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# Effect of the Mathematics Workshop Model on Middle School English Language Learners' Achievement

Khethiwe Hudson
*Walden University*

# Walden University

College of Education

This is to certify that the doctoral study by

Khethiwe Hudson

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Review Committee
Dr. John Harrison, Committee Chairperson, Education Faculty
Dr. Marilyn Simon, Committee Member, Education Faculty
Dr. Beate Baltes, University Reviewer, Education Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
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Abstract

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by

Khethiwe Hudson

MA, George Mason University, 2018

MA, Kennesaw State University, 2009

BS, KwaZulu-Natal University 2000

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Most English learners (ELs) face challenges upon entering schools in the United States. The problem addressed in this study was that more than half of middle school ELs did not reach basic proficiency on their mathematics inventory in a Mid-Atlantic school district between 2017 and 2022. The purpose of this quantitative study was to investigate the differences in the Spring mathematics inventory scores between low-English functioning middle school ELs (Level 1 entering and Level 2 emerging) and medium functioning middle school ELs (Level 3 developing and Level 4 expanding) who were instructed in the mathematics workshop model for 18 weeks and those who were not, while controlling for the Fall mathematics inventory scores. The mathematics workshop model and the study were based on Tomlinson's differentiation theory which suggests differentiating instruction to students' learning needs. An analysis of covariance was used to analyze archival data from 625 middle school ELs in six different middle schools. For both groups, no statistically significant difference was found between the two groups, with $p$ = .91 for the 154 EL Levels 1-2 students and $p$ = .63 for the EL Levels 3-4 students. These results contradict the current findings in the literature and therefore, it is recommended that districts evaluate the implementation of the mathematics workshop model. This study contributes to social change by bringing awareness to the unsolved issue of ELs' struggle to learning mathematics due to their language challenges. As the mathematics workshop was not found to minimize this struggle, educators should explore additional models, resources, and support for ELs.

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## Dedication

To God be the glory! I dedicate this study to my parents, Armstrong, and Mavis Mdluli, who encouraged me and my brothers to go above and beyond what was presented. They taught us the value of perseverance, kindness, and respect for others. Dad, even though you did not get to witness this moment, I thank God Almighty for you and your hard work, even when times were hard. To my brothers, thank you for your support and love. To my husband, Dexter, thank you for your support and encouragement. My children, Kwami and Akhona, thank you for understanding why I had to spend all that time in the study; you are my joy.

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## The Local Problem

The problem addressed in this study was that more than half of middle school English learners (ELs) did not reach basic proficiency on their mathematics inventory (MI) at Hobbs School District (HSD, a pseudonym) in the Mid-Atlantic region. Title III of the Elementary and Secondary Education Act (ESEA) legislation requires ELs to meet academic requirements in core subject areas, such as mathematics (Soland & Sandilos, 2021). However, ELs have performed lower than average in mathematics on state and national assessments (Sanford et al., 2020; Saxe & Sussman, 2019). One study found that by the time ELs reached 8th grade, approximately 72% scored below basic in mathematics assessments (Soland & Sandilos, 2021). ELs have exhibited low academic achievement in mathematics and struggled to score proficient on national assessments (Arizmendi et al., 2021; Maarouf, 2019).

The Every Student Success Act (ESSA, 2015) asserts the importance of academic success of ELs in mathematics. ELs mathematics scores remained consistently low on a national level (Sandilos et al. ,2020; Saxe & Sussman, 2019; Suhr et al., 2021). According to National Center for Education Statistics (NCES, 2022) report, students in fourth and eighth grade scored lower in 2022 assessments compared to the assessment in 2019; EL mathematics scores were significantly lower ($p < .05$) than 2019.

## Evidence of the Problem at the Local Level

According to an HSD 2022 report, ELs enrollment increased to 9.2% in 2021–2022 school year. ESSA provides opportunities for school districts to improve accountability measures and assessments; furthermore, states were allowed to design accountability systems that support student learning and align content and English proficiency standards (Lee, 2018; Maarouf, 2019). According to Soland and Sandilos (2021), the low EL performance in mathematics supported the changes in accountability measures to ensure that ELs performed successfully. HSD recognized the urgent need to improve the mathematics scores because of the persistent low middle school mathematics scores (Carnoy & García, 2017). The English language proficiency levels included Level 1 “entering”, Level 2 “emerging”, Level 3 “developing”, and Level 4 “expanding, bridging, and reaching”. The percentages of EL Levels 1–4 middle school students who scored below basic in the Fall and Spring assessments at HSD is shown in Table 1. Middle school data from HSD in 2022 for the past 5 years showed that when disaggregated by EL proficiency status, 60% or more ELs score below proficiency.

**Table 1**

*Percentage and the Number of EL Students’ Score Below Basic in Levels 1–4 on the MI at HSD*

| | Below basic | |
|---|---|---|
| MI administration | Number of students | Percentage of students |
| 2017–2018 Fall | 445 | 83 |
| 2017–2018 Spring | 288 | 65 |
| 2018–2019 Fall | 435 | 82 |
| 2018–2019 Spring | 202 | 61 |
| 2019–2020 Fall | 460 | 76 |
| 2020–2021 Fall | 386 | 75 |
| 2020–2021 Spring | 322 | 60 |
| 2021–2022 Fall | 608 | 86 |
| 2021–2022 Spring | 678 | 64 |

The MI, which is a mathematics screener, could be given in the student's home language if a student has low English proficiency levels. The MI is a computer–adaptive screener that measures students' readiness for mathematics instruction. The MI was used as a tool at HSD to assess student domains, number sense, computation and estimation, geometry, measurement, algebra, and data analysis and probability. The MI score uses a developmental continuum called quantiles to report students' mathematical understanding of a concept. It could also identify students struggling with specific skills, and these data help teachers provide necessary interventions as needed by students.

While the assessment spanned grade level, the tool's precision was focused on grade-level content, progress, and providing targeted instruction for students. HSD students who scored below basic received individualized interventions and remediation instruction because students in this category did not demonstrate grade-level readiness. Quantile growth could be influenced by many factors including developmental ability and interventions provided (Houghton Mifflin Harcourt, 2020). To increase academic rigor, language development, and consistency in EL achievement, the mathematics workshop model (MWM) developed by Lempp (2017) was implemented based on differentiated instruction and student-centered instruction. The treatment was 18 weeks during the two 9-week quarters.

MWM is a research-based teaching framework used by mathematics teachers in the HSD. When fully implemented, the MWM incorporates differentiated instruction including four components comprised of: (a) content, (b) process, (c) product, and (d) affect (Tomlinson, 2015). The MWM combines direct instruction with hands-on, guided mathematics and student-centered learning opportunities (Math Solutions Professional Learning Team, 2018). MWM does not follow a traditional teaching method but instead uses a collaborative learning structure, rich classroom discourse, and problem-solving (Hattie et al., 2016). A fully implemented workshop begins with a numbers sense routine, a mini lesson facilitated by the teacher, followed by a large block of time devoted to small group learning and guided groups. It concludes with a brief closure activity or summary (Math Solutions Professional Learning Team, 2018).

## Rationale

Data at HSD indicated that more than half of middle school EL scored below basic in mathematics assessment. According to Soland and Sandilos (2021), ELs, in general, perform below grade level in every content area that is a federal requirement. As EL numbers are expected to grow in the United States, there is a need to help prevent these students from falling behind academically (Maarouf, 2019). Reform policies supported increased English language acquisition and early interventions to improve mathematics achievement and language proficiency (Sorto et al., 2019). Low EL achievement must promote the use of high-quality teaching and interventions that target students' individual needs (Soland & Sandilos, 2021). The purpose of this quantitative study was to investigate the differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who were instructed in the MWM for 18 weeks and EL students who were not, while controlling for the Fall MI scores at HSD.

## Definition of Terms

Special terms associated with the problem in this study are defined as:

*Differentiated instruction*: A research based instructional practice that supports students with diverse needs and backgrounds (Tomlinson, 2017).

*Mathematics inventory*: A research-based adaptive universal screener that assesses student domains, number sense, computation and estimation, geometry, measurement, algebra, and data analysis and probability. The Houghton Mifflin Harcourt Math Inventory was formally called the Scholastic Math Inventory (Houghton Mifflin Harcourt, 2020).

*Mathematics workshop model (MWM)*: A research-based framework created by Lempp (2017) to support differentiated instruction, student-centered instruction, and formative assessment. The MWM combines direct instruction with hands-on, guided mathematics and student-centered learning opportunities (Math Solutions Professional Learning Team, 2018).

## Significance of the Study

I addressed the local problem of low EL scores on the MI. The purpose of this study was to investigate the differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who were instructed in the MWM for 18 weeks and EL students who were not. Mathematics learning builds mental discipline and supports logical reasoning. Mathematical knowledge also plays a crucial role in understanding other school subjects such as science, social studies, history, music, and art. In addition, the number of ELs in the United States continues to grow.

**Research Questions and Hypotheses**

The purpose of this quantitative study was to investigate the differences in the Spring mathematics inventory scores between middle school English learner Levels 1–2 and English learner Levels 3–4 students who were instructed in the mathematics workshop model for 18 weeks and English learner students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District.

Research Question 1 (RQ1): What is the difference in Spring mathematics inventory scores between middle school English learner Levels 1–2 students who were instructed in the mathematics workshop model for 18 weeks and middle school English learner Levels 1–2 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District?

$H_0 1$: There is no significant difference between the Spring mathematics inventory scores between English learner Levels 1–2 middle school students who were instructed in the mathematics workshop model for 18 weeks and English learner Levels 1–2 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District.

$H_A 1$: There is a significant difference between the Spring mathematics inventory scores between English learner Levels 1-2 students who were instructed in the mathematics workshop model for 18 weeks and middle school English learner Levels 1-2 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District.

Research Question 2 (RQ 2): What is the difference in Spring mathematics inventory scores between middle school English learner Levels 3-4 students who were instructed in the mathematics workshop model for 18 weeks and middle school English learner Levels 3-4 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District?

$H_0 2$: There is no significant difference between the Spring mathematics inventory scores between English learner Levels 3-4 middle school students who were instructed in the mathematics workshop model for 18 weeks and English learner Levels 3-4 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District.

$H_A 2$: There is a significant difference between the Spring mathematics inventory scores between English learner Levels 3-4 students who were instructed in the mathematics workshop model for 18 weeks and middle school English learner Levels 3-4 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District.

## Review of the Literature

The purpose of this quantitative study was to investigate the differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who were instructed in the MWM for 18 weeks and EL students who were not, while controlling for the Fall MI scores at HSD. In the literature review, I synthesized current literature regarding differentiated instruction in a middle school mathematics classroom. I discuss the role of second language acquisition, ELs' learning experiences, and the

MWM, including how its two components, small groups instruction and classroom discourse, could improve ELs MI scores.

Peer-reviewed journals provided resources and literature about differentiated instruction, ELs performance in mathematics, and the MWM as an intervention. Research conducted in the last 5 years met the criteria for inclusion in this literature review, and terms such as *middle school*, *English learners*, *differentiated instruction*, *mathematics instruction*, *classroom discourse*, *small group instruction*, *second language acquisition*, *and math workshop* defined the literature search. Databases from the Walden University library provided access to current literature, including ERIC, Education Source, Thoreau Multi-database, SAGE, Primary Source, Teacher Reference Center, and Political Science.

The United States experienced shifts in teaching and learning, requiring school leaders to change instructional practices that promote 21st century skills where ELs could acquire language and use their emerging English to engage in content learning simultaneously (Walqui & Bunch, 2019). According to Soland and Sandilos (2021), the population of ELs in public schools increased by more than 30%, increasing from 3.8 million in 2000 to almost 5 million in 2016, or 9.6% of the total student population nationally; further, 9.4% of ELs were enrolled in EL programs at HSD during the 2014–2015 school year.

According to NCES (2019), ELs made up 10.1% of the school-age population in the Fall of 2017, with nearly 75% of these children having Spanish as their first language (L1) with the expectation that by 2025, 25% of students in the schools will be ELs, increasing to 40% by 2030. It is vital that mathematics teachers understand that ELs bring varied language proficiency depending on how much exposure they have received. It is challenging when ELs reaching competency in mathematics were not fluent in their first language. In the MWM environment, teachers build the mathematics community using different modes of mathematics vocabulary, for example, minus- sum+ allows students to identify the word with either a symbol, representation, or a song. According to Powell et al. (2020), ELs must be exposed to mathematics vocabulary and comprehension to improve mathematical understanding. A differentiated learning environment calls for flexibility and support in students' learning (Ginja & Chen, 2020).

The MWM provides a flexible, supportive, and differentiated approach to instruction. Students are at the center of learning through inquiry, problem-solving, and productive discourse as a community of mathematicians (Sharp et al., 2019). The literature provides differentiated instruction in a middle school mathematics classroom, ELs learning experiences, the MWM, and how its two components, small groups instruction and classroom discourse can improve ELs mathematics inventory scores.

## Theoretical Framework

Tomlinson's differentiation theory (2000), central to differentiating instruction to students' learning needs, grounded this study. According to Tomlinson (2015), differentiated instruction theory supports adapting teaching strategies into a maximized learning process. Differentiating instruction is a pedagogical approach that teachers use to plan instruction based on the needs of their students, on-going assessments, small groups instruction, critical thinking, and engagement in classroom discourse (Hackenberg et al., 2021). Differentiation of instruction relates to the National Council of Teachers of

Mathematics' (NCTM, 2014) principle of equity. Current reforms require teachers to provide a student-centered approach to teaching mathematics and differentiate instruction by content, process, environment, education, culture, and product to facilitate learning and maximize the learning environment (Swanson et al., 2020). According to Pozas et al. (2020), differentiated instruction effectively addresses the needs of diverse learners. Differentiated instruction considers the level of student preparedness, learning styles, and environment to effectively support the diverse needs in the classroom (Yenmez & Özpinar, 2017).

The MWM incorporates a differentiation strategy that offers an alternative to traditional teaching strategy, additionally offering instruction that focuses on students' individual needs and experiences (Hoffer, 2012). Students' different learning needs vary by readiness, learning profiles, and interests, making it fundamental for instruction to be responsive to students' needs (Tomlinson, 2010). The use of differentiated instruction within the MWM allows teachers to be proactive and accommodate students' learning needs through content, process, and product (Cardimona, 2018). It supports MWM student-centeredness, offers multiple entry points to mathematical tasks, and maximizes learning experiences for all students turning the teaching process into a learning process as well (Tomlinson, 2017). The differentiation learning theory helps to understand how teachers use the MWM as a teaching and learning strategy to meet ELs' needs in middle school classrooms.

**Differentiated Instruction**

Students come to the classroom with varying readiness levels, as a result, teachers are required to understand and respond to students' individual needs (Tomlinson, 2010). Teachers are expected to plan for multiple approaches and maximize learning and achievement, implementing differentiated instruction (DI) strategies addresses whole group and individual needs (Lai et al., 2020). The expectation for teachers who use DI is to meet the learning needs of all students regardless of readiness (Cardimona, 2018).

