceptual explanation	~50-60%

Note. Percentages represent approximate patterns observed across clicker quizzes, written assessments, and reflection tasks analyzed during the study.

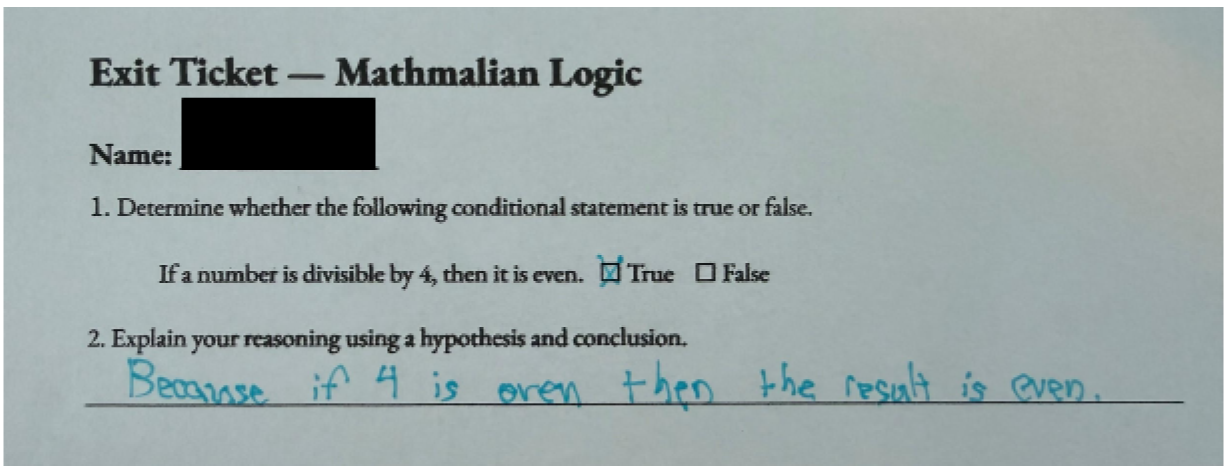
These results influenced my instructional decision-making throughout the study. While the clicker quiz results indicated that students were mastering procedures, the written assessments revealed conceptual gaps not immediately apparent in multiple-choice responses alone. I increased the use of modeling and real-time feedback during classroom discussions, prompting students to elaborate on their reasoning and connect procedural steps to underlying mathematical concepts. Figure 1 provides an example of a student response that demonstrates procedural accuracy while revealing limited conceptual explanation.

Several students demonstrated accuracy on digital assessments, but either did not show their work or provided minimal written explanations. My reflection journal notes further supported this pattern. In multiple entries, I observed that students were frequently able to complete procedures correctly, but struggled to explain why those procedures worked when prompted during discussion. In response to this pattern, I adjusted subsequent lessons to include more structured mathematical discourse and opportunities for students to explain their thinking.

Rather than accepting procedural completion as sufficient evidence of understanding, I increasingly asked students to defend their reasoning, compare solution strategies, and discuss why mathematical procedures worked. These instructional adjustments aligned with the unit's meaning-centered focus by shifting attention from answer production to explanation, justification, and conceptual reasoning.

Figure 1

Student Exit Ticket Demonstrating Procedural Understanding Without Conceptual Explanation



Exit Ticket — Mathmalian Logic

Name: [redacted]

1. Determine whether the following conditional statement is true or false.

If a number is divisible by 4, then it is even. ☒ True ☐ False

2. Explain your reasoning using a hypothesis and conclusion.

Because if 4 is even then the result is even.

Note. The student's name has been redacted to protect confidentiality. The student correctly identified the conditional statement as true, but provided an incomplete explanation that did not demonstrate conceptual understanding of the mathematical relationship.

Triangulating evidence from clicker quiz data, written work, reflection journals, and teacher observations strengthens this finding and challenged my assumptions about what constitutes mathematical understanding. Before this study, I often viewed procedural completion as a strong indicator of mastery, yet the data indicate that correct answers alone did not necessarily reflect conceptual understanding. This realization led me to place a stronger emphasis on questioning strategies, collaborative reasoning tasks, and written explanations throughout the instructional sequence. These included partner discussion prompts, sentence frames, requests for students to justify reasoning, and opportunities to compare multiple solution strategies during class discussion.

Procedural Fluency in Digital Assessments

Clicker quiz data provided one of the clearest indicators of students' procedural fluency throughout the instructional unit. Across multiple lessons, most students accurately applied skills such as the distributive property, combining like terms, and identifying equivalent expressions. Observation notes further documented instances in which students arrived at correct answers, but struggled to explain the reasoning behind their solutions, reinforcing the distinction between procedural fluency and conceptual understanding.

At the same time, the clicker quiz primarily measured procedural accuracy because it is designed as a multiple-choice assessment. While useful for identifying patterns in student performance, they provided limited evidence of students' conceptual reasoning without additional discussion, written explanation, or follow-up questioning. While students frequently selected correct answers, the digital assessments did not consistently require students to explain why expressions were equivalent or justify the reasoning behind procedural choices. As a result, methodological accuracy occasionally masked conceptual uncertainty that later became visible through written explanations and classroom discussion.

Participation patterns in the clicker quizzes also revealed inconsistencies that influenced data interpretation. On the day of the primary clicker assessment, only 15 of 22 students participated digitally due to absences, uncharged Chromebooks, or lack of engagement. Several students either relied entirely on paper-based responses or did not complete any portions of the assessment. These participation gaps reinforced the importance of examining student understanding through multiple sources of evidence, as clicker quiz results alone suggested stronger understanding than was demonstrated in written explanations and classroom discussions. While students generally demonstrated success on tasks emphasizing procedural execution and answer recognition, the same level of success did not consistently appear when they were asked to explain or justify their reasoning. This finding led me to incorporate additional discussion prompts, reasoning tasks, and opportunities for students to justify their thinking, aligning instruction more closely with the unit's meaning-centered goals and the constructivist and sociocultural principles that guided the study.