The DI approach is a pedagogical and student-centered approach that balances concepts, learning styles, and student success; it helps advance below basic students connect concepts, tasks, and social interactions (Tomlinson, 2017). MWM promotes a differentiated classroom allowing students to learn based on their readiness. Teachers actively plan for learners' needs in a differentiated classroom to maximize learning (Ginja & Chen, 2020). According to Tomlinson (2017), teachers can differentiate instruction's content, process, and product by readiness learning profiles and interests.

Current reforms require teachers to provide a student-centered approach to teaching mathematics and differentiate instruction by content, process, environment, education, culture, and product to facilitate learning and maximize the learning environment (Swanson et al., 2020). DI effectively addresses the needs of diverse learners (Pozas et al., 2020). DI considers the level of student preparedness, learning styles, and environment to effectively support the diverse needs in the classroom (Yenmez & Özpinar, 2017). In 2014, NCTM recognized teachers' influence and DI on student learning. As a result, NCTM recommended that education move away from teacher-centered practices instead into differentiated, student-centered classrooms (Sharp et al., 2019). The MWM is a differentiated student-centered approach that could improve EL achievement by promoting engagement in learning outcomes, confidence, and student success (Lai et al., 2020).

**Mathematics Inventory**

Mathematics Inventory (MI) is a research-based adaptive universal screener used as a tool at HSD to assess student domains, number sense, computation and estimation, geometry, measurement, algebra, and data analysis and probability (Erwin et al., 2019; Sanders, 2019). The MI score helps teachers identify students' proficiency in concepts and skills, make instructional decisions for each student, and monitor progress. School district leaders used the data to monitor students' progress towards district goals and career readiness (Lehman et al., 2018). The MI can take 20–35 minutes, and it is adaptive with a bank of questions across the five mathematical strands. When students take the MI, it adjusts the level of difficulty based on student performance (Sanders, 2019).

The MI uses the quantile framework, with more than 500 skills and concepts aligned with state standards (MetaMetrics, 2022). The quantiles report ranges from 0Q (emerging mathematician) to above 1600Q, indicating student success from kindergarten to Algebra 2. The data are reported in criterion-referenced, and norm-referenced terms for teachers with links to instructional planning tools and differentiation strategies by identifying specific skills students need to work on and how results compared with other students (Houghton Mifflin Harcourt, 2020).

**Second Language Acquisition**

Language acquisition is vital for ELs because it supports achievement and determines the programs or courses students can enroll in. Teachers must understand second language acquisition, instructional strategies, and the mathematics curriculum to support ELs (De Araujo et al., 2018). The linguistic diversity of students increased in the United States, with many students' L1 differing from their language of instruction (L2). Krashen's (1982) theory of second language acquisition states there is a relationship between second language acquisition and the academic success of ELs. Second language acquisition analyzes English language learning based on the acquisition perspective promoting student-centered learning (Yuan, 2018).

According to Krashen (1982), acquisition is vital in learning rather than language knowledge; it is unconscious behavior. Krashen's (1982) comprehensible input hypothesis asserts that acquiring a second language is vital. However, the acquisition input must be higher than individual language knowledge. The comprehensible input is based on existing language skills. The teacher presents students with learning outcomes, they use language knowledge to generate more language, and the teacher uses the language knowledge content to form students' comprehensible input. Krashen's (1977) second language acquisition theory states that students who view English as a second language improve their comprehensible input and acquire more language proficiency.

Language learning requires a conscious effort to learn a second language by improving the grammar and rules of the language (Gökcan & Çobanoğlu Aktan, 2018). According to Krashen (1982), children acquire the native language, which is also possible for adults who learn a second language. Krashen's comprehensible input hypothesis recommends that teachers implement a differentiated approach to promote language acquisition. Confidence, camaraderie, and a positive attitude helps students acquire a second language. Krashen (1981) distinguished between language learning and language acquisition because learning took place during instruction while language acquisition took place unconsciously defining the comprehensible input.

Second language acquisition occurs through student social interactions, which are less cognitively demanding. In contrast, academic language is more cognitively demanding (Bossé et al., 2018). ELs learn mathematics in a second language starting with teacher-driven to a student production of communication. Krashen's (1977) monitor model argues that language learning and acquisition happens simultaneously in the classroom. According to Krashen (1982), comprehensible input is a student's understanding of a language combined with learning beyond their communication production. The silent period is when students can understand the communication but have difficulty reconstructing ideas on their own words.

In Krashen's (1982) theory, the emergence of speech to intermediate fluency happens when students communicate ideas and improve proficiency and comprehension. In the early intermediate stage, students are more proficient and share ideas and understanding, for example, using multiple representations to solve a task. According to Chu and Hamburger (2019), mathematics instruction must draw upon ELs' cultural and linguistic structures and explicitly support productive mathematical discourse. Mathematical tasks and discussions require students to interact with the target language.

ELs can respond when challenged and supported during meaningful classroom discourse, making it critical for teachers to support ELs to engage in quality interactions with their peers (Walqui & Heritage, 2018).

**Middle School Mathematics**

According to Hackenberg et al. (2021), in a differentiated classroom, teachers help manage students' diversity and plan accordingly to address all diverse needs. This approach is consistent with the NCTM (2014) principles to reform middle school mathematics instruction for equity. Middle school mathematics teachers often find it challenging to differentiate instruction for diverse learners, affecting student achievement (Smets et al., 2020). Teachers' responsiveness to diverse needs allows for differentiated teaching practices, adjustment of instruction, and an equitable learning environment.

Tomlinson (2017) asserted that teachers need support to accommodate students' needs by readiness, interest, and learning profile to maximize learning Early access to interventions and rigorous learning opportunities can improve ELs academic achievement (Maarouf, 2019). According to Sorto et al. (2019), differentiated and challenging mathematics classrooms are those which are student-centered and promote student thinking. Students are actively engaged in sense-making, reasoning, making connections, and critically thinking using multiple representations of mathematics. A high-quality mathematics classroom promotes justification, generalization, reasoning, leverage of high-cognitive demand tasks, and a language-rich classroom. According to Sanford et al. (2020), to address the needs of ELs, teachers must use various teaching strategies to explicitly support the use of academic language, for example working in small groups.

Chu and Hamburger (2019) claimed the critical mission is for teachers to draw upon ELs' cultural and linguistic contributions as they work on challenging mathematical tasks. It is important to offer supportive opportunities to engage in mathematical practices while having productive discourse with their peers. Therefore, emphasizing the need to expand learning opportunities for ELs to engage in differentiated and challenging mathematics content while developing language acquisition (Chu & Hamburger, 2019).

**ELs and Mathematics Performance**

According to the National Center for Education Statistics (2019), the number of ELs in public schools continues to increase. In addition, the mathematics scores remain low on a national level when compared to non-ELs. Every Student Succeeds Act (ESSA; 2015) provides an opportunity for school districts in federal Title III to mitigate the low achievement in mathematics and establish high-quality academic standards to meet the needs of all learners (Suhr et al., 2021). ELs have varying English proficiency levels, and on an estimate, it could take 4 to 7 years to meet proficiency levels. Proficiency levels vary from state to state.

It could be challenging for ELs to meet the requirements while learning mathematical skills in a language they are not proficient in. ELs struggle with the content of cognitive academic language proficiency compared with basic communication skills (Soland & Sandilos, 2021). According to Suhr et al. (2021), solid oral language predicts how ELs perform in mathematical reasoning, problem-solving, and computation skills. There is a need for ELs to engage in challenging but differentiated mathematics instruction as they learn new skills, syntax, vocabulary, and differentiated content based on their readiness.

ELs bring various language proficiency levels, cultures, and formal education to a mainstream mathematics class. Most teachers find it challenging to differentiate instruction (Cardimona, 2018). It also is vital that mathematics teachers to understand that the ELs bring varied language proficiency depending on how much exposure they received. In MWM, teachers build the mathematics community using different modes of a mathematics vocabulary, for example, minus, - sum+ to allow students to identify the word with either a symbol, representation, or a song.

DI within MWM allows students to participate in mathematical sense-making, promoting multiple entry points when engaging in tasks and developing solid mathematical proficiency (Sorto et al., 2019). In a mathematically productive classroom, teachers DI is based on student needs. There is an opportunity for high cognitive demand tasks, in a language-rich classroom where students engage and interact in discourse to build language proficiency.

Appropriate instructional support in MWM helps ELs who struggle with language and content by promoting rich classroom discourse, small group instruction, and student choice (Soland & Sandilos, 2021). Differentiating instruction for ELs means that teachers modify learning, offer choice and flexible grouping to engage all students. As ELs engaged in the mainstream mathematics classroom, the goal is to achieve academic success by modifying content, process, and product, and essentially understanding that goals may differ based on readiness (Tanjung & Ashadi, 2019).

Mathematics teachers encourage communication to improve ELs' conceptual understanding, and students share and extend their mathematical knowledge during discussions. MWM aims to develop students' conceptual understanding and fluency through inquiry-based classroom discourse in a community of mathematicians (Sharp et al., 2019). Vygotsky's social constructivist approach describes social learning under a knowledgeable educator (Gallagher et al., 2019). Vygotsky (1978) asserted that when learners socially interact, this helps them make sense of new information. Students create new knowledge using existing knowledge and make sense of concepts. The teacher facilitated instruction and encouraged engagement. According to Banse et al. (2017), supporting ELs requires posing questions that engage students, scaffold, and revoice their ideas as valuable in the mathematics community. This ensures that teacher language was accessible to ELs. The sheltered instruction observation protocol model encourages comprehensible input for teachers to articulate clearly, revoice, scaffold to help ELs comprehend what was discussed. Communication skills and language acquisition were fundamental approaches to improving ELs mathematics achievement.

## Mathematics Interventions for ELs

According to Title VI of the Civil Rights Act of 1964, the Equal Educational Opportunities Act of 1974, and the ESSA of 2015, state lawmakers had to ensure ELs' full participation in education. School administrators had to provide appropriate interventions to support ELs' and academic achievement (Rios et al., 2020). ELs made up 10% of the student population in 2017, and it was expected that they would make 25% of the student population in 2025 and increase to 40% by 2030. It is essential that interventions addressing specific mathematics challenges are designed (Arizmendi et al., 2021). Most teachers found it challenging to implement intervention programs because they had to identify and address specific mathematics competencies, as well meet pacing requirements (Parker et al., 2019). Several interventions focus on vocabulary, building blocks, explicit and sequential instruction; however, these strategies are often designed for monolingual students, making it critical for EL interventions to be systematic, comprehensive, and organized to meet students where they are (Arizmendi et al., 2021). Mathematics interventions could also address barriers to success of the program (Parker et al., 2019).

**Math Workshop Model**

Math Workshop Model (MWM) is a research-based framework created by Lempp (2017) to support differentiated instruction, student-centered instruction, and formative assessment. MWM combines direct instruction with hands-on, guided mathematics and student-centered learning opportunities (Math Solutions Professional Learning Team, 2018). A fully implemented MWM incorporates the following: (a) number sense routine, (b) focus lesson, (c) guided math workshop groups, (d) learning stations, and (e) student reflection.

MWM components vary depending on the lesson focus (Lempp, 2017). It does not follow a traditional teaching method instead, it is comprised of collaborative learning structures, rich classroom discourse, and problem-solving (Hattie et al., 2016). The number sense routine is the opening practice that allows students to share their ideas about a mathematical problem or scenario, a mini lesson, or an explicit instructional practice that models a particular content for the day. Students then engage in a task or work time where they work independently, in small groups, or with the teacher. The final component is the reflection, which summarizes what students learned about the concept and their understanding (Sharp et al., 2019).

According to Dack (2019), differentiation allows teachers to respond to students' needs, readiness, profiles, and learning styles. Additionally, differentiation is rooted in differences in the classroom, making it critical that teachers adjusted their instruction accordingly (Tomlinson, 2017). Gallagher et al. (2019) asserted that ongoing reflections about instructional practices helped teachers make sense of and analyzed specific instructional qualities. The MWM promotes a community of diverse learners who bring value to their community and engage in meaningful mathematical tasks and discussions (Sharp et al., 2019). Students in a MWM setting experience collaborative learning, rich classroom discourse, and application of concepts instead of teacher-centered lessons (Hattie et al., 2016). According to (Lempp, 2017), MWM creates an environment where students are engaged in making choices, collaborative discourse, and productive struggle. MWM empowers student independence and risk-taking and builds a strong number sense and conceptual understanding of mathematics.

A fully implemented MWM incorporates differentiated instruction's four components, which are: (a) content, (b) process, (c) product, and (d) affect (Tomlinson, 2015); with the consideration that content is modified based on the curriculum, standards, and assessments. The process allows students to make sense of learning experiences, the product enables students to demonstrate mastery in different ways, and the effect promotes positive student interactions (Lempp, 2017).

In a MWM environment, teachers are purposeful about differentiating instruction that accommodated different learning experiences, use data to drive decisions, and facilitate mathematics communities that celebrate student choice, diversity, engagement, and thinking strategies. The MWM centers instruction on students and progresses toward independent thinking and inquiry-based learning (NCTM, 2014). Differentiating instruction using the MWM allows teachers to engage students in rigorous, student-centered, and inquiry-based instruction (Sharp et al., 2019).

HSD implemented MWM during the 2016–2019 school year. The training included mathematics coaches and elementary and middle school teachers. Some middle school teachers found it challenging to fully implement in their classrooms. This challenge resulted in some teachers fully implementing, some partially implementing, and a few who did not execute. During the 2019–2020 school year, some teachers continued instructing in MWM in middle school. In 2020–2021, instruction was disrupted by the Coronavirus 2019 (COVID-19) pandemic, shifting the instructional focus to online access, which resulted in new learning for teachers and students.

**Small Group Instruction**

Vriesema and McCaslin (2020) asserted that a small group setting requires students to work together to reason about the mathematical learning experiences. These activities are designed to enhance student learning of the concepts yielding an understanding of different perspectives that different students brought to the classroom. Small group instruction promotes diversity, conceptual understanding, confidence, and academic success. Teachers learned student readiness and styles. The MWM supports small group instruction because students can be grouped based on their readiness, choice, and content knowledge, allowing different viewpoints on learning strategies (Lempp, 2017). During the guided mathematics component of MWM, the teacher pulls small groups to conference, review, reteach, or teach a mini lesson with students. Students can work in other small groups and share ideas about different activities presented during the lesson.

**Mathematical Discourse**

According to NCTM standards (2014), effective mathematics teaching engages students in discourse to advance the mathematical learning of the whole class. In mathematics classrooms, high-quality discussions support students learning of mathematics by helping students learn how to communicate their ideas. Making students' thinking visible encourages them to evaluate their and each other's mathematical ideas. In the classroom where there is meaningful mathematical discourse, teachers engage students in communicating their ideas, justifying their reasoning, and making real-life connections (NCTM, 2014). ELs were involved in discussions to acquire language and built a deeper conceptual understanding. Mathematical communication is essential to doing mathematics (NCTM, 2014). Language is important when learning mathematics. Teachers who promote a language learning goal for ELs, increase proficiency, and allow students to succeed (Erath et al., 2018). The MWM structures allow ELs to interact with teachers and peers during the whole, small, and guided groups.