Paper-Based Assessments and Conceptual Reasoning

While clicker quiz data primarily highlighted procedural fluency, the paper-based assessments provided deeper insight concerning students’ relational understanding and mathematical reasoning. These assessments required students not only to simplify expressions correctly, but also to demonstrate procedural steps, explain equivalence, and reflect on areas of misunderstanding or challenge. As a result, the written assessments uncovered patterns that were not always immediately visible through digital response data alone.

One of the clearest findings from the paper-based assessments was the inconsistency between procedural-level accuracy and conceptual explanation. Many students arrived at correct answers but offered little insight into their reasoning. In several cases, explanations were omitted or limited to brief comments, such as noting which problem was “hard,” without further detail.

These patterns prompted me to reflect on how reasoning and explanation were emphasized during instruction. While students were regularly asked to solve problems accurately, the data suggest that I needed to intentionally support students in communicating their mathematical thinking.

Before this study, I often viewed procedural accuracy as a strong indicator of student understanding. However, the written assessments repeatedly revealed that correct answers did not necessarily correspond with conceptual explanation. This challenged my assumptions about assessment and led me to reconsider how frequently students were being asked to explain, justify, and communicate their mathematical thinking.

The contrast between digital and written performance became particularly significant during the analysis of student work samples. Although several students demonstrated high procedural accuracy on digital assessments, they did not show their work or explain their thinking on paper-based tasks, often solving problems mentally and viewing explanations as unnecessary once the answer was obtained. This pattern highlights how mathematical success was frequently equated with speed and the production of answers, rather than with conceptual communication. This finding was significant because the instructional unit's purpose was to promote meaning-centered mathematical reasoning. When students viewed mathematics primarily as answer production, they were less likely to engage in the explanation, justification, and discourse necessary for developing deeper conceptual understanding.

In contrast, other students demonstrated stronger evidence of conceptual reasoning despite occasional procedural mistakes. These students showed more complete written work and a greater willingness to explain procedural thinking step by step. Although calculation errors occasionally occurred in the work, the written explanations revealed partial mathematical justification that would not have been as apparent in multiple-choice assessment formats alone. This distinction became important during data analysis because it suggested that operational accuracy did not always correlate directly with conceptual understanding.

Written reflections and teacher observation notes additionally reinforced this finding. During several lessons, students appeared comfortable identifying procedural steps but became hesitant when prompted to explain why those steps preserved equivalence within expressions. When asked to justify their reasoning verbally or in writing, many students used phrases such as "that's the rule," suggesting they relied on memorized procedures rather than a relational understanding. These responses indicated that students often viewed algebraic manipulation as a sequence of isolated operations rather than as transformations that maintained mathematical balance and equivalence. From a constructivist perspective, this suggested that many students had learned procedural rules without fully constructing meaning around the underlying mathematical relationships.

The paper-based assessments also revealed that students who demonstrated stronger conceptual understanding were often more willing to persist when asked to explain their reasoning. Some students demonstrated effort through showing work and attempting explanations even when uncertain, while others disengaged once procedural difficulty increased. Reflection notes documented several instances in which students repeatedly erased work, stopped mid-problem, or waited for peer confirmation before continuing. These behaviors suggest that tasks requiring conceptual explanation and justification placed a higher cognitive demand on students than procedural exercises alone, particularly when students were uncertain about how to communicate their reasoning.

At the same time, the written assessments created opportunities for students to externalize thinking in ways that digital assessments could not completely capture. Showing procedural steps, annotating work, and responding to reflection prompts allowed students to reveal misconceptions, partial understandings, and emerging conceptual connections. This provided a richer picture of student learning and helped identify areas where students needed additional instructional support. In particular, the written data indicated persistent difficulties with mathematical explanations, the use of academic vocabulary, and the justification of equivalence. These challenges were particularly important because meaning-centered mathematics instruction relies on students' ability to explain, justify, and communicate mathematical relationships rather than simply produce correct answers.

This evidence reinforced one of the central conclusions emerging from Theme 1: procedural fluency alone did not necessarily indicate deeper reasoning. While many students developed greater confidence in applying algebraic procedures throughout the instructional unit, fewer regularly demonstrated the ability to explain why those procedures worked or how equivalent expressions maintained the same mathematical relationships. Ultimately, evidence across multiple data sources suggested that procedural fluency did not necessarily correspond to conceptual understanding. While many students successfully applied procedures, written explanations, and reflections revealed persistent gaps in reasoning, justification, and mathematical communication.

Student Misconceptions and Concealed Patterns

Beyond the measurable differences between procedural fluency and conceptual understanding, the data also revealed multiple fundamental patterns in how students perceived mathematical success in the classroom. Observation notes, written reflections, and classroom exchanges collectively suggested that many students associated mathematical competence primarily with speed, answer production, and procedural completion rather than conceptual explanation or mathematical communication.

Throughout the instructional unit, several students showed visible displeasure or hesitation when prompted to explain their reasoning after arriving at correct answers. Reflection journals and observation notes documented responses such as “that’s just the rule” or “that’s what comes next,” suggesting reliance on memorized procedures rather than conceptual understanding. This pattern became especially noticeable among students who demonstrated strong procedural fluency on digital assessments but resisted showing work or explaining their reasoning in writing.

At the same time, classroom observations showed that participation and confidence did not always align with conceptual understanding. Some students actively participated in discussions and answered procedural questions quickly, but struggled to explain equivalence or a mathematical model, while others produced stronger written reasoning despite less visible participation.