ELs were actively engaged in speaking, listening, and thinking about mathematical ideas. They were exposed to multiple representations, for example, used manipulatives to explain their thinking and eventually transitioned to abstract concepts (Barnes et al., 2018). The assumption that ELs would understand mathematics because numbers were universal, proved to be inaccurate. Limited consideration was given that students must explain, justify, and model their thinking. Not accessing language was a barrier for ELs in mathematics.

Language and mathematics worked together requiring mathematics discourse to be in English, a language different from the one spoken at home. Speaking mathematically, identity construction in mathematics and language acquisition connected with the MWM (De Araujo et al., 2018). According to De Araujo et al. (2018), mathematics teachers need to promote language acquisition and classroom discourse while ELs are still learning the language because it allows students to share knowledge and learn from others during the MWM. It is essential to recognize ELs strengths in supporting mathematically rich problems, academic language, and multimodal ways, such as representations of communicating with students.

De Araujo et al. (2018) identified support for ELs including eliciting classroom discourse and mathematical language, modeling discourse by repeating, and emphasizing concepts and definitions. Revoicing helps teachers acknowledge student contributions and position them as valuable members of the mathematics community by stating what they said. Lastly, teachers recognize the value the students bring in the classroom. Students who code-switched or explained in their L1 to develop mathematical understanding. MWM offers a differentiated environment for all students, using classroom discourse to promote student learning (Lempp, 2017). According to Wester (2021), student discourse promotes explanations, reasoning, and solution methods shared with others making students aware of the value of sharing different ideas. Students develop a deeper conceptual understanding and explicitly share their knowledge. According to NCTM (2014), communication, one of the process goals of mathematics teaching, helps students organize their thinking and expertise and accurately expressed themselves using mathematical language. Facilitating classroom discourse helps students share their thinking and learnt what others think about mathematics (Costello, 2021).

Teaching using discourse can help develop ELs communication skills, become active participants, and make sense of different lessons' contributions (Kabael & Baran, 2017). ELs develop a shared understanding of mathematical ideas, created their experience, improve mathematics language, and actively engage in learning, allowing teachers to evaluate students' abilities, and thinking (NCTM, 2014). According to Roberts (2021), teachers could avoid cognitively demanding classroom discourse when teaching ELs because of the lack of understanding and scaffolding strategies. However, as NCTM (2014) pointed out, there should be a greater focus on communications and reasoning by allowing ELs to hear the language and become part of the mathematics learning community. Teaching with mathematics discourse in mind helps ELs to think about their contributions to the community, deepening their mathematical understanding, communicate, built meaning, and know that every contribution is valued and meaningful to the learning experience (Anderson-Pence, 2017)

## Implications

The purpose of this quantitative study was to investigate the differences in the Spring MI scores between middle school EL students who were instructed in the MWM and EL students who were not, while controlling for the Fall MI scores at HSD. The implications for positive social change include the potential for developing standard operating procedures to monitor the implementation and fidelity of mathematics programs to improve mathematics achievement. Differentiating instruction using MWM had implications for teachers to engage students in rigorous, student-centered, and inquiry-based instruction (see Sharp et al., 2019).

## Summary

In the literature review section, I synthesized relevant literature regarding DI in a middle school mathematics classroom. The role of language acquisition, ELs' learning experiences, the MWM, and its two components, small group instruction and classroom discourse, were explored as a strategy to improve ELs MI scores. Data at HSD indicated low ELs mathematics performance in state and local assessments. A differentiated learning environment is flexible and supports in students' learning (Ginja & Chen, 2020). The MWM provides a flexible, supportive, and differentiated approach to instruction. Students are at the center of learning through inquiry, problem-solving, and productive discourse as a community of mathematicians (Sharp et al., 2019). The findings in this study had implications for quality instruction to address the low EL scores in this district.

Findings from this study may help other researchers explore the implementation of differentiation using the MWM and expand the sample population or collect qualitative data. This study has a potential to add to positive social change because it provides this school district with tools to monitor the effectiveness of differentiated instruction within the mathematics workshop model. Section 2 explores the methodology outlining the study purpose, research questions, research design, and the rationale for the selection. This section also discusses the target population, sampling size, data collection method, limitations, assumptions, and other related study procedures.

# Section 2: The Methodology

## Research Design and Approach

The purpose of this quantitative study was to investigate the differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who were instructed in the MWM for 18 weeks and EL students who were not, while controlling for the Fall MI scores. The treatment was 18 weeks, made up of two 9-week quarters. An ANCOVA was the appropriate statistical test to apply because it helped determine whether the independent variable, MWM instruction, influenced the dependent variable, MI scores, after controlling for preexisting differences with the covariate, the Fall scores. The categorical variable was whether instruction occurred in MWM or not. The continuous dependent variable was the EL Levels 1–2 and EL Levels 3–4 students Spring MI scores. Student level data included deidentified student Level 1–2 MI scores and EL Level 3–4 MI scores for Fall and Spring whether students were instructed in MWM. Data from six middle schools were collected and consisted of three grade levels: (a) Grade 6 (239), (b) Grade 7 (192), and (c) Grade 8 (194).

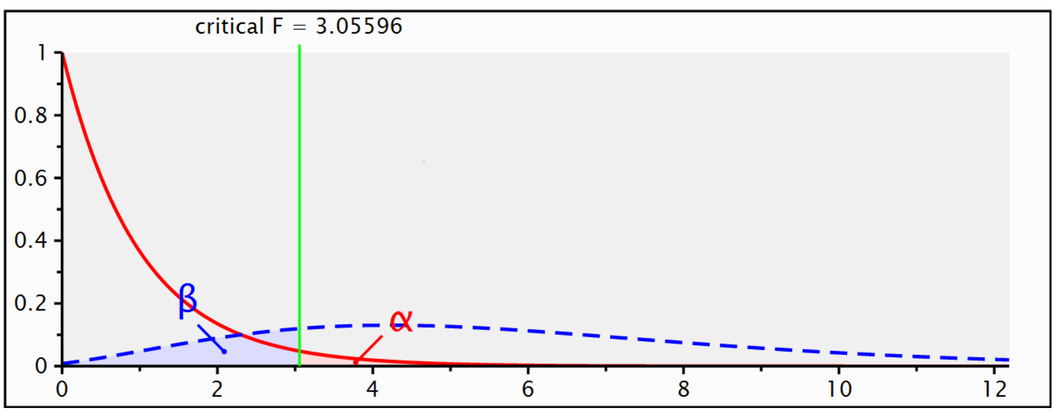
### Setting and Sample

The sample was 100% of the EL Levels 1–2 and EL Levels 3–4 students from six middle schools, totaling 625 students. The students in the study were from sixth grade (38.2%), seventh grade (30.8%), and eighth grade (31%). The breakdown of EL proficiency levels was EL Level 1 (11%), EL Level 2 (13%), EL Level 3 (40%), and EL Level 4 (35%). According to Frankfort-Nachmias et al. (2021), a sample in the population helps researchers generalize the observation to the general population.

According to Frankfort-Nachmias et al. (2021), population represents individuals, groups, or events that the researcher is interested in researching. A sample is the subset of the population to generalize observations (Thomas, 2017). According to Pogrow (2019), effect size identifies the study's significance, points out the difference between groups, is not affected by the sample size, and helps researchers define effective practices in a study. For RQ1, the G* analysis for the EL Levels 1–2 students, was based on a sample of *n* = 154, with a medium effect size (.25), an alpha level of .05, and two degrees of freedom in the numerator and the post hoc result achieved the power to be .791 (see Figure 1).

**Figure 1**

*G*Power for Research Question 1*

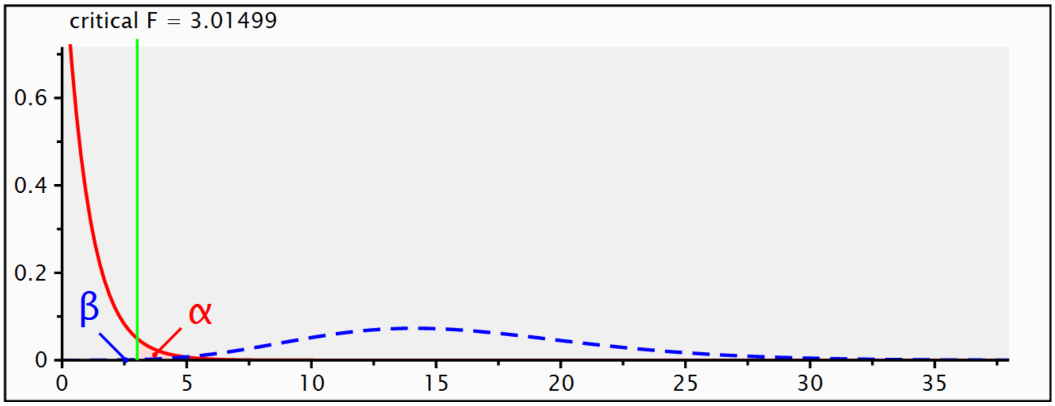



*Note*. *F* tests - ANCOVA: Fixed effects, main effects, and interactions.

For RQ2, the G* power analysis for the EL Level 3-4 students, was based on a sample of *n* = 471, with a medium effect size (.25), an alpha level.05, and two degrees of freedom in the numerator and the post hoc result achieved power to be .999 (see Figure 2).

**Figure 2**

*G*Power for Research Question 2*




*Note*. *F* tests - ANCOVA: Fixed effects, main effects, and interactions.

Walden University's Institutional Review Board approved my study prior to data collection. The Institutional Review Board approval number for this study was 10-24-22-0199357. Then, HSD agreed to provide the archival data. HSD officials deidentified student level data, MWM participation, and the proficiency level of each EL. Barnes et al. (2018) asserted that using archival data could show meaningful implications, balance limitations for the study, help with socially sensitive materials, and foster transparency.

## Instrumentation and Materials

The dependent variable and covariate, the Spring MI scores, and the Fall MI scores respectively, are scores generated from a computer-administered, research-based adaptive universal screener that has been used since 2014 at HSD. The MI scores indicate if students are below basic, basic, proficient, or advanced, which helps teachers make instructional decisions for each student and monitor progress (Lehman et al., 2018). School district leaders use the data to monitor student progress toward district goals and career readiness (Houghton Mifflin Harcourt, 2020). When students take the MI, the assessment adjusts the level of difficulty based on student performance. The test is usually administered a minimum of three times a year, and the goal is to determine progress throughout the year (Lehman et al., 2018). The MI scores use quantiles to report students' mathematical understanding, indicating if a student scores below basic, basic, proficient, or advanced and thus identifying students in need of mathematics interventions (Lehman et al., 2018). The quantile framework uses more than 500 skills and concepts aligned with state standards (MetaMetrics, 2022).

An instrument is valid when it measures what it was meant to measure (Nachmias et al., 2021; Thomas, 2017). An instrument demonstrates reliability when a measurement produces consistent results (Frankfort-Nachmias et al., 2021). The MI scores are a reliable indicator at .97 for a computer-adaptive assessment, and it correlates with other data measures of student performance. According to Metametrics (2022) and HSD, the MI showed a 0.78 reliability coefficient. According to MetaMetrics (2022) and Erwin et al. (2019), the MI scores are reliable and valid test measures because the evidence and theory. The construct validity of the MI could be measured in relation to other assessments. The MI assessment provides accurate test results and connections to instruction (MetaMetrics, 2022).

There is a clear articulation of the MI providing appropriate evidence, demonstrating validity at .78 and reliability at .97 (Gitomer et al., 2021). Reports generated after each administration help teachers support instructional planning and monitor college and career readiness growth. The MI score identifies instructional planning skills students need to work on to improve on the next test (MetaMetrics, 2022).

## Data Collection and Analysis

Deidentified student level archived EL MI data were provided by HSD. Data collected, included 625 EL Levels 1–2 and EL Levels 3–4 middle school students, Spring and Fall MI score, and whether students were instructed in MWM. The data were recorded on a Microsoft Excel spreadsheet. The spreadsheet included deidentified data including:

- Teacher name (Teacher 1, Teacher 2, etc.)
- Teacher MWM use
- Teacher MWM not used
- Grade level
- Student proficiency level
- Fall MI score
- Spring MI score
- Student unique number (Student 1, Student 2, etc.)

According to Ravitch and Carl (2021), researchers must select data collecting tools based on the study and be closely aligned to the research question to tell a story and construct its meaning. I used the Statistical Package for the Social Sciences for Windows v27 to conduct the one-way ANCOVA to compare differences in the MI scores for ELs Level 1–2 and EL Level 3–4 among teachers who instructed in the MWM during the 18 weeks. The ANCOVA was conducted separately for each research question.

The ANCOVA determined whether the independent variable, the intervention, or treatment, influenced the dependent variable while controlling with the covariate, the Fall scores. The test used one continuous variable, one categorical variable, participation in the MWM as instruction, and one continuous covariate, the Fall scores. Descriptive statistics describe the relationship between variables in a sample or population; researchers calculate it before making inferential comparisons between variables (Kaur et al., 2018). The nominal measurement level indicates numbers that represent a set of categories to label or classify observations (Frankfort-Nachmias et al., 2021). Teacher instruction in MWM assigned categories to name and classify observations; the categories were not rank-ordered (Frankfort-Nachmias et al., 2021).

## Assumptions, Limitations, Scope, and Delimitations

### Assumptions

It was assumed that the teachers who attended the training for MWM were attempting to properly instruct in MWM. The district trained all mathematics teachers who were in service during the 2017–2020 school years.

### Limitations

The first limitation in this study was that the teachers are different and have varying comfort with mathematics There is no guarantee that they have the same or similar teaching styles or skills. Another limitation is that the differences in MI scores might be attributed to teacher skills or other confounding variables such attendance instead of the students being exposed to MWM.

### Scope and Delimitations

The scope of this study included six middle schools EL Levels1–2 and EL Levels 3–4 in one district, totaling 625 students who received the same curriculum and intervention under different instructional designs for 18 weeks. Archival data were used for this study. The delimitations narrowed the focus of the study based on participants, time, and location (see Burkholder et al., 2020). Delimitations provided a reason behind my actions, boundaries, or limits during the research process (see Theofanidis & Fountouki, 2018).

## Protection of Participants' Rights

For this study, deidentified archival data were provided by HSD. There was no contact with any of the students or teachers. There was no risk for the participants. To keep information confidential, numbers were assigned to students and teachers. Data were stored in a secure password-protected computer and will be destroyed 5 years after the study's conclusion.

## Data Analysis Results

The purpose of this quantitative study was to investigate the differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who were instructed in the MWM for 18 weeks and EL students who were not, while controlling for the Fall MI scores at HSD. Archival data for 625 students were used for this study.

Research Question 1 (RQ1): What is the difference in Spring mathematics inventory scores between middle school English learner Levels 1–2 students who were instructed in the mathematics workshop model for 18 weeks and middle school English learner Levels 1–2 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District?

$H_0 1$: There is no significant difference between the Spring mathematics inventory scores between English learner Levels 1–2 middle school students who were instructed in the mathematics workshop model for 18 weeks and English learner Levels 1–2 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District

$H_A 1$: There is a significant difference between the Spring mathematics inventory scores between English learner Levels 1-2 students who were instructed in the mathematics workshop model for 18 weeks and middle school English learner Levels 1-2 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District.