The data also revealed that the assessment structure influenced students' engagement in critical thinking tasks. During the clicker quiz, students focused on speed and answer selection. At the same time, the paper-based assessments slowed the process and required written reasoning, often exposing misconceptions or uncertainty not seen in digital formats.

While the clicker quiz provided efficient formative assessment data and increased participation, the emphasis on rapid answer selection may have unintentionally reinforced students' perceptions that mathematical success is primarily associated with speed and procedure completion. As a reflective practitioner, this finding suggests a need to intentionally balance efficiency-based formative assessment with opportunities for slower, explanation-centered mathematical discourse. These responses prompted me to reconsider how often students were asked to explain the reasoning behind procedures. While my lessons included practice opportunities, the data suggested that conceptual explanation needed to be modeled and reinforced more consistently.

Taken together, these concealed patterns imply that students entered the unit with differing assumptions regarding the purpose of mathematics instruction and assessment. For many, mathematical success appeared to be primarily connected to step-by-step correctness rather than conceptual meaning-making or discourse. This suggests that increasing conceptual understanding may require not only different instructional tasks but also a broader shift in how students define success in mathematics classrooms.

Conclusion

The findings for Theme 1 revealed a persistent gap between procedural fluency and conceptual understanding. While students often demonstrated success with algebraic procedures, the data challenged my assumption that procedural accuracy alone reflected mathematical understanding. This realization led me to place greater emphasis on mathematical explanation, collaborative reasoning, and opportunities for students to justify their thinking. Ultimately, Theme 1 not only highlighted a student learning pattern but also informed changes to my instructional practice throughout the study.

Increased Engagement By Structured and Team-Based Activities

While the previous findings identified a consistent gap in conceptual reasoning, the second theme addresses the specific instructional environment designed to bridge it. Analysis of observation notes and reflection journals showed that student engagement increased when I intentionally structured lessons around collaborative, meaning-centered mathematical tasks. This finding aligns closely with the sociocultural framework guiding the study, which emphasizes learning through discussion, collaboration, and shared meaning-making. To support these goals, I incorporated group-based problem-solving, discussion prompts, and shared reasoning tasks rather than relying primarily on individual procedural practice.

Throughout lessons in which I incorporated meaning-centered problem-solving tasks, observation notes documented increased student discussion, more frequent question asking, and greater participation during mathematical activities. Reflection journal entries further supported this pattern. In one entry, I noted that students remained engaged longer during collaborative tasks and were more likely to ask questions, explain ideas to one another, and remain on task when mathematical reasoning was shared among peers.

This pattern of increased engagement with collaborative meaning-centered tasks was apparent not only in students' digital work but also in their written reflections. Paper-based work provided additional insight into student engagement patterns. Some students demonstrated strong effort by showing their work and providing written explanations, while others either completed only the final answer or did not fully engage with the task. This variation suggests that engagement was influenced not only by the task design but also by the structures I used to support participation. Collaborative group roles, shared expectations for problem-solving, and discussion prompts appeared to encourage greater student involvement during mathematical tasks.

Across all data sources, a clear pattern appeared: student engagement increased when I structured tasks to be collaborative, meaning-centered, and connected to important mathematical goals. However, participation remained inconsistent for some students, indicating a need for more intentional strategies to ensure all students were actively involved in learning.

Collaborative Structures and Student Interaction

Observation notes and journal reflections consistently indicated that collaborative classroom structures positively influenced learner participation and mathematical discussion throughout the instructional unit.

Desk Groups. I arranged desks in collaborative groups of approximately three or four students to encourage peer interaction and mathematical discussion. This structure reflected the sociocultural perspective guiding the study by creating opportunities for students to construct understanding through interaction with peers. Compared to more independent work periods earlier in the unit, students participated in more mathematical discussions and were more likely to seek clarification from peers before asking the teacher for assistance. Observation notes documented that, when seating was changed, students frequently compared solution strategies, asked clarifying questions, and sought support from peers before approaching the teacher. This arrangement appeared to reduce barriers to participation and created more opportunities for students to verbalize their thinking during mathematical tasks.

Paired Problem-Solving Opportunities. I incorporated paired problem-solving activities that required students to explain their reasoning and work toward shared solutions. Reflection journal entries noted that students were more often willing to share ideas with a partner before participating in larger discussions. These structures encouraged mathematical discourse and provided opportunities for students to refine their thinking through conversation.

Whole-Group Discussion Routines. I regularly facilitated whole-group discussions after pair or small-group work, during which students could explain solution strategies, justify answers, and respond to questions from classmates. Observation notes indicated that these discussions often revealed misconceptions that may not have surfaced through independent work alone. These misconceptions became evident in students' verbal explanations, questions posed during discussion, and differences among proposed solution strategies. These routines helped make student thinking visible and provided opportunities for clarification and deeper conceptual understanding.

An increase in peer interaction grew especially noticeable during meaning-centered tasks that required students to compare solution strategies and justify whether different expressions were equivalent. For example, in the Mathmalian Logic lesson, students worked in assigned partnerships to solve problems. They were required to justify why their steps worked using sentence frames such as "I distributed because ___" and "This expression is equivalent because___." During the partner-solve portion of the lesson, students compared strategies, explained their reasoning, and checked one another's work before sharing solutions with the class. In a reflection journal entry, I noted that several students who rarely volunteered during whole-class instruction contributed ideas during partner and small-group discussions. These observations suggested that collaborative structures were most effective when paired with tasks that required mathematical explanation, shared reasoning, and discussion, rather than with isolated procedural completion.

When I implemented collaborative structures in lessons, observation notes indicated that collaboration reduced hesitation among students who had previously demonstrated uncertainty during independent work. In several lessons, students who initially paused, waited for assistance, or expressed uncertainty during independent work, re-engaged after hearing peer explanations and observing classmates model solution strategies. At these times, collaboration functioned not only as a social structure but also as a scaffold that supported students' confidence and mathematical persistence.

At the same time, observation notes suggested that collaboration alone did not guarantee equitable participation among all students. While some lessons included explanation prompts, discussion structures, and shared reasoning expectations, student participation still varied, particularly when accountability measures were not consistently enforced. In several lessons lacking explicit accountability measures, I observed that stronger procedural students completed tasks quickly, and quieter or less confident students took more passive roles in group discussions. In one observation note, I recorded that a single student completed most of the procedural tasks while other group members copied answers or waited for direction before contributing. These observations led me to recognize that collaborative learning structures required intentional accountability measures, such as assigned roles, discussion prompts, and shared responsibility for explanations, to ensure meaningful participation from all students. This finding aligns with the sociocultural framework guiding the study, suggesting that collaboration promotes learning most effectively when instructional structures actively require students to contribute to shared meaning-making.

The effectiveness of collaborative learning appeared closely connected to how I structured tasks and communicated expectations. During lessons that required students to justify their reasoning, compare solution strategies, or explain equivalence to peers, observation notes documented higher levels of mathematical discussion and participation compared with lessons focused primarily on independent procedural practice. For example, in the Mathmalian Logic lesson, students were required to explain their reasoning using sentence frames and defend their conclusions during partner discussion before sharing with the class. Conversely, when activities emphasized procedural completion alone without structured discussion requirements, students were more likely to exchange answers than engage in conceptual discussion. These observations suggested that collaborative learning was most effective when I intentionally designed tasks that required explanation, reasoning, and shared mathematical thinking. Table 4 summarizes the collaborative structures I implemented throughout the instructional unit, the corresponding teacher moves, and their intended instructional outcomes.

Table 4
"Collaborative Structure Implemented During the Instructional Unit"

Structure	Teacher Move	Intended Outcome
Desk Group	Students seated in collaborative groups	Increased peer interaction
Partner Solve	Students explain reasoning to a partner	Increased discourse
Strategy Share	Students compare approaches publicly	Conceptual understanding
Sentence Frames	Structured mathematical language	Improved explanation

Participation, Access, and Accountability

Although collaborative and structured learning activities generally increased pupil engagement, this portion of the study revealed limitations in the instructional structures I used to support participation. This finding aligns with the study's sociocultural framework, while the limitations discussed below highlight the importance of designing equitable participation structures that are consistent with culturally responsive teaching. During the study, I did not always provide alternative participation pathways for absent students, did not have a charged Chromebook, or chose not to participate digitally. As a result, some students had fewer opportunities to engage with instructional activities and assessments.

One instructional challenge emerged during my implementation of the digital clicker quiz. I relied on Chromebook-based participation as a primary source of formative assessment data; however, only 15 of the 22 students participated digitally during the primary assessment. Participation varied across assessment formats, although attendance, Chromebook access, and student engagement also influenced the extent of this variation. These inconsistencies in participation limited the completeness of the digital assessment data. As a result, I relied on paper-based work, observation notes, and reflection responses to develop a more complete understanding of student learning. This experience highlighted the importance of providing multiple pathways for participation and assessment rather than depending primarily on a single digital tool, as participation rates varied across assessment formats throughout the instructional unit (see Table 5).

Table 5
Participation Across Assessment Formats

Assessment Type	**Student Participation**	**Notes**
Clicker Quiz	15/22	Absences and device access affected participation
Paper-Based Assessment	13/22	Completed during class instruction
Exit Ticket	18/22	Some incomplete responses

Note. This illustrates the uneven participation patterns observed across assessment formats. These inconsistencies reflected the realities of classroom-based action research, where attendance, access to technology, and varying levels of participation influenced both instruction and data collection. The low participation rate on the paper-based assessment reflected student absences during the assessment day as well as a couple of incomplete submissions.

Access to technology appeared to be one factor associated with participation patterns throughout the instructional unit, although attendance, preparedness, and student engagement likely also contributed. Students who regularly participated in digital activities often arrived with their Chromebooks charged and functioning, while students experiencing technology barriers sometimes missed opportunities to participate in digital assessments. These inconsistencies occasionally complicated comparisons between digital and written assessment data. As a result, I recognized the importance of designing lessons and assessments that include multiple pathways for participation so that access to technology does not become a barrier to engagement or to evidence of learning.

Observation notes also documented instances in which students with full access to digital materials still demonstrated inconsistent participation during instructional tasks. In some cases, students completed only minimal portions of activities, relied heavily on peers for answers, or avoided written explanation tasks even when process questions were answered correctly. These patterns suggested that access to technology was only one factor influencing engagement and did not guarantee meaningful participation. Within my classroom, students participated more consistently when collaborative tasks included clear expectations, discussion requirements, and shared responsibility for explaining mathematical reasoning.

The data also revealed a distinction between participation and substantive engagement. For this study, participation was defined as visible involvement in classroom activities, such as completing tasks, contributing to group work, or remaining on task. Substantive engagement referred to evidence of mathematical reasoning, explanation, justification, and conceptual discussion. This distinction reflects the constructivist framework guiding the study, which emphasizes active meaning-making and mathematical reasoning rather than simple task completion. Some students appeared behaviorally compliant during collaborative activities but engaged in minimal mathematical discussion or conceptual reasoning. For example, observation notes document several instances in which students completed written work, copied procedural steps from peers, or recorded final answers while contributing little mathematical explanation during group discussions. When asked to explain their reasoning individually, these students often gave brief responses or could not justify why a procedure worked. This finding led me to recognize that participation structures alone were insufficient indicators of learning. To better understand student thinking, I needed instructional routines that required students to explain, justify, and communicate their mathematical reasoning.