Research Question 2 (RQ 2): What is the difference in Spring mathematics inventory scores between middle school English learner Levels 3-4 students who were instructed in the mathematics workshop model for 18 weeks and middle school English learner Levels 3-4 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District?

$H_0 2$: There is no significant difference between the Spring mathematics inventory scores between English learner Levels 3-4 middle school students who were instructed in the mathematics workshop model for 18 weeks and English learner Levels 3-4 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District.

$H_A 2$: There is a significant difference between the Spring mathematics inventory scores between English learner Levels 3-4 students who were instructed in the mathematics workshop model for 18 weeks and middle school English learner Levels 3-4 students who were not, while controlling for the Fall mathematics inventory scores at Hobbs School District.

One–way ANCOVA was used to determine if there were significant differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who were instructed in the MWM for 18 weeks and EL students who were not. ANCOVA is a combination of a *one-way* ANOVA and a regression analysis. ANCOVA tests for equality of means for several univariate groups, adjusted for covariance with another variate. The data analysis below summarizes data from the entire sample of EL Levels 1–2 and EL Levels 3–4; furthermore, it summarized findings by each research question. Table 2 displays the descriptive statistics for the mathematics scale scores for the entire sample ($N = 625$). Fall mathematics scores, which was the covariate for the study, had a mean of $M = 604.11$. Spring mathematics scores, which was the dependent variable with this study, had a mean of $M = 700.55$. This resulted in an average gain in mathematics (spring minus fall) of $M = 96.44$ (see Table 2).

**Table 2**

*Descriptive Statistics for Mathematics Scale Scores (Entire Sample)*

| Variable | *M* | *SD* | Low | High |
|---|---|---|---|---|
| Fall | 604.11 | 160.79 | 151 | 1,120 |
| Spring | 700.55 | 182.57 | 293 | 1,283 |
| Gain | 96.44 | 131.56 | –313 | 620 |

*Note*. $n = 625$.

Table 3 displays the descriptive statistics for the math scale scores for the teachers who did not instruct in MWM ($n = 308$). Fall mathematics scores, which was the covariate for the study, had a mean of *M* = 591.61. Spring math scores, which was the dependent variable with this study, had a mean of *M* = 687.97. This resulted in an average gain in math (spring minus fall) of *M* = 96.37 (see Table 3).

**Table 3**

*Descriptive Statistics for Mathematics Scores (MWM Not Used)*

| Variable | *M* | *SD* | Low | High |
|---|---|---|---|---|
| Fall | 591.61 | 160.27 | 227 | 1,120 |
| Spring | 687.97 | 189.18 | 293 | 1,283 |
| Gain | 96.37 | 138.94 | -313 | 620 |

*Note*. $n = 308$.

Table 4 displays the descriptive statistics for the math scale scores for teachers who instructed in MWM ($n = 317$). Fall mathematics scores, which was the covariate for the study, had a mean of *M* = 616.26 Spring mathematics scores, which was the dependent variable with this study, had a mean of *M* = 712.77. This resulted in an average gain in mathematics (Spring minus Fall) of *M* = 96.51 (see Table 4).

**Table 4**

*Descriptive Statistics for Mathematics Scale Scores (MWM Use Only)*

| Variable | *M* | *SD* | Low | High |
|---|---|---|---|---|
| Fall | 616.26 | 160.61 | 151 | 1,083 |
| Spring | 712.77 | 175.34 | 293 | 1,222 |
| Gain | 96.51 | 124.19 | -250 | 410 |

*Note*. $n = 317$.

Eighty-seven percent of the students had a Fall mathematics proficiency at a below basic. The students in the study were from sixth grade (38.2%), seventh grade (30.8%), and eighth grade (31%). About half the teachers (50.7%) participated in MWM and approximately half of the students were in MWM while the other half was not (see Table 5).

**Table 5**

*Frequency Counts for Selected Variables*

| Variable | Category | *n* | Percentage |
|---|---|---|---|
| Fall math proficiency categories | | | |
| | Below basic | 543 | 86.9 |
| | Basic | 72 | 11.5 |
| | Proficient | 6 | 1 |
| | Advanced | 4 | 0.6 |
| Grade level | | | |
| | 6th | 239 | 38.2 |
| | 7th | 192 | 30.8 |
| | 8th | 194 | 31 |
| MWM instruction | | | |
| | No | 308 | 49.3 |
| | Yes | 317 | 50.7 |

## Answering RQ1

Table 6 displays the frequency counts for selected variables. Twenty-five percent of the sample were at EL Level 1 or Level 2.

**Table 6**

*Frequency Counts for Selected Variables*

| Variable | Category | *n* | Percentage |
|---|---|---|---|
| EL Fall Level | | | |
| | 1 | 70 | 11.2 |
| | 2 | 84 | 13.4 |
| Fall EL categories | | | |
| | Levels 1 and 2 | 154 | 24.6 |

*Note*. $n$ = 154.

As additional findings, Table 7 displays the one-way ANOVA tests for the test scores based on teacher instruction and EL level. These test scores included Fall, Spring, and gain (Spring minus Fall). None of the three ANOVA models were significant for the Level 1 and 2 students.

**Table 7**

*One Way ANOVA Tests for Test Scores Based on Teacher Instruction Using MWM and EL Level*

| EL Level | Score | MWM teacher | *n* | *M* | *SD* | η | *F* | *p* |
|---|---|---|---|---|---|---|---|---|
| 1 and 2 | Fall | | | | | .05 | .35 | .56 |
| | | Yes | 78 | 537.83 | 153.15 | | | |
| | | No | 76 | 553.07 | 166.18 | | | |
| | Spring | | | | | .04 | .25 | .62 |
| | | Yes | 76 | 661.95 | 183.58 | | | |
| | | No | 78 | 647.23 | 187.74 | | | |
| | Gain | | | | | 0 | 0 | .98 |
| | | Yes | 76 | 108.88 | 148.18 | | | |
| | | No | 78 | 109.4 | 148.17 | | | |

To answer RQ1, Table 8 displays the ANCOVA model comparing Spring mathematics scores based on teacher instruction in MWM controlling for Fall mathematics scores for students that were Levels 1 and 2. The overall model was significant ($p$ = .001) and accounted for 48.1% of the variance in the Spring mathematics scores. The covariate was significant ($p$ = .001) while the independent variable was not significant ($p$ = .91). The combination of findings led to the decision to fail to reject the null hypothesis (see Table 8). The choice to not reject the null hypothesis did not lead me to the conclusion that no association or differences existed, but instead that the analysis did not detect any association or differences between the variables or groups.

**Table 8**

*ANCOVA Model Predicting Spring Mathematics Score Based on Teacher Instruction in MWM Controlling for Fall Mathematics Scores (Levels 1 and 2 Only)*

| Source | SS | df | SS | F | p | Partial eta squared |
|---|---|---|---|---|---|---|
| Full model | 2,522,551.59 | 2 | 1,261,275.79 | 69.99 | .001 | .481 |
| Fall score | 2,514,214.73 | 1 | 2,514,214.73 | 139.51 | .001 | .48 |
| Teacher MWM instruction[a] | 230.59 | 1 | 230.59 | 0.01 | .91 | 0 |
| Error | 2,721,262.91 | 151 | 18,021.61 | | | |
| Total | 5,243,814.49 | 153 | | | | |

*Note*. $n = 154$.

Levene's Test for Equality of Error Variance: $F$ (1, 152) = 2.45, $p$ = .119.

[a] Teacher Instruction in MWM: 0 = *No* 1 = *Yes*.

## Assumption Testing

According to Frankfort-Nachmias et al. (2021), there are nine assumptions that need to be met for ANCOVA models including:

1. dependent variable and covariate variable(s) are continuous scale scores,
2. two or more categorical, independent groups for the independent variable,
3. independence of observation,
4. no significant outliers,
5. normally distributed residuals,
6. homogeneity of variances,
7. linearly related covariate,

8. homoscedasticity, and
9. homogeneity of regression of slopes.

### *Assumption 1*

Assumption 1 was that the dependent variable and the covariate are continuous. The scale scores were standardized continuous test scores. This assumption was met.

### *Assumption 2*

Assumption 2 was the independent variable was categorical/nominal. I had two categorical groups (whether they were instructed in MWM or were not). This assumption was met.

### *Assumption 3*

Assumption 3 was independence of observations. Students were in only one of the groups and their data were measured in Spring and Fall. This assumption was met.

### *Assumption 4*

Assumption 4 was no significant outliers. Assumption 4 was tested by examining the standardized residual scores. Only one residual outlier was found in a sample of $n$ = 625. The outlier was not dropped because of the large sample and linear scatterplots, which did not make a difference on the findings. This assumption was met.

### *Assumption 5*

Assumption 5 was normally distributed residuals. This assumption was examined in Table 9 using Kolmogorov-Smirnov tests. Test statistics for Levels 1 and 2 ($p$ = .059) were not significant so this assumption was met.

**Table 9**

*Normality Statistics for the Standardized Residual for Spring Scores Based on EL Level*

| | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| EL Level | Statistic | *df* | *p* | Statistic | *df* | *p* |
| Levels 1 and 2 | .07 | 154 | .059 | .99 | 154 | .336 |

### *Assumption 6*

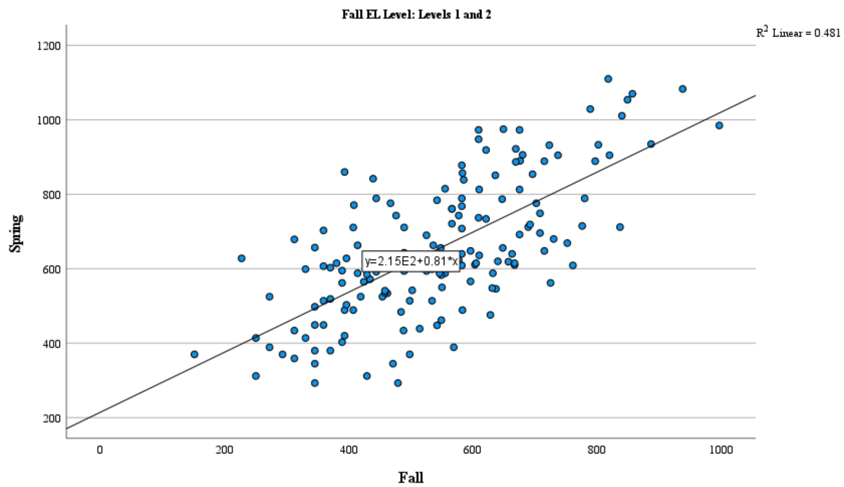
Assumption 6 was homogeneity of variance. This was examined using Levene's test for equality of error variance. Neither the Levene's test for Levels 1 and 2 ($p$ = .119) was statistically significant, so this assumption was met.

### *Assumption 7*

Assumption 7 was linearly related covariate. Strong linear patterns were noted (see Figure 3). This assumption was met.

**Figure 3**

*Scatterplots to Determine Linearity Between Covariate and Dependent Variable-Fall EL Level 1–2*

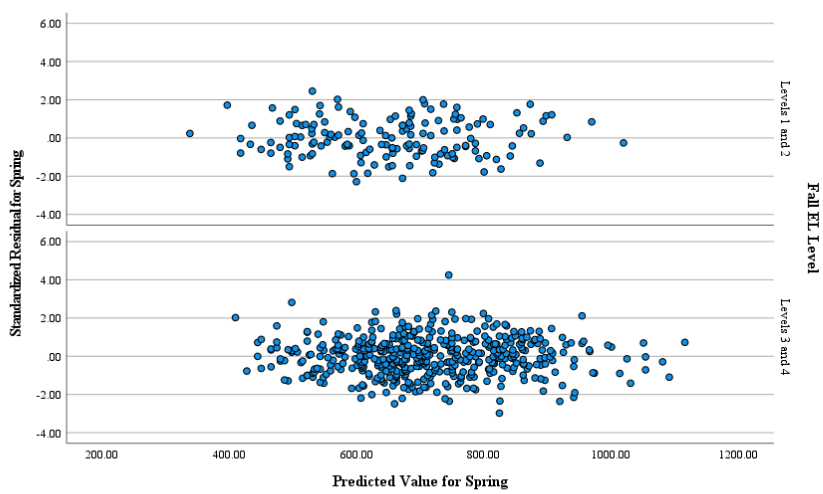



### *Assumption 8*

Assumption 8 was homoscedasticity. This assumption was examined based on the inspection of the scatterplots (see Figure 4). This assumption was met.

**Figure 4**

*Homoscedasticity Plots Based on EL Level*

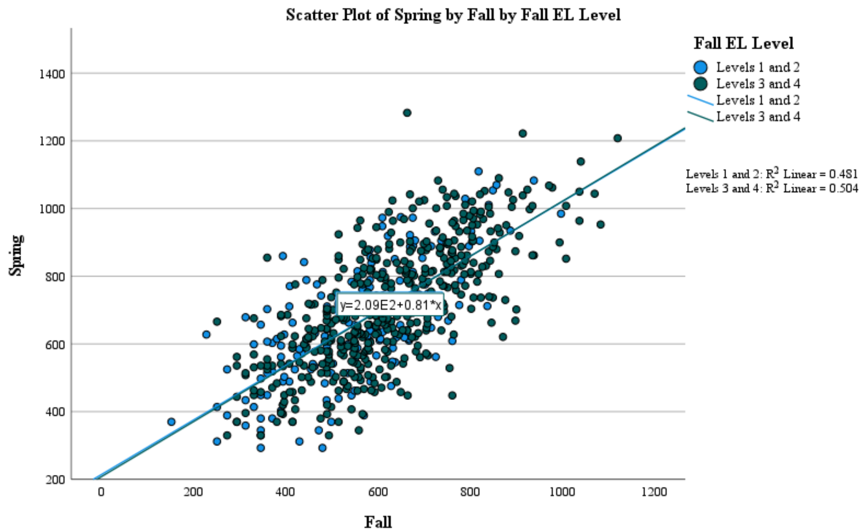


***Assumption 9***

Assumption 9 was homogeneity of regression slopes. This assumption was examined based on inspection of the scatterplot including the accompanying regression lines (see Figure 5). This assumption was met.

**Figure 5**

*Scatterplot Examining Homogeneity of Regression Slopes*




Taken together, all nine assumptions for ANCOVA were met. In summary, I used archival data from 625 students to investigate the differences in the Spring MI scores between middle school EL Level 1–2 students who were instructed in the MWM for 18 weeks and EL students who were not, while controlling for the Fall MI scores at HSD. For Hypothesis 1, differences for Level 1 and Level 2 students, I failed to reject the null hypothesis because the results were above the *p*-value ($p < .05$) and showed no statistically significant differences. No statistical differences in EL Levels 1–2 instructed in MWM were revealed.