In one reflection journal entry, I noted students participated more actively when tasks required them to explain their reasoning using sentence frames, show their work, or contribute verbally during collaborative activities. During these lessons, mathematical discourse was more focused, and students were more likely to justify their thinking. Conversely, when accountability expectations were less explicit, some students disengaged from conceptual discussion and focused primarily on procedural completion or on producing answers.

These data suggest that participation in collaborative mathematics classrooms is shaped by multifaceted interactions among instructional structure, technology availability, accountability expectations, and students' perceptions of mathematical success. While structured group activities often increased visible engagement, maintaining substantive engagement required intentional accountability structures, which encouraged all students to contribute conceptually rather than merely comply procedurally. These findings suggested that meaningful participation depended on intentional instructional structures rather than collaboration alone. Table 6 summarizes the primary accountability and discussion structures implemented during the instructional unit and their observed influence.

Table 6
Instructional Structures Supporting Meaningful Participation

Teacher Move	Purpose	Observed Impact
Desk Groups	Increased peer interaction	More student discussion
Partner Solve	Require explanation of reasoning	Increased participation from quieter students
Sentence Frames	Support mathematical communication	More complete explanations
Strategy Share	Compare solution	Greater conceptual discussion
Accountability Prompts	Require Justification	Less answer-copying

Conclusion

The findings associated with Theme 2 suggest that structured, collaborative learning environments positively influenced student participation, discussion, and willingness to engage with mathematical tasks throughout the instructional unit. Observation notes and assessment data consistently indicated that students were more likely to verbalize thinking, seek clarification, and continue engaged when instruction emphasized accountability, partnership, and collaborative problem-solving. At the same time, the findings also revealed that visible participation did not always correspond directly with meaningful conceptual engagement. Factors such as responsibility frameworks, access to technology, group dynamics, and students' perceptions of mathematical success strongly influenced the quality and consistency of participation during instruction.

The findings directly support the study’s focus on meaning-centered mathematics instruction. Engagement was strongest when students were expected to explain their reasoning, justify mathematical thinking, and participate in collaborative discourse rather than simply complete procedures. The findings suggest that collaboration most effectively supports engagement when paired with intentional structures that promote conceptual accountability and meaningful participation.

Variations in Students’ Use of Academic Language

The third theme that emerged from the data concerned students' use of academic language when responding to instructional opportunities designed to support mathematical explanation and reasoning. Throughout the instructional unit, I incorporated sentence frames, structured discussion prompts, partner explanations, and written justification tasks intended to support mathematical communication. Observation notes and written assessments suggested that only a minority of students demonstrated strong written and verbal explanations using appropriate terminology. At the same time, a larger group continued to provide minimal or incomplete responses. Across multiple data sources, students demonstrated varying levels of confidence and precision when communicating mathematical reasoning.

Paper-based assessments, reflection prompts, classroom discussions, and teacher observations served as the primary data sources for this theme. Examples of the reflection prompts, discussion prompts, and observation criteria used during the instructional unit are summarized in Table 7.

Table 7

Examples of Academic Language Supports and Data Sources

Instructional Support / Data Source	Example
Sentence Frame	"This expression is equivalent because…"
Discussion Prompt	"How do you know these expressions represent the same relationship?"
Reflection Prompt	"Explain why your solution works using mathematical vocabulary."
Teacher Observation Focus	Use of terms such as equivalent expression, distributive property, and combining like terms

Some students provided detailed, accurate justifications, clearly showing both deeper reasoning and the ability to communicate their thinking. One student explained that "the distributive property allows the expression to be written as 3x + 6, showing the two expressions are equivalent." In contrast, other students provided brief responses such as "they are the same answer" or simply identified a problem as difficult without explaining their reasoning. These differences suggested that opportunities to use mathematical vocabulary alone were insufficient to support meaningful academic language development. Future instruction could incorporate additional language supports, such as classroom word banks, anchor charts, and structured vocabulary routines, to help students use mathematical terminology more accurately and consistently. This finding aligns with the constructivist and sociocultural frameworks guiding the study, suggesting that academic language develops most effectively when students repeatedly use mathematical vocabulary in meaningful discussion, explanation, and collaborative reasoning.

This distinction became apparent when comparing digital and written responses. Students who demonstrated strong procedural fluency on the clicker quiz did not always show the same level of understanding in written justifications. While clicker quiz data provided efficient formative information about method accuracy, the format remained limited in its ability to capture the depth of students' mathematical reasoning and communication. The results showed that triangulating across written work, observation notes, and reflection responses was necessary to fully comprehend students' conceptual meaning-making and their use of academic language.

Mathematical Explanation and Conceptual Communication

One of the clearest findings regarding academic language was the gap between students' ability to complete procedural tasks and their ability to explain their mathematical reasoning with appropriate vocabulary. Many students demonstrated familiarity with procedures such as the distributive property and combining like terms, yet struggled to explain why those procedures worked or how equivalent expressions maintained the same mathematical relationships. This pattern became especially visible during written reflections and justification tasks. A small group of students accurately used mathematical vocabulary and connected procedures to conceptual meaning. For example, one student explained that the distributive property maintained equivalence because each term inside the parentheses was multiplied by the same factor. Approximately half of the students provided incomplete explanations, such as "they are equal because they are the same answer," while others omitted explanations altogether. These responses suggested that procedural accuracy often developed more quickly than students' ability to communicate conceptual understanding through academic mathematical language.