## Answering RQ2

RQ2: What is the difference in Spring MI scores between middle school EL Levels 3–4 students who were instructed in the MWM for 18 weeks and middle school EL Levels 3–4 students who were not, while controlling for the Fall MI scores at HSD? The related null hypothesis: There is no significant difference between the Spring MI scores between EL Levels 3–4 middle school students who were instructed in the MWM for 18 weeks and EL Levels 3–4 students who were not, while controlling for the Fall MI scores at HSD. The alternate hypothesis: There is a significant difference between the Spring MI scores between EL Levels 3–4 students who were instructed in the MWM for 18 weeks and middle school EL Levels 3–4 students who were not, while controlling for the Fall MI scores at HSD.

## Descriptive Statistics

Table 10 displayed the frequency counts for selected variables. 39.5 EL were in Level 3 and 35.8 EL were Level 4.

**Table 10**

*Frequency Counts for Selected Variables*

| Variable | Category | *n* | Percentage |
|---|---|---|---|
| EL Fall Level | | | |
| | 3 | 247 | 39.5 |
| | 4 | 224 | 35.8 |
| Fall EL Categories | | | |
| | Levels 3 and 4 | 471 | 75.4 |

*Note*. $N = 471$.

Table 11 displays the one-way ANOVA tests for the test scores based on teacher instruction and EL level. These test scores included Fall, Spring, and gain (Spring minus

Fall). None of the three ANOVA models were significant for the Level 3 and 4 students (see Table 11).

**Table 11**

*One Way ANOVA Tests Scores Based on Teacher Instruction Using MWM and EL Level*

| EL Level | Score | MWM teacher | *n* | *M* | *SD* | η | *F* | *p* |
|---|---|---|---|---|---|---|---|---|
| 3 and 4 | | | | | | | | |
| | Fall | | | | | .08 | 3.34 | .07 |
| | | Yes | 241 | 636.18 | 153.85 | | | |
| | | No | 230 | 609.84 | 158.84 | | | |
| | Spring | | | | | .08 | 2.68 | .1 |
| | | Yes | 241 | 728.79 | 170 | | | |
| | | No | 230 | 701.79 | 188.076 | | | |
| | Gain | | | | | 0 | 0 | .96 |
| | | Yes | 241 | 92.61 | 123.84 | | | |
| | | No | 230 | 91.95 | 135.71379 | | | |

Table 12 displays the ANCOVA model predicting Spring mathematics scores based on teacher instruction in MWM controlling for Fall mathematics scores for students that were Levels 3 and 4. The overall model was significant ($p$ = .001) and accounted for 50.5% of the variance in the Spring mathematics scores. The covariate was significant ($p$ = .001) while the independent variable was not significant ($p$ = .631). This combination of findings led me to the decision to fail to reject the null hypothesis (see Table 12). The choice to not reject the null hypothesis did not lead me to the conclusion that no association or differences exist, but instead that the analysis did not detect any association or differences between the variables or groups.

**Table 12**

*ANCOVA Model Predicting Spring Mathematics Score Based on Teacher Instruction Controlling for Fall Mathematics Scores (Levels 3 and 4 Only)*

| Source | *SS* | *df* | *SS* | *F* | *p* | Partial eta squared |
|---|---|---|---|---|---|---|
| Full Model | 7,630,684.46 | 2 | 3,815,342.23 | 238.35 | .001 | .505 |
| Fall Score | 7,544,883.73 | 1 | 7,544,883.73 | 471.34 | .001 | .502 |
| Teacher MWM Instruction[a] | 3,701.28 | 1 | 3,701.28 | 0.23 | .631 | 0 |
| Error | 7,491,439.88 | 468 | 16,007.35 | | | |
| Total | 15,122,124.34 | 470 | | | | |

*Note*. $n = 471$.

Levene's Test for Equality of Error Variance: $F$ (1, 469) = 1.92, $p = .167$.

[a] Teacher Instruction in MWM: 0 = *No* 1 = *Yes*.

## Assumption Testing

According to Frankfort-Nachmias et al. (2021), there are nine assumptions that need to be met for ANCOVA models.

### *Assumption 1*

Assumption 1 was that the dependent variable and the covariate are continuous scale scores were standardized continuous test scores. This assumption was met.

### *Assumption 2*

Assumption 2 was the independent variable was categorical/nominal. I had two categorical groups (whether they were instructed in MWM or did not get MWM instruction). This assumption was met.

### *Assumption 3*

Assumption 3 was independence of observations. Students were only in one of the groups and their data were measured in Spring and Fall. This assumption was met.

### *Assumption 4*

Assumption 4 was no significant outliers. Assumption 4 was tested by examining the standardized residual scores. Only one residual outlier was found in a sample of $n$ = 471. The outlier was not dropped because of the large sample and linear scatterplots, which did not make a difference on the findings. This assumption was met.

### *Assumption 5*

Assumption 5 was normally distributed residuals. This assumption was examined in Table 13 using Kolmogorov-Smirnov tests. Test statistics for Levels 3 and 4 ($p$ = .2) were not significant so this assumption was met.

**Table 13**

*Normality Statistics for the Standardized Residual for Spring Scores Based on EL Level 3–4*

| | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| EL Level | Statistic | *df* | *p* | Statistic | *df* | *p* |
| Levels 3 and 4 | 0.03 | 471 | .2 | 1 | 471 | .339 |

### *Assumption 6*

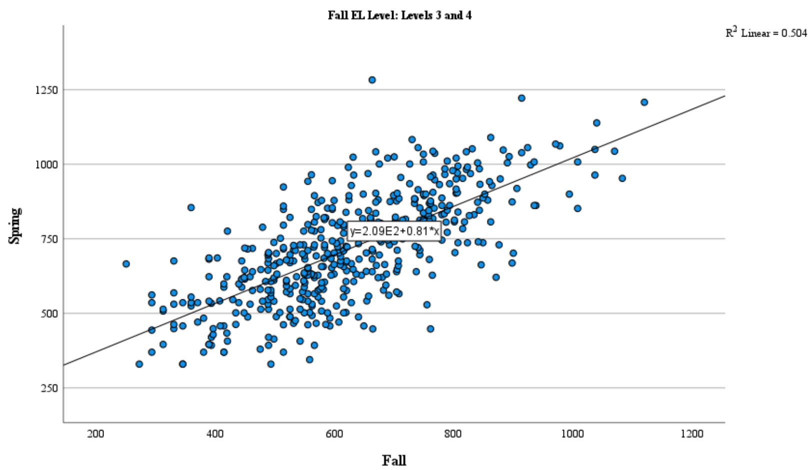
Assumption 6 was homogeneity of variance. This was examined using Levene's test for equality of error variance. Neither the Levene's test for Levels 3 nor 4 ($p$ = .167) was statistically significant, so this assumption was met.

### *Assumption 7*

Assumption 7 was linearly related covariate. Strong linear patterns were noted (see Figure 6). This assumption was met.

**Figure 6**

*Scatterplots to Determine Linearity Between Covariate and Dependent Variable- Fall Level 3–4*

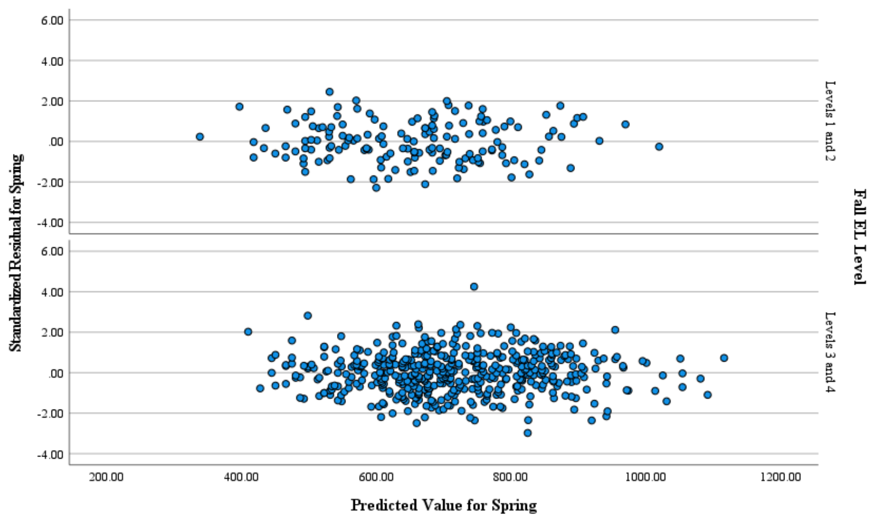



### *Assumption 8*

Assumption 8 was homoscedasticity. This assumption was examined based on the inspection of the scatterplots (see Figure 7). This assumption was met.

**Figure 7**

*Homoscedasticity Plots Based on EL Level*

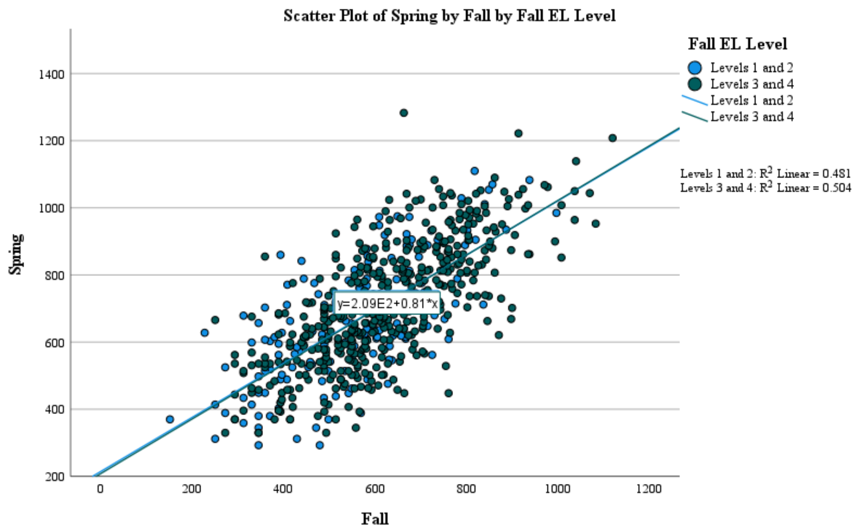



### *Assumption 9*

Assumption 9 was homogeneity of regression slopes. This assumption was examined based on inspection of the scatterplot including the accompanying regression lines (see Figure 8). This assumption was met.

**Figure 8**

*Scatterplot Examining Homogeneity of Regression Slopes*




All nine assumptions for ANCOVA were met. In summary, I used archival data from 471 students to investigate the differences in the Spring MI scores between middle school EL Levels 3-4 students who were instructed in the MWM for 18 weeks and EL students who were not, while controlling for the Fall MI scores at HSD. For Hypothesis 2, differences for Level 3 and 4 students, I also failed to reject the null hypothesis because the *p*-value of less than .05 and showed no statistically significant differences (see Table 13). No statistical differences in EL Levels 3-4 instructed in MWM were revealed. Other variables, such as the nature of standardized testing, the COVID-19 pandemic, and teachers' skill and experience, were not considered in this study and may have affected the results. As noted, the choice to not reject the null hypothesis did not lead to the conclusion that no association or differences exist, but instead that the analysis did not detect any association or difference between the variables or groups.

## Standardized Testing

According to Abedi et al. (2020), the nature of standardized testing could depend on student readiness for the test. Lack of sleep, language barrier, bad days, and anxiety could affect student performance. It is also essential to note that standardized testing could negatively impact ELs because it requires English language proficiency. Appropriate accommodations might be considered to help ELs access the curriculum and assessments (i.e., removing unnecessary texts, preparing students for using accommodations, and teacher training). This will assist teachers with presenting deeper and differentiated conceptual understanding to avoid teaching to the test (Sonnert et al., 2019).

## COVID-19

It is also important to note that the COVID-19 pandemic had tremendous effect on student learning. Some students took longer to recover from the learning loss while they learned virtually (Maher & Zollman, 2021). Students who were already behind fell even more behind, and inequity for ELs, special education, and low-socioeconomic students was enhanced (Blaskó et al., 2022). As a result, this variable could influence student outcomes.

## Teacher Experience

Teacher quality and skill benefits student success. District officials must accentuate the need for skilled teachers, recruitment policies, and teacher retention (Burns et al., 2020). The MWM training occurred during the 2017–2019 school years before the pandemic. Teachers went through an 8-hour training on fully implementing

MWM. A fully implemented MWM incorporates differentiation, small group instruction, student choice, and student discourse. Teachers learned about the three buckets, classroom arrangement, routines, and procedures, and building a mathematics community (Lempp, 2017). The training was designed to help teachers understand that MWM is about students doing most of the work, making choices, talking, and reasoning about mathematics, making connections, and productively struggling through challenging mathematics (Lempp, 2017). Based on the data, a 3-week self-paced online professional development (PD), facilitating meaningful classroom discourse, was proposed.

The project highlighted the need to improve teacher training on these skills because ELs scores have been low for the last 5 years at HSD. The program evaluation's results provided recommendations for ongoing teacher PD to support ELs. There was no follow-up training because of the COVID-19 pandemic. According to Darling-Hammond and Oakes (2019), no amount of reform could outweigh a quality teacher. Investing in teacher PD was of utmost importance. I focused on supporting teacher quality and retention by providing ongoing PD that would allow teachers to collaborate collegially (see Burns et al., 2020). This PD advanced teachers' confidence by shifting from a teacher-centered mathematics classroom to a student-centered one. This PD highlights an ongoing collaboration between middle school teachers and district staff, unlike the initial MWM training. According to Mailizar et al. (2022), online PD could accommodate teacher schedules and geographical boundaries and personalize learning to accommodate teacher needs.

The project was an asynchronous and synchronous 3-week self-paced online PD.

Teachers engaged with peers through Canvas modules, discussions, assignments, and announcements throughout the 3 weeks. The course sequence starts with a group PD on Microsoft Teams, followed by self-paced activities and weekly discussions. For the final product, teachers applied PD strategies on discourse by selecting a short clip from their classroom recording to present and receive feedback from their peers using a rubric. The online course was grounded in the NCTM (2014) principles of action for effective mathematics teaching practices. This course (see Appendix A) balanced content and pedagogy, including elements and strategies of effective characteristics of two math teaching practices that promoted student learning including: (a) posing purposeful questions and (b) facilitating meaningful classroom discourse.

The PD applied Glickman et al.'s (2018) stages of successful PD. An online platform was a preferred method because PD attendance needed to be higher due to the proximity of middle schools to each other. This format allowed teachers to collaborate at their own pace. Section 3 addresses the project, project evaluation plan, recommendations, and implications for positive social change.

# Section 3: The Project

In this quantitative study, I investigated the differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who were instructed in the MWM for 18 weeks and EL students who were not, while controlling for the Fall MI scores. No statistical differences in EL Levels 1–2 and EL Levels 3–4 instructed in MWM were revealed. In this section, I provide: (a) the project description, (b) literature review supporting this project, and (c) recommendations for effective PD. This online PD was intended to help teacher practice and promote implementing instructional strategies with fidelity.

The goal of this PD was to enhance ongoing middle school teachers' confidence by shifting from a teacher-centered mathematics classroom into one that is student-centered and providing voice, and a choice in how teachers learn (see Campbell & Cox, 2018). Soland and Sandilos, (2021) asserted that school reform policies must increase ELs English language acquisition, high-quality teaching, and interventions to address low EL achievement. At HSD, data indicated low EL scores in mathematics in the last 5 years. According to the 2019 EL program evaluation report, after observing 72 EL classrooms, data indicated that ELs were not engaged in higher-level thinking tasks or activities, explicitly attending to language, and had limited quality interactions.