Observation notes indicated that some students communicated mathematical ideas more effectively during peer discussion than in written responses. For example, students were often able to explain procedures to classmates verbally using informal language and gestures. Still, they later struggled to express the same reasoning in writing using formal mathematical terminology. This pattern suggests that students' conceptual understanding sometimes exceeded their ability to communicate it in written academic language. This finding aligns with sociocultural perspectives on learning, which suggest that students often develop understanding through conversation and interaction before they can independently communicate ideas using formal academic language.

The data further indicated that academic language development was closely connected to opportunities for discussion, modeling, and repeated explanation. Students who actively participated in collaborative discourse generally demonstrated greater willingness to attempt written explanations and verbal justification during instruction. In contrast, students who participated less frequently in mathematical discussion often produced shorter or less detailed written responses. This finding reinforces the importance of structured mathematical discourse as a support for both conceptual understanding and academic language development.

Written and Verbal Mathematical Communication

A more specific example of this pattern emerged when comparing students' verbal explanations with their formal written responses. Observation notes from the Lesson 5 group solving activity documented students explaining procedures, identifying errors, and assisting peers while working in collaborative groups. During the discussion, students readily explained solution strategies. They corrected one another's thinking, yet some of the same students later provided only brief written justifications when asked to explain their reasoning independently. This pattern suggests that students were often more comfortable communicating mathematical thinking verbally than through formal written explanations.

When I incorporated cooperative teamwork tasks and collaborative problem-solving opportunities, students regularly used conversational language, gestures, and partially formed reasoning to communicate procedural ideas with peers. The interactions frequently demonstrated emerging relational understanding, even when students found it difficult to express the same ideas in writing using formal mathematical vocabulary. For example, students were frequently able to verbally identify when terms could be combined or when the distributive property was needed. Yet, their written explanations often lacked specificity about why those procedures preserved equivalence within expressions.

Reflection prompts and paper-based assessments were intentionally used to require written justification of reasoning, making this difference especially evident. Several students who actively participated in classroom discussions produced incomplete written responses when asked to explain conceptual thinking independently. In some cases, students who verbally demonstrated confidence during collaborative activities left explanation sections blank or provided only minimal written justification. These patterns imply that students' conceptual understanding and verbal participation occasionally exceeded their ability to communicate mathematically through formal written language.

My reflection notes documented that despite opportunities for mathematical discussion, students frequently relied on informal phrasing rather than academic mathematical terminology. While this informal communication still supported engagement and collaborative reasoning, it sometimes limited students' ability to articulate conceptual understanding precisely in written assessment formats. Students often described procedures using phrases such as "move it over," "cancel it out," or "do the opposite" instead of terms such as equivalent expressions, inverse operations, or the distributive property. To support academic language development, I incorporated sentence frames, discussion prompts, and modeling of mathematical vocabulary throughout the unit. These supports encouraged students to connect procedural steps to underlying mathematical concepts. Developing formal mathematical language was important because it allowed students to more clearly justify their reasoning and communicate their conceptual understanding, aligning with the study's meaning-centered goals.

Structured verbal discussion opportunities functioned as an important scaffold for mathematical communication and conceptual development. Observation notes documented several instances in which collaborative conversations helped students clarify procedural reasoning before transitioning to written tasks. Students who participated in peer discussion were often more willing to attempt written explanations afterward, even when those explanations remained incomplete. These observations suggest that regular opportunities for mathematical discourse may support students' confidence and the development of academic mathematical language.

The contrast between written and verbal communication ultimately reinforced the study's broader findings on conceptual comprehension and involvement. While many students demonstrated emerging mathematical reasoning through group discussion, formal written explanation remained a significant area for continued instructional growth. These data suggest that mathematics instruction should intentionally support both verbal discourse and written justification to strengthen students' ability to communicate mathematical reasoning across multiple contexts.

Conclusion

The findings for Theme 3 revealed considerable variation in students' ability to communicate mathematical reasoning using academic language. While some students effectively incorporated mathematical vocabulary and conceptual explanations into their responses, many struggled to move beyond procedural descriptions, particularly in written assessments. Observation notes and student work suggested that collaborative discussions often supported emerging reasoning and encouraged participation, but students frequently struggled to translate informal thinking into precise academic language. These findings support the study's focus on meaning-centered mathematics instruction by highlighting the importance of structured opportunities for explanation, discussion, and mathematical justification. Developing academic mathematical language strengthened students' ability to communicate, justify, and refine their mathematical thinking. Opportunities to explain reasoning using mathematical vocabulary appeared to support conceptual understanding by helping students articulate relationships and make their thinking visible.

Chapter 5 - Discussion, Limitations, and Conclusion

Discussion

Purpose of the Study and Overview of Findings

This action research project evaluated meaning-centered mathematical tasks in a seventh-grade classroom, focusing on both student outcomes and my development as a reflective practitioner. Through the cycles of planning, implementation, observation, and reflection, I examined how instructional choices shaped classroom climate and student learning. The data revealed three consistent findings: a gap in students' procedural fluency and conceptual reasoning; a notable increase in engagement during structured collaborative tasks; and persistent challenges in articulating mathematical thinking using academic language. These insights underscored the influence of instructional decisions on learner involvement and the need for procedural accuracy with conceptual understanding.

The Gap Between Procedural Fluency and Conceptual Reasoning

The findings reinforced research from Chapter 2, which suggests mathematical learning involves more than memorization and procedural completion, thereby underscoring the importance of teaching for understanding (Boaler, 1998; Hiebert & Grouws, 2007). Although many students applied algebraic procedures correctly and completed the task successfully, they often struggled to justify their reasoning using academic mathematical language. This pattern appeared across assessments, observation, notes, and reflection journals.