Based on data collection and observations from the program evaluation, the recommendations were: (a) help teachers create classrooms that cultivate learning; (b) help teachers promote academic rigor; (c) offer quality opportunities for ELs to engage in sustained talk and reciprocal interactions; (d) integrate purposeful language practices; and

(e) provide teachers with a well-defined, coherent, and sustained approach to PD to be able to provide opportunities for students to engage in language practices that require them to share information and comprehend challenging texts.

This PD was created to address these recommendations and to support mathematics teachers in improving student outcomes. The PD was a self-paced online course grounded in the NCTM (2014) principles of action for effective mathematics teaching practices. This course (see Appendix A) balanced content and pedagogy, including elements and strategies of effective characteristics of two math teaching practices that promote student learning including: (a) posing purposeful questions and (b) facilitating meaningful classroom discourse. The online course was an asynchronous and synchronous 3-week self-paced online PD provided through Canvas modules, discussions, assignments, and announcements. The course sequence included: (a) synchronous meetings on Microsoft Teams; (b) asynchronous self-paced activities and group discussions, and (c) a final product of a video recording.

**Table 14**

*Program Structure*

| Date | Module | Activity | Time |
|---|---|---|---|
| 01/09/2023 | Module 1 Week 1 Posing Purposeful Questions | Synchronous workshop: Introduction to posing purposeful questions | I hour |
| Week of 01/09/23 | Asynchronous | Debrief and complete module 2 tasks | Throughout week 1 |
| 01/17/2023 | Module 2 Week 2 Workshop: Introduction to facilitating meaningful discourse | Synchronous workshop: Introduction to facilitating meaningful discourse | 1 hour |
| Week of 01/17/22 | Asynchronous | Debrief and complete module 3 task using the rubric | Throughout week 2 |
| 01/23/2023 | Module 3 Week 3 Video Analysis | Bring video clip to share and discuss: Posing purposeful questions Facilitating meaningful discourse | I hour |
| Week of 01/30/23 | Glickman et al. final stage-Feedback | Continuous experimentation and reflection Developing new learning structures | Ongoing |

## Rationale

No statistical differences in EL Levels 1-2 and EL Levels 3-4 instructed in MWM were revealed. Teachers received MWM training before the COVID-19 pandemic, and there was no follow-up PD to continue teaching using MWM. There were limited opportunities for teachers and school leaders to address the 2019 EL program evaluation recommendations because of the COVID-19 pandemic. Tomlinson's differentiation theory (2000) grounded this study. The differentiation approach supports adapting learning to maximize learning. The project was differentiated to address teacher learning needs by modifying learning by process, content, and process (Tomlinson, 2015). The PD modeled how teachers could apply differentiated classroom strategies to support student learning.

The project provided ongoing PD to support the results, the research questions, and use of a component of MWM: facilitating meaningful classroom discourse. The 2019 program evaluation also recommended language development, sustained talk, and rigor. The success of these recommendations depended on ongoing PD to support teachers in teaching and applying these strategies. According to Mailizar et al. (2022), online PD allows teachers to participate in formal and informal interactions and is not limited to one environment. A 3-week self-paced course was an appropriate and convenient way to reach all middle school teachers because it is online, practical, and conceptual.

The PD aligned with NCTM's (2014) initiatives which underscored the importance of student communication in mathematics because it allows students to clearly show their thinking and understanding to others. Students could make connections with what their peers shared. Education reform calls for mathematics instruction that shifts away from teacher-centeredness to a more student-centered approach to improve student learning and outcomes (Legesse et al., 2020). I aimed to improve student outcomes and support teachers with sustained and ongoing PD.

**Review of the Literature**

I investigated the differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who were instructed in the MWM for 18 weeks and EL students who were not while controlling for the Fall MI scores at HSD. No statistical differences in EL Levels 1-2 and EL Levels 3–4 instructed in MWM were revealed. Teachers' skill, gender, nature of standardized testing, socioeconomic status, and MWM training effects were some of the variables that were not considered. During the COVID-19 pandemic, there was limited PD opportunities as teachers were teaching online. Priority was given to students' online access ensuring learning continuation. The project was appropriate because it provided opportunities for teachers to collaborate conveniently and share differentiation strategies to improve student outcomes (see Russo et al., 2021). The aim of the project was to collect ongoing teacher reflection and feedback on differentiated learning, mathematics discourse, and student learning.

Peer-reviewed journals provided resources and literature on PD, e-learning, learning management systems, universal design of learning (UDL), and meaningful classroom discourse. Databases from the Walden university library provided access to current literature, including ERIC, Education Source, Thoreau Multi-database, SAGE, Primary Source, Teacher Reference Center, and Political Science. Search terms included: *professional development*, English learners, *classroom discourse*, *universal design*, *e-learning*, and *middle school mathematics*. The literature review supported this project by reviewing the elements of professional learning, online learning, differentiated instruction, and ongoing support. A 3-week self-paced online course was created to support teacher learning using various platforms, tools, and collaboration structures. UDL and e-learning as tools helped facilitate this online course.

**Professional Development (PD)**

According to Kohen and Borko (2022), connecting theory to practice in PD could be challenging because these programs need ongoing support. These authors recommend sustained and effective PD. It was essential to identify relevant PD components to support teachers, design engaging learning experiences, and offer teaching tools (see Sztajn et al., 2020). There was often a disconnect between teacher knowledge and practice. Forty-eight percent of middle school teachers reported the implementation of interventions, and 89% of teachers indicated a need for support with interventions (see Codding et al., 2022). Teachers need PD that provides content and pedagogical knowledge for effective mathematics instruction that is in accord with the content tested in the MI. The project highlighted the need to allow teachers to collaborate, transform instructional practices, and become experts in their content knowledge over time (see Bennett et al., 2022). The facilitating meaningful classroom discourse project, a component of MWM, was recommended as a teaching practice to support and enhance mathematics instruction.

In organizing a successful PD, it is essential to understand teacher individual learning as well as their background in subject matter. The focus should not only be on how effective the PD is, but also focus on teacher learning (Bertram & Rolka, 2022). The communication of ideas, which could be in the form of oral language, symbols, and models, could take place either during pair-work, guided groups, whole-class, small-groups, and teacher discussions to promote student engagement, synthesis of new ideas, and learning (Costello, 2021; Legesse et al., 2020; & Woods, 2022). According to Mok et al. (2022), a PD that facilitates mathematical classroom discourse could be productive because it promotes sociocultural perspectives, vocal contributions, and student thinking, and students can build on each other's ideas. When students communicate their understanding, teachers can use that knowledge to collect data, address misconceptions and provide appropriate instruction (Costello, 2021).

According to Jacobs et al. (2022), the intentional use of teaching practices that promoted classroom discourse is essential because a PD allows the teacher to identify and practice how they could facilitate an atmosphere of discourse. According to Glickman et al. (2018) and Darling-Hammond et al. (2017), a successful PD program must have the following:

- Teacher involvement in planning, implementing, and evaluating
- Focus on teaching and learning
- Integration of PD goals with school improvement goal
- Coherence of individual, group, and school-wide PD
- Administrative support
- Relevant, job-embedded PD
- Collegiality and collaboration
- Active learning
- Inquiry
- Self-reflection

- Inclusion of content on diversity and cultural responsiveness
- Follow-up to support the application of learning
- Ongoing, data-based program assessment
- Assurance that the PD becomes part of the school culture
- Development of leadership capacity

An ongoing professional develop plan could improve teachers' instructional strategies and ability to adapt their instruction to meet students' needs and classroom management skills. It could establish a professional culture that relies on shared beliefs about the importance of teaching and learning and the emphasis on teacher collegiality. According to Glickman et al. (2018), three stages support the implementation of a successful PD, which include: (a) orientation, (b) integration, and (c) refinement. During the orientation stage, benefits, responsibilities, and personal concerns were addressed, and the initial real-world application training opportunities occurred. In the integration stage, teachers were assisted in moving beyond PD to application in their classrooms.

Through this support, teachers can build confidence and competence in their classrooms. A follow-up plan on this implementation was necessary to improve the initiative. Teachers moved from basic competence to expertise through continuous experimentation and reflection (Glickman et al., 2018). Teachers became experts in this field to help and support their team members. During the refinement stage, teachers went beyond creating units through support and working with others, and they developed new learning structures to become staff developers. As teams reflect, they found it necessary to conduct action research to plan, implement, and assess their learning using current research.

To orient PD, teachers had the opportunity to review the findings of this study prior to attending to prepare for the PD. Teachers then integrated new knowledge and applied it in their classrooms and supported peers in the district. An online platform was a preferred method because of limited geographical boundaries, it provided personalized learning, online resources, and collaboration (see Mailizar et al., 2022).

**eLearning**

eLearning is the application and connection of technology using tools, resources, digital communication, and collaboration to advance learning experiences (Alhabeeb & Rowley, 2017). According to Nuncio et al. (2020), eLearning communicates technology in an asynchronous or synchronous process to promote learning and engage students. eLearning was personalized to allow teacher voice and choice in the learning process (see Redmond & Macfadyen, 2020). Online learning provides opportunities to extend learning and could offer mobile tools such as laptops, iPads, and smart phones to enhance learning (Videla et al., 2022). Creating an eLearning community that promoted digital citizenship tools and collaboration produces balanced social media experiences for teachers.

The learning community needs to work together in the learning ecosystem to form critical relationships and uphold the learning system's existence, support, and stability (van de Heyde & Siebrits, 2019). According to Lim and Richardson (2021), cognitive presence engaged students in high-level discussions and complex tasks; teaching presence was essential in offering a successful online learning experience, and social presence may influence learning outcomes when participants interact as a community.

The ecosystem coordinated the facilitation of the community learning styles and the profoundly rooted activities in inquiry and engagement (Lim & Richardson, 2021). The learning management system (LMS) supported pedagogy and social and cultural influences in the learning community (van de Heyde & Siebrits, 2019).

Wannapiroon and Petsangsri (2020) asserted the importance of preparing teachers and students for 21st century social and emotional skills in this changing world. Calamlam (2021) asserted that students needed to be equipped with communication, thinking, problem-solving, and interpersonal skills. Teachers must know the different learning styles, the learning community, the pedagogy, and the learning environment. Teachers were a part of a learning ecosystem that was learning to change with the times. The online course supported teachers and students and the stability of the learning system using 21st century learning skills (van de Heyde & Siebrits, 2019). The online course provided voice, and a choice in how teachers learn (Campbell & Cox, 2018).

In computer-supported collaborative learning, teachers work together to advance knowledge; they are task-oriented and used technology to structure learning represented visually and scaffolded (Zabolotna et al., 2023). The community of inquiry promoted inquiry-based learning and communication to make meaning of available information and connections (Faulconer et al., 2018). Online tools, when used appropriately, enhance learning, collaboration, communication and promote resource sharing among users (Al-Azawei, 2019). A successful social presence involves meaningful learning experiences by engaging in cognitive, social, and instruction (Lim & Richardson, 2021). The teachers' presence fosters pedagogy that promote discourse and teaching that balanced the cognitive and social reality, forming solid relationships and critical thinking when learning (Lim & Richardson, 2021). It was essential to use online tools to educate, engage, collaborate, and share strategies among its users, furthermore, balanced with other activities. Sustainability of this course depended on the successful implementation of quality learning programs, innovation, progress, and effectiveness. According to Alharthi et al. (2019), a sustainable eLearning system must accommodate human needs and improvements, and a diverse social connection, adapt to changes in technology and environmental conditions, and preserve economic sustainability.

**Learning Management System (LMS)**

Canvas LMS was used because it provided flexible approaches to academic, social, cognitive, and affective engagement for online learners (Zanjani et al., 2017). LMS are used to organize content, give feedback, assess, grade, and other resources that allow students to work ahead or review content (Shchedrina et al., 2021). Canvas provided teachers with the opportunity to connect and engage with their peers. Canvas' software is open and reliable and allows institutions to manage digital learning and permit educators to create and present online learning (Zanjani et al., 2017).

**Universal Design for Learning (UDL)**

UDL guided the teaching of this course to focus on flexible learning, provide accommodations for teachers, and remove barriers to accessing those resources (Basham et al., 2020). There was ongoing support, data-driven decisions, and research-based practices, thus offering different ways to engage students by providing access and disrupting the status quo (Fornauf et al., 2021). The UDL guidelines provided a practical way to engage teachers in online learning. Smartphones and other mobile devices provided more engagement and teacher motivation than traditional teaching methods (Basham et al., 2020). In online learning, UDL addresses curriculum design, instructional resources, and teacher PD (Basham et al., 2020).

**Breakout Rooms on Microsoft Teams**

Microsoft Teams' breakout room is an interactive, collaborative tool that allows participants to share ideas and construct new knowledge (Karchmer-Klein et al., 2019). Teachers collaborated in real-time engaging in discussions and sharing work with peers. Successful eLearning employed a social constructivist approach with collaboration, interactions, critical thinking, and a community inquiry framework (Issa et al., 2014). To maintain a strong eLearning community in the network, communication, and collaboration tools were readily available to users and were flexible to allow interaction between users (Issa et al., 2014). Breakout rooms enabled teachers to set small groups based on students' needs, such as one-on-one instruction, asking questions and facilitating meaningful classroom discussions (Calder et al., 2021). Teachers assigned groups randomly or manually to differentiate instruction based on the group's dynamics or needs. The chat feature allowed teachers to write down ideas, divide tasks, and solve problems (Karchmer-Klein et al., 2019).

**Project Description: Meaningful Mathematics Discourse**

The purpose of this online PD course was to:

- Learn about the characteristics of mathematics teaching practices that promote student learning including: (a) posing purposeful questions, (b) facilitating meaningful classroom discourse, and (c) classroom practice.

- Collaborate with peers and get feedback in whole or break-out rooms.
- Discuss how the use of different discourse structures (i.e., whole-class, small-group, teacher-led, student-led, etc.) can affect mathematical discourse in the classroom.
- Engage in eLearning activities that strengthen student conceptual knowledge, assist group discussion by posing purposeful questions, and facilitate meaningful discourse.
- Collaborate with others in job-embedded and ongoing PD and support maintaining high-quality instructions and having high expectations for all students (Trust & Pektas, 2018).
- Select a video to share with others for feedback.

***Potential eLearners and Characteristics***

The potential learner group for this course were middle school math teachers grades 6-8, including special education (Sped) and EL teachers.

***Age, Ethnicity, and Gender***

- Participants were middle school teachers from the district.
- There were multiple ethnic groups represented.
- There were varying levels of mathematics teaching experience.
- Different cultural backgrounds and gender.

## Key Needs

### *Educational Goals*

- The online course promoted teacher professional goals, job enhancement, and earning recertification points (see Stavredes & Herder, 2014).
- Teachers engaged in small manageable tasks to complete during the course.
- Stress management strategies were shared with staff every week from the employee assistance program department.
- Collaborative work benefits.
- Break-out rooms.

### *Issues of Diversity*

- All were T-scale employees and work at the school level.
- Staff were from different cultural backgrounds.
- The staff had varying levels of mathematics teaching experience.
- There were some staff members who teach Sped and EL.

### *Technology Needs*

- Teachers accessed learning goals, activities, and materials through Canvas.
- Some teachers preferred pages, and some preferred modules.
- Throughout this course, modules were used.
- Some teachers needed assistance with navigating modules.

### *Computer Literacy*

- Access to Microsoft Teams and Canvas.
- All teachers had experience using the district's LMS, Canvas.

- Teachers communicated with students through Canvas messages and Microsoft Teams.
- Computer-based interaction.
- Teachers posted on discussion boards, and they were familiar with social media platforms, such as Google, Canvas, Microsoft Teams, and Nearpod.

***Hours of Employment***

- Teachers were employed full-time, 7.5 hours a day.
- The synchronous meeting occurred the 3 days during the 3-week self-paced course on Microsoft Teams.

***Family Responsibilities***

- Deadlines considered the teachers' current schedule and workload. Teachers engaged in small and manageable tasks.

***Course Access***

- Teachers accessed Canvas through school issued iPads, in addition to MacBooks and Dell computers.
- Canvas was also accessible on mobile phones.
- Mobile phone access was optional, but it was available to staff.

***Proposed LMS***

- Teachers could download the Canvas app on their mobile devices and logged in using their one login access.

Teachers engaged in learning activities that strengthened their conceptual knowledge by posing purposeful questions and facilitating meaningful discourse. They uncovered common misconceptions and conducted appropriate interventions to deepen their students' understanding. Teachers used Canvas modules, discussions, assignments, and announcements throughout the course. Teachers met on Teams weekly for 1-hour synchronous sessions. There were weekly self-paced activities and collaboration with other middle school teachers. Teachers reviewed using modules on Canvas as a prerequisite for this course.

The course sequence included whole-group PD on Microsoft Teams, followed by self-paced activities and weekly discussions. For the final product, teachers recorded a lesson they taught that week, applied mathematical discourse strategies, and selected a short clip to present in the last meeting to receive feedback from their peers using a rubric. Teachers registered on a PD platform where they register for courses.

The course discussions and assignments focused on interactions, learner-to-learner, learner-to-instructor, and learner-to-content, ensuring that teachers were actively engaged in the course (see Martin & Bolliger, 2018). The discussions and assignments were designed with teachers in mind because they enhance engagement and connect students as a community. Teachers actively engaged in Microsoft Teams and used the chat feature to participate in discussions, assignments, and classroom strategies. The course offered content in different modes to accommodate teacher learning needs, and its organization provided easy access for all teachers (see Whiteside et al., 2017). According to Martin and Bolliger (2018), positive online experiences offer multiple entry points for learners to collaborate with others, support cognitive development, create new knowledge, and share resources and teaching strategies. Although the content was important, teacher engagement was crucial to the course's success because it allowed active engagement and feedback from other teachers.

Teachers actively interacted with the instructor in the meaningful classroom discourse course synchronously. The asynchronous part of the course helped to build rapport, group work collaboration, and feedback and facilitated engagement using the chat features, discussion boards, and groups task (Martin & Bolliger, 2018). The assignments were linked in the syllabus (see Appendix A), pages, assignment tab, and multimedia (see Appendix D) to facilitate classroom discussions. The UDL drove the content in this course, allowing multiple entry points into the course and materials to build a collaborative community that meaningfully engaged with the content and explicitly described the criteria for success (Whiteside et al., 2017).

The final video upload assignment, an authentic task, required teachers to apply knowledge from the course discussions, assignments, prior experience, and resources (see Martin & Bolliger, 2018). Teacher success in the course was measured by the rubric score of four. Teachers began the course with the end in mind, thinking about how their videos would reflect and transfer knowledge learned during the first two modules, posing purposeful questions, and facilitating meaningful discussions (McTighe & Wiggins, 2014). The desired outcome required that teachers share a video of themselves posing purposeful questions and facilitating meaningful mathematics discourse. The rubric assessed how teachers effectively posed purposeful questions and facilitated meaningful discourse in their classrooms.

### ***Sustainability of the Course***

Quality learning resources, instructional design, flexibility, and student engagement indicated effective attainment measures. The PD course considered the teacher's time, cost, experiences, and differentiated instruction based on each building's needs. The course met the sustainability threshold because individual needs were considered, ensuring it was a diverse group. It used current technology and tools to make the course successful and cost-efficient (Alharthi et al., 2019).

### ***Backwards Design***

Participants transferred knowledge learned during the first two modules into a practical tool they could use with students (see McTighe & Wiggins, 2014). The desired outcome required that teachers share a video of themselves posing purposeful questions and facilitating meaningful mathematics discourse. The rubric assessed how teachers effectively posed purposeful questions and facilitated meaningful discourse.

### ***Assessments Aligned to Learning Outcomes***

Formative assessments included discussions and assignments during the first two modules. In the summative assessment, teachers effectively applied their knowledge gained from formative assessments and used their learning in the classroom (see McTighe & Wiggins, 2014).

### ***Sequencing of Instruction***

Teachers accessed the course, materials, rubrics before the before the course started. The course featured modules on purposeful questions, mathematics discourse, and video analysis. Modules were synchronous and asynchronous. The final session culminated all strategies learned in the 3 weeks.

## Project Evaluation Plan

I used objective-based evaluation. The objective-based evaluation clarified the project's purpose and the information collected. According to Turhan and Kent (2021), the objective-based model predicts the project's intent and purpose (see Appendix A); the purpose of the online course was to engage and build teacher confidence. To shift from teacher-centered teaching to a more student-centered approach by promoting classroom discourse. The key stakeholders were middle school teachers who had varying teaching experiences, from different cultural backgrounds, and different technology use understanding. The objective was to balance content and pedagogy, including elements and strategies of effective characteristics of two math teaching practices that promote student learning including: (a) posing purposeful questions and (b) facilitating meaningful classroom discourse.

I applied the analysis, design, development, implementation, and evaluation (ADDIE) model used by instructional designers to facilitate learner-centeredness. Using the ADDIE model helped identify common themes that would guide the course, selected overarching themes, created course objectives, and learning outcomes, and aligned assessments and instructional strategies. The development stage articulated the goals and expectations of the course, the creation of modules, syllabi, and support for different learners (see Appendix A). Middle school teachers engaged in learning activities that strengthened their conceptual knowledge and facilitated group discussions in their classrooms by posing purposeful questions and facilitating meaningful discourse.

The final product highlighted teacher knowledge and understanding of mathematical practices that supported student engagement, justification, mathematical reasoning, and making mathematical generalizations (see NCTM, 2014). Teachers were provided with tools to appreciate productive student discussions to promote quality interactions and conceptual understanding because learning is a social process (Vygotsky, 1978). Teacher surveys and peer feedback were used to evaluate the course effectiveness.

## Project Implications

No statistical differences in EL Levels 1-2 and EL Levels 3-4 instructed in MWM were revealed. Some variables were not considered, for example, teacher skill and student gender. This project was appropriate because there has yet to be ongoing and practical PD at HSD. During the COVID-19 pandemic, teachers focused on student online access to avoid falling further behind. This PD had the potential for a positive social change because it was designed to address the gap at HSD and provide district leaders an opportunity to monitor the effectiveness of online and ongoing PD efforts. The project addressed the need for a shift in mathematics teaching and areas of improvement and identified a correlation between teachers who attend the training and student outcomes. Relevant research supported the use of mathematical discourse practices because they could be effective in supporting students in actively making sense of mathematics by: (a) building upon prior understanding and experience and (b) talking with others to provide and receive feedback on mathematical reasoning.

NCTM (2014) recommended these practices for supporting student learning; this project had the potential to help other mathematics teachers improve student discourse and outcomes. School leaders could use the data from teacher satisfaction surveys to make further recommendations about providing similar courses to improve student outcomes. The limited scope of this project was not generalizable to schools in other settings.

## Section 4: Reflections and Conclusions

This section includes a review of the strengths and limitations of the project, recommendations for alternative approaches, and a reflection on the importance of the work. A description of the potential social change impact, directions for future research, and the project summary are also included.

### Project Strengths and Limitations

The strength of this project was built upon literature supporting an instructional shift in mathematics teaching. Meaningful classroom discourse helps develop teachers' communication skills, supports active participation, and makes sense of different lessons' contributions (Kabael & Baran, 2017). I aimed to develop teacher confidence by shifting from a teacher-centered mathematics classroom into one that is student-centered and connects theory to practice (see Kohen & Borko, 2022). Research-informed actions for mathematics teachers supported the project. NCTM (2014) provided a framework for teaching and learning with eight mathematics teaching practices. Two practices were incorporated into this project: posing purposeful questions and facilitating meaningful classroom discourse.

The limitation of the project was that it was an online learning platform compared to traditional face-to-face PD. The project could offer a more blended approach, promoting differentiation. In a blended learning environment, students learn online and in-person with an opportunity for choice, pace, and one-piece with the teacher (Calamlam, 2021). Another limitation of this project was that the focus limited mathematics instruction to one teaching component, mathematics discourse in middle school. The project could expand to other topics that improve student learning and elementary and high school mathematics teachers.

## Recommendations for Alternative Approaches

Based on this project, two alternative approaches were recommended. One is to open this course to all teachers because classroom discourse is not only a mathematical issue. Rather, it affects all content areas and grade levels in this local setting. The second alternative approach could include teachers demonstrating knowledge they have gained by presenting lesson plans and recording the lessons given in their classes.

## Scholarship, Project Development and Evaluation, and Leadership and Change

While working on this project, scholar-practitioner and leadership skills were developed and acquired. The literature supported the project and had the potential to improve mathematics outcomes and engage students in rich mathematical experiences. Walden University (2022) asserted that the goal of being a social change agent is to mentor students to become change-makers in their communities and to empower them with tools to make lasting and sustainable change. According to Ashoka (2017), a change agent could be anyone with an imagination to make things better for their community and ultimately inspire others to do the same. Applying the ADDIE model for online instructors and thinking about the project outcomes and evaluation were elements of the project that I learned. Instruction and tasks were written in student-friendly language and provided easy access for participants who have disabilities. Learning was scaffolded using knowledge maps to assist visual learners with understanding concepts, inserting a start here document, precise evaluation tools, and providing real-time support to explain concepts differently (Stavredes & Herder, 2014).

## Reflection on Importance of the Work

Regardless of the number of years in teaching, teachers need PD that supports learning and student success. The project was evidence-based; however, improving mathematics is not limited to one strategy. Research has indicated a need to address the low mathematics scores, strengthening the theory with practice and sustaining coherent mathematics PD (Kohen & Borko, 2022). This work has helped me in becoming a scholar-practitioner and educator and to make a positive social change impact in the district and beyond.

## Implications, Applications, and Directions for Future Research

Findings from this study emphasized the need for evaluating ongoing and targeted mathematics PD programs in schools and documentation of mathematical practices. The project contributes to positive social change by promoting ongoing and convenient professional learning, reflection, feedback, school and peer support, and positive student academic success. Future researchers could build on the importance of classroom discourse because teachers play a role in promoting its effectiveness to assess the effect of classroom discourse in online mathematics courses. Further research is recommended to investigate how teachers perceive a fully developed PD process. Additional studies focusing on how teachers experience the implementation of a new instructional methodology and their effects on student engagement and achievement could also be helpful in implementation planning. Future researchers could examine school leaders' role in supporting teachers to improve their pedagogy and learning. Exploring mathematics content, pedagogy, and teaching practices may support student outcomes.

There is a profound need for effective PD that results in changes in teacher practices and improvements in student learning outcomes. To define features of effective PD, Darling-Hammond et al (2017) conducted a meta-analysis and concluded that an effective PD provides built-in time for teachers to think about, receive input on, and make changes to their practice by facilitating reflection and soliciting feedback. Further, it should have sustained duration; effective PD provides teachers with adequate time to learn, practice, implement, and reflect upon new strategies that facilitate changes in their praxis.

## Conclusion

The project study focused on ongoing online PD after the study's findings. The problem was that most middle school ELs needed to reach basic proficiency on their MI at HSD. I used archival data from 625 students to investigate the differences in the Spring MI scores between middle school EL Levels 1–2 and EL Levels 3–4 students who participated in the MWM for 18 weeks and EL students who did not, while controlling for the Fall MI scores at HSD. Hypothesis 1 (differences for Level 1 and 2 students) was not supported (see Table 6). Hypothesis 2 (differences for Level 3 and 4 students) was also not supported (see Table 13). No statistical differences in EL Levels 1-2 and EL Levels 3-4 instructed in MWM were revealed. Discussing the project, local and future research implications, and contributing to positive social change help enhance lifelong learning skills. As reflected in the project scholarship, I learned skills on project development, writing as an academic scholar, leadership skills, and creating online courses.

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# Appendix A: The Project

Course Syllabus

**Course Description**

This three-week course is grounded in the National Council of Teachers of Mathematics (NCTM) (2014) Principles to Action for effective mathematics teaching practices. This course will balance content and pedagogy, including elements and strategies of effective characteristics of two math teaching practices that promote student learning:

- Posing purposeful questions
- Facilitating meaningful classroom discourse

Teachers will engage in learning activities that strengthen their conceptual knowledge, facilitating group discussion by posing purposeful questions and facilitating meaningful discourse. They will also uncover common misconceptions and carry out appropriate interventions designed to move their students to a deeper level of understanding.

**Student Learning Outcomes**

Participants will:

1. Learn about the characteristics of two math teaching practices that promote student learning:
    - Posing purposeful questions
    - Facilitating meaningful classroom discourse
2. Apply strategies with peers

- Collaborate with your peers in discussions and assignments and get feedback.
- Discuss how the use of different discourse structures (whole-class, small-group, teacher-led, student-led, etc.) can affect mathematical discourse in the classroom.

3. Engage in eLearning activities that will strengthen student conceptual knowledge, facilitate group discussion by posing purposeful questions, and facilitating meaningful discourse.
    - Collaborate with others in job-embedded and ongoing professional development and support maintaining high-quality instructions and having high expectations for all students (Trust & Pektas, 2018).
    - Select a video to share with others for feedback using the rubric.

**Program Structure**

| Date | Module | Activity | Time |
|---|---|---|---|
| 01/09/2023 | Module 1 Week 1 Posing Purposeful Questions | Synchronous Workshop: Introduction to Posing Purposeful Questions | I hour |
| Week of 01/09/23 | Asynchronous | Debrief and complete module 2 tasks | Throughout week 1 |
| 01/17/2023 | Module 2. Week 2 Workshop: Introduction to facilitating meaningful discourse | Synchronous Workshop: Introduction to Facilitating Meaningful Discourse | 1 hour |
| Week of 01/17/22 | Asynchronous | Debrief and complete module 3 task using the rubric | Throughout week 2 |
| 01/23/2023 | Module 3 Week 3 Video Analysis | Bring video clip to share and discuss:<br>Posing purposeful questions<br>Facilitating meaningful discourse | I hour |
| Week of 01/30/23 | Glickman et al.'s final stage-Feedback | • continuous experimentation and reflection<br>• developing new learning structures | Ongoing |

**Assessments**

**Module 1 Discussions**

- How do you use questioning in your classroom? Give specific examples.
- Effective mathematics teaching uses purposeful questions to assess and advance students' reasoning and sense-making about important mathematical ideas and relationships. What does that look like in your classroom? Can you share an example you have used?
- To what extent does the teacher use purposeful questions to assess and advance students' reasoning and sense-making about important ideas and relationships?