Reasoning-centered tasks prompted students to justify their reasoning, analyze strategies, and engage deeply with mathematical concepts, thereby reinforcing the importance of teaching for understanding.

These findings substantially shifted my understanding of mathematics instruction by demonstrating that procedural accuracy alone provided an incomplete picture of student understanding. The inquiry challenged my former assumptions about mastery and assessment, revealing that procedural success does not guarantee conceptual reasoning. As a result, I began to focus on assessing students' mathematical explanations and justifications alongside procedural reasoning. In response to these developments, future instruction will prioritize conceptual questioning, mathematical justification, and structured opportunities for explanation during classroom discussions. Through encouraging students to explain the rationale behind procedures, compare various solution strategies, and reflect on mathematical reasoning, instruction will continue to address the gap between procedural and conceptual understanding. Additional supports, including sentence frames, guided discussion prompts, and collaborative problem-solving tasks, will help all students articulate their thinking while reinforcing procedural fluency.

Engagement Through Meaning-Centered Collaboration

The findings regarding learner engagement closely aligned with the scholarship reviewed in Chapter 2 on sociocultural learning theory, collaborative discourse, and meaning-centered mathematical instruction. The literature emphasized that conceptual understanding is strengthened when students explain reasoning, justify procedures, and communicate mathematical thinking through discussion and reflection. Consistent with these findings, this study found that students participated more regularly and were more actively involved in collaborative mathematical tasks requiring group discussion, collective reasoning, and shared problem-solving.

Engagement increased when students explained strategies, compared thinking, and participated in collaborative reasoning tasks. Observation notes documented greater participation and focus during lessons that emphasized peer interaction and mathematical discourse, aligning with sociocultural perspectives on learning through collaborative meaning-making (Vygotsky, 1978; Cobb & Yackel, 1996).

This study differentiated between general group work and genuinely collaborative reasoning instruction. Engagement increased only when tasks required students to discuss reasoning, justify their thinking, and evaluate solution strategies collectively, rather than merely being seated in groups. This distinction underscores the importance of intentional instructional design in fostering engagement and participation.

Some challenges persisted, including uneven participation due to attendance issues, limited access to devices, and varying levels of student engagement. Although collaborative learning structures often enhanced engagement and mathematical discussion, this inquiry also identified challenges in achieving equitable participation across all groups. Balancing collaborative discourse, conceptual reasoning, pacing expectations, and accountability structures was sometimes difficult in a middle school mathematics classroom. These challenges highlighted the complexities of implementing meaning-centered instruction while conducting classroom-based action research.

These findings illustrate that collaborative structures are most effective when students are provided with clear expectations, accountability measures, and opportunities to explain their reasoning, justify solutions, and participate in shared mathematical discourse. Moving forward, instruction will incorporate clearer expectations for participation, defined collaborative roles, and intentional accountability measures to support the involvement of all students. Structured questions and explicit requirements for explanation will further enhance participation and conceptual engagement, consistent with research emphasizing mathematical discourse and accountable talk as supports for conceptual understanding (Stein et al., 2008).

Academic Language and Mathematical Explanation

The findings on academic language and mathematical explanation aligned closely with the scholarship discussed in Chapter 2 on mathematical discourse, conceptual communication, and language development in mathematical instruction through structured discussion and collaborative reasoning (Walshaw & Anthony, 2008; Stein et al., 2008). The literature emphasized that conceptual understanding is strengthened when students are given opportunities to explain their reasoning, justify procedures, and communicate their mathematical thinking through structured discussion and written reflection. Similarly, this study found that many students struggled to fully articulate mathematical reasoning, even when they completed procedures and arrived at correct solutions. Across multiple data sources, students often demonstrated procedural fluency but did not consistently provide detailed conceptual explanations. Many relied on brief responses, incomplete explanations, or minimal mathematical justification when asked to explain their reasoning. In several instances, students appeared to understand how to complete procedures but struggled to explain why those procedures worked or how mathematical relationships supported their conclusions.

The findings further emphasized the importance of mathematical discourse and structured language supports during instruction. During collaborative activities and classroom discussions, students often demonstrated stronger conceptual communication when provided with sentence frames, guided conversation prompts, and opportunities to explain strategies to peers. These instructional supports helped students organize their mathematical thinking and participate more confidently in discussions. The findings are consistent with research indicating that mathematical understanding develops through explanation, discussion, and reflection within collaborative learning environments.

The reflective process during this inquiry significantly shaped my understanding of mathematical communication and instructional scaffolding. Before this study, I often assumed that students who successfully completed mathematical procedures also possessed strong conceptual understanding. However, the findings revealed that procedural success did not always lead to clear mathematical explanations or academic language development. This realization reinforced the necessity of intentionally teaching students to communicate mathematical reasoning in academic language rather than assuming these skills will develop independently through procedural practice.

In future instruction, I will place greater emphasis on scaffolding mathematical communication through structured discussion opportunities, explicit modeling of academic language, and clearer expectations for reasoning. Students will be encouraged to explain procedures, compare strategies, and justify conclusions throughout lessons. Additional supports, including sentence frames, guided reasoning prompts, and structured collaborative discussion opportunities, may help students strengthen both conceptual understanding and academic mathematical communication during meaning-centered mathematics instruction.

Overall Interpretation

Overall, the findings from this study support the value of meaning-centered mathematics instruction in fostering learning engagement, collaborative participation, and conceptual understanding in the mathematics classroom through collaborative reasoning and conceptual engagement (Boaler, 1998; Stein et al., 1996). The study also reinforced the need to balance procedural fluency with conceptual understanding. While many students demonstrated proficiency with mathematical procedures, the findings indicated that conceptual reasoning developed less consistently and often required intentional instructional support. The reflective process throughout this inquiry further emphasized that engagement alone does not ensure conceptual understanding, and that collaborative instruction is most effective when discussion structures and reasoning expectations are deliberately designed. These findings influenced my understanding of mathematics instruction and highlighted several theoretical, methodological, and practical limitations to consider when interpreting the results.