- To what extent does the teacher use purposeful questions to assess and advance students' reasoning and sense-making about essential math ideas and relationships?
- How is the approach like or different from the Ferris Bueller example?
- Review the patterns of questions.
- Do you agree that the *Ferris Bueller* example illustrates the "Pre-determined Path" questioning pattern? Why or why not?
- Find an example of the "Responsive to Student Thinking" questioning pattern in the *Two Tanks* transcript. Explain.

**Module 2 Discussions**

1. When do you use discussion in the classroom?

- For what types of activities? For what purpose?
- What do you do to encourage students to participate in math discussions?

2. Discussion and student learning

- As students analyze and compare their approaches and arguments with others, they deepen their mathematical understanding.
- How can teachers facilitate productive discussions that advance student understanding?

3. Group discussion-Read the case for Mr. Crane's class.

- What does Mr. Crane provide opportunities for students to analyze and compare approaches/arguments to deepen their mathematical understanding?
- What more could he have done?

4. After watching Mr. Dubno's video, discuss

- How does the sequence of presentations allow for the development of mathematical ideas?
- In what ways do the students analyze and critique the approaches?
- What types of questions does Mr. Dubno use to encourage analysis, comparison, and connections leading to deeper understanding? (Think back to Module 1)
- How do these questions affect the discussion?

*Be sure to use the transcript to provide evidence for your responses.*

5. Moving toward meaningful mathematics discourse. Use the rubric to determine where Mr. Dubno's classroom falls on this chart?

| Level | Teacher role | Questioning | Explaining mathematical thinking |
|---|---|---|---|
| 1 | The teacher is at the front of the room and dominates the conversation | The teacher is the only questioner. Questions serve to keep students listening to the teacher. Students give short answers and respond to the teacher only | Teacher questions focus on correctness. Students provide short answer-focused responses. The teacher may provide an answer |
| 2 | The teacher encourages the sharing of math ideas and directs students to talk to the class. | Teacher questions begin to focus on student thinking and less on answers. The only teacher asks questions. | The teacher probes students' thinking somewhat and elicits one or two strategies. The teacher may fill in the explanation. Students provide brief descriptions of their thinking in response to teacher probing. |
| 3 | The teacher facilitates conversation between students and encourages students to ask questions of one another. | The teacher asks probing questions and facilitates some student-to-student talk. Students ask questions of one another with prompting from the teacher. | The teacher probes more deeply to learn about student thinking. The teacher elicits multiple strategies. Students respond to the teacher probing and volunteer their thinking. Students begin to defend their answers. |
| 4 | Students carry the conversation themselves. The teacher only guides from the periphery of the conversation. The teacher waits for students to clarify the thinking of others. | Students-to-student talk is student-initiated. Students ask questions and listen to responses. Many questions ask "why" and call for justification. Teacher questions may still guide discourse. | The teacher follows student explanations closely and asks students to contrast strategies. Students defend and justify their answers with little prompting from the teacher. |

Adapted from NCTM Principles to Action (2014)

**Discussions Rubric**

| Not Present | Low | Mid | High |
|---|---|---|---|
| Not present or minimally present. Participants may contribute a word or a phrase infrequently. | Very brief contributions, for example, one or two-word answers or partial descriptions of mathematical ideas. | There are some substantive contributions. Engage in limited mathematical ideas and reasoning. | Contributions are substantive and provide specific examples—engaging others in purposeful sharing of mathematical ideas, reasoning, and varied approaches. Compares and contrasts different approaches when solving a task |

## Assignments

### Module 1 Assignment 1

### Types of Questions

Use the transcript and video to identify the types of questions asked by the teacher.

Feedback will be given by peers using the rubric.

### Module 1 Assignment 2- Two Storage Tank- Solve the task

- 8th-grade students.
- Students have previously written linear expressions to describe relationships represented by graphs, numerical patterns, and visual patterns.
- Work on the task individually and then as a group.
- What are some different ways the task can be solved?
- What challenges might students face in working through the task?

### Module 3 Assignment

Select ***one*** of the two assignments below. Be ready to share out with the group during week 3

**Choice 1**

**Record a short video clip where you as a teacher are:**

- Advancing student understanding by asking questions that build on, but do not take over or funnel, student thinking
- Making sure to ask questions that go beyond gathering information to probing thinking and requiring explanation and justification
- Asking intentional questions that make the mathematics more visible and accessible for student examination and discussion
- Allowing sufficient wait time so that more students can formulate and offer responses

**Choice 2**

Record a short video clip where students are:

- Expecting to be asked to explain, clarify, and elaborate on their thinking
- Thinking carefully about how to present their responses to questions clearly, without rushing to respond quickly
- Reflecting on and justifying their reasoning, not simply providing answers
- Listening to, commenting on, and questioning the contributions of their classmates.

**Video Analysis Rubric**

| Level | Teacher's role | Questioning | Explaining mathematical thinking |
|---|---|---|---|
| 1 | The teacher is at the front of the room and dominates the conversation | The teacher is the only questioner. Questions serve to keep students listening to the teacher. Students give short answers and respond to the teacher only | Teacher questions focus on correctness. Students provide short answer-focused responses. The teacher may provide an answer |
| 2 | The teacher encourages the sharing of math ideas and directs students to talk to the class. | Teacher questions begin to focus on student thinking and less on answers. Only the teacher asks questions<br>. | The teacher probes students' thinking somewhat. One or two strategies may be elicited. The teacher may fill in the explanation. Students provide brief descriptions of their thinking in response to teacher probing. |
| 3 | The teacher facilitates conversation between students and encourages students to ask questions of one another. | The teacher asks probing questions and facilitates some student-to-student talk. Students ask questions of one another with prompting from the teacher. | The teacher probes more deeply to learn about student thinking. The teacher elicits multiple strategies. Students respond to the teacher probing and volunteer their thinking. Students begin to defend their answers. |
| 4 | Students carry the conversation themselves. The teacher only guides from the periphery of the conversation. The teacher waits for students to clarify the thinking of others. | Students-to-student talk is student-initiated. Students ask questions and listen to responses. Many questions ask "why" and call for justification. Teacher questions may still guide discourse. | The teacher follows student explanations closely. The teacher asks students to contrast strategies. Students defend and justify their answers with little prompting from the teacher. |

Adapted from NCTM Principles to Action (2014)

## Appendix B: Course Alignment

| | Big Ideas/ Topics | Student Learning Outcomes | Learning Resources | Discussions | Assignments |
|---|---|---|---|---|---|
| **Week 1** | Introduction to facilitating meaningful discourse | Discuss the purpose of questioning.<br>Learn different types of questions.<br>Compare and contrast two videos.<br>Review the patterns of questions.<br>Apply questioning techniques in the classroom | • NCTM's Principles to Actions book<br>• Two Storage Tank Task<br>• Task Overview<br>• Counting Cubes<br>• Task Overview<br>• Rubric<br>• **http://www.nctm.org/PtAToolkit/**<br>• Microsoft Teams Link<br>• MacBook<br>• iPad<br>• Dell<br>• Smartphone<br>• Questioning Slides<br>• Facilitating Meaning Discussions slides<br>• **eLearning Course Multimedia (Links to an external site.)- Introduction to posing purposeful questions.**<br>• **Introduction to course multimedia**<br>• **Grading Criteria** | • How do you use questioning in your classroom? Give specific examples.<br>• Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense-making about important mathematical ideas and relationships. What does that look like? Can you share an example you have used?<br>• To what extent does the teacher use purposeful questions to **assess** and **advance** students' reasoning and sense-making about important ideas and relationships?<br>• To what extent does the teacher use purposeful questions to assess and advance students' reasoning and sense-making about important math ideas and relationships?<br>• How is the approach like or different from the Ferris Bueller example?<br>• Review the patterns of questions.<br>• Do you agree that the *Ferris Bueller* example illustrates the "Pre-determined Path" questioning pattern? Why or why not?<br>• Find an example of the "Responsive to Student Thinking" questioning pattern in the *Two Tanks* transcript. Explain. | **Module 1 Assignment 1- Two Storage Tank- Solve the task:**<br><br>Two Storage Tank Task<br><br>Task Overview<br><br>• Given to 8th grade students.<br>• Students have previously written linear expressions to describe relationships represented by graphs, numerical patterns, and visual patterns<br>• Work on the task individually and then as a group.<br>• What are some different ways the task can be solved?<br>• What challenges might students face in working through the task? |
| **Week 2** | | | • 5 Practices for Orchestrating Productive Mathematics Discussions book | **Module 2 Discussions** | Solve and Discuss the **Counting Cubes Task**<br><br>Watch the video clip and discuss what the teacher does to support his |

| | Big Ideas/ Topics | Student Learning Outcomes | Learning Resources | Discussions | Assignments |
|---|---|---|---|---|---|
| | | | • [Meaningful classroom discourse Slides]() | 1. When do you use discussion in the classroom?<br>• For what types of activities? For what purpose?<br>• What do you do to encourage students to participate in math discussion?<br>2. Discussion and student learning<br>• As students analyze and compare their approaches and arguments with others, they deepen their own mathematical understanding.<br>• How can teachers facilitate productive discussions that advance student understanding?<br>3. Group discussion-Read the case for Mr. Crane's class.<br>• What does Mr. Crane do to provide opportunities for students to analyze and compare approaches/arguments to deepen their mathematical understanding?<br>• What more could he have done?<br>4. After watching Mr. Dubno's video, discuss<br>• How does the sequence of presentations allow for development of mathematical ideas?<br>• In what ways do the students analyze and critique the approaches?<br>• What types of questions does Mr. Dubno use to encourage analysis, | students' engagement in and understanding of mathematics<br>Discuss the effective mathematics teaching practices of *use and connect mathematical representations and facilitate meaningful mathematical discourse.*<br>[Counting Cubes Task]()<br>[Task Overview]()<br>[Rubric]() |

| | Big Ideas/ Topics | Student Learning Outcomes | Learning Resources | Discussions | Assignments |
|---|---|---|---|---|---|
| | | | | comparison, and connections leading to deeper understanding? (Think back to Module 1)<br>• How do these questions affect the discussion?<br><br>*Be sure to use the transcript to provide evidence for your responses.* | |
| **Week 3** | Introduction to facilitating meaningful discourse<br>Video Analysis | Discuss meaning classroom discourse.<br>Discuss discourse moves used by Mr. Crane.<br>Apply the **5 Practices for Using Student Responses in Discourse**<br>Watch video of a teacher and find evidence using a rubric | | | **Module 3 Assignment**<br><br>Select ***one*** of the two assignments below. Be ready to share out with the group during week 3<br><br>**Choice 1**<br><br>**Record a short video clip where you as a teacher are:**<br><br>• Advancing student understanding by asking questions that build on, but do not take over or funnel, student thinking<br>• Making certain to ask questions that go beyond gathering information to probing thinking and requiring explanation and justification<br>• Asking intentional questions that make the mathematics more visible and accessible for student examination and discussion<br>• Allowing sufficient wait time so that more students can formulate and offer responses |

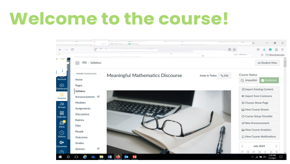
| | Big Ideas/ Topics | Student Learning Outcomes | Learning Resources | Discussions | Assignments |
|---|---|---|---|---|---|
| | | | | | **Choice 2**<br><br>Record a short video clip where students are:<br><br>• Expecting to be asked to explain, clarify, and elaborate on their thinking<br>• Thinking carefully about how to present their responses to questions clearly, without rushing to respond quickly<br>• Reflecting on and justifying their reasoning, not simply providing answers<br>• Listening to, commenting on, and questioning the contributions of their classmates.<br><br>Rubric |

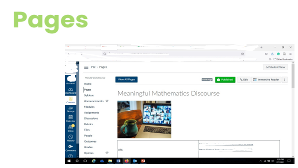
Appendix C: Course Materials

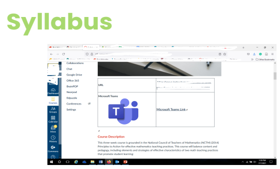
| District issued devices | Teams Access | NCTM Videos | Tasks | PowerPoint slides | Books (issued to each school) |
|---|---|---|---|---|---|
| MacBook<br><br>iPad<br><br>Dell<br><br>Smartphone | Microsoft Teams link | Two storage tank task<br><br>Counting Cubes | Two storage tanks task<br><br>Mr. Dubno and counting cubes task | Questioning slides<br><br>Meaningful discussions Slides | NCTM's Principles to Actions book<br><br>5 Practices for Orchestrating Productive Mathematics Discussions book |

Appendix D: Modules

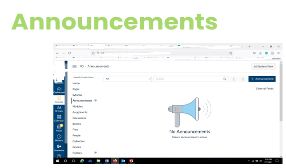
Introduction-Module 1

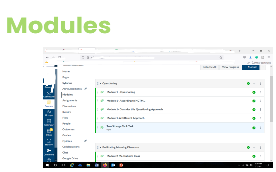



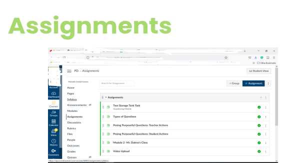



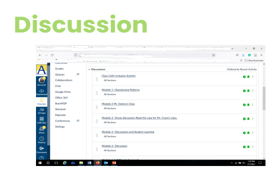



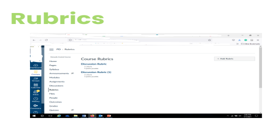


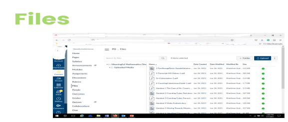



Rubrics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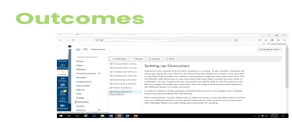
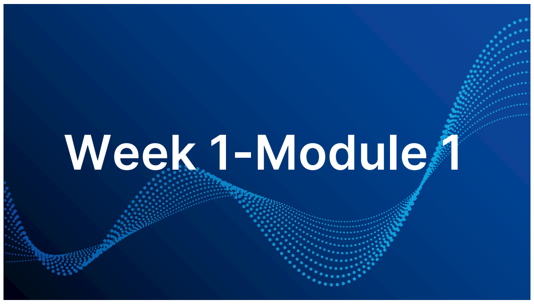
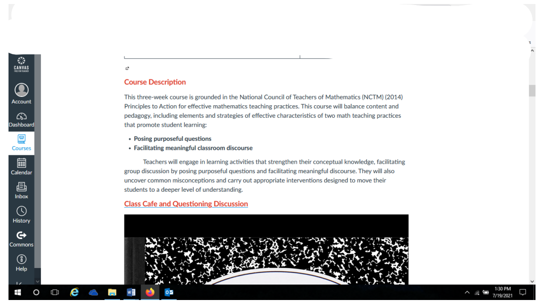