Limitations

Theoretical Limitations

While Constructivist and Sociocultural theories offered a strong framework for interpreting many findings in this study, the results also revealed limitations in these perspectives when applied to classroom instruction (Piaget, 1952; Vygotsky, 1978). Although collaborative, meaning-centered mathematical tasks increased engagement, some students continued to rely primarily on procedural thinking and struggled to provide conceptual explanations. These findings indicate that increased engagement does not automatically result in deeper conceptual understanding for all learners and reinforce the distinction between participation and conceptual reasoning identified throughout this study.

Additionally, not all students participated equally within collaborative learning structures. Although many students actively engaged in group discussions and collaborative reasoning tasks, participation levels varied with confidence, accountability, attendance, and individual learning needs. Future instruction could address these factors through structured participation roles for less confident students, individual accountability measures within group tasks, alternative pathways for absent students, and differentiated supports that accommodate diverse learning needs. These differences in participation highlighted the need for instructional supports, including structured participation roles, individual accountability measures, alternative pathways for absent students, and differentiated supports for students with diverse learning needs.

Future studies could further examine how structured participation roles, accountability systems, and differentiated discussion supports influence both conceptual reasoning and equitable participation during collaborative mathematical instruction.

Methodological Limitations

Several methodological limitations should be considered when interpreting this study's findings. The research was conducted in a single seventh-grade mathematics classroom, yielding a very small sample size of 22 students, which limits the generalizability of the results. Additionally, the instructional unit took place over a limited timeframe of five days, which limited opportunities to observe long-term changes in conceptual understanding and mathematical communication.

Furthermore, because this inquiry was conducted as practitioner research, my dual role as teacher and researcher may have influenced the interpretation of classroom interactions and students' engagement patterns.

Future studies could strengthen this research by extending instructional time, incorporating multiple classrooms, and collecting additional student discourse data over a longer period of instruction.

Practical Limitations

This study also identified several practical limitations in implementing collaborative conceptual mathematics instruction in a middle school classroom. Collaborative instruction requires instructional time, established classroom routines, clear expectations for participation, and effective teacher facilitation. Additionally, pacing pressures and curriculum requirements sometimes limited opportunities for deeper conceptual exploration. As a result, the effectiveness of meaning-centered collaborative instruction may vary depending on classroom structure, curriculum pacing, and available instructional resources.

Conclusion

This action research project investigated how meaning-centered mathematical tasks affected learner engagement and conceptual understanding in a seventh-grade mathematics classroom. First, students demonstrated greater procedural fluency than conceptual reasoning, often arriving at correct solutions but struggling to explain their mathematical thinking clearly. Second, collaborative meaning-centered tasks enhanced learner engagement and mathematical discussion. Third, students continued to face challenges in using academic mathematical language to articulate their conceptual understanding, particularly in fully verbal explanations. Collectively, these findings demonstrated that meaningful mathematical engagement required more than procedural success alone, reinforcing the importance of intentionally supporting conceptual reasoning, mathematical discourse, and collaborative explanation through instruction. Taken together, the findings support both constructivist and sociocultural perspectives by suggesting that students develop deeper mathematical understanding when they actively construct meaning through explanation, reflection, and collaborative discourse.

Conducting this action research project significantly influenced my understanding of mathematics instruction, assessment, and learner engagement. The reflective process challenged several of my prior assumptions about student mastery and procedural success. Previously, I often regarded procedural completion as a strong indicator of understanding. However, the findings revealed that students may complete mathematical procedures while still struggling to communicate conceptual reasoning or explain mathematical relationships. This realization reinforced the importance of designing instruction that intentionally supports mathematical explanation, collaborative reasoning, and conceptual understanding in addition to procedural fluency.

The study also strengthened my commitment to collaborative mathematics instruction, meaningful mathematical discourse, and structured learning experiences that encourage active student participation. Throughout the inquiry, I observed that students were more willing to share ideas, ask questions, and engage in mathematical reasoning when lessons included structured opportunities for discussion and collaborative problem-solving. These observations reinforced my belief that learning is strengthened when students actively construct understanding with and from their peers.

As I transition into my initial years of teaching, this inquiry will continue to inform both my instructional goals and professional development. In future instruction, I plan to incorporate structured partner discussions, assigned collaborative roles, sentence frames for mathematical explanation, and written reflection prompts that require students to justify their reasoning. I also intended to use participation structures that increase accountability within group work and provide multiple opportunities for students to contribute mathematical ideas. These routines will support conceptual understanding, mathematical communication, and more equitable participation during collaborative learning activities.

Moving forward, this inquiry will continue to influence my instructional practice. I plan to strengthen conceptual understanding by incorporating structured discussion routines, collaborative reasoning tasks, sentence frames, and clearly defined participation roles. These supports will help students explain their thinking, engage more equitably in mathematical discourse, and connect procedural strategies to deeper conceptual understanding. Ultimately, this study reinforced the importance of creating mathematics learning environments that encourage students not only to arrive at correct answers but also to understand, communicate, and meaningfully engage with the mathematical ideas underlying those solutions.

Developing students' ability to explain, justify, and communicate mathematical reasoning may also better prepare them for future mathematics courses that require increasingly abstract thinking and problem-solving. As students encounter more advanced mathematical concepts, the ability to connect procedures to underlying ideas can support deeper understanding, greater independence, and more flexible use of mathematical strategies. These skills extend beyond a single unit of study and provide a foundation for continued mathematical learning.

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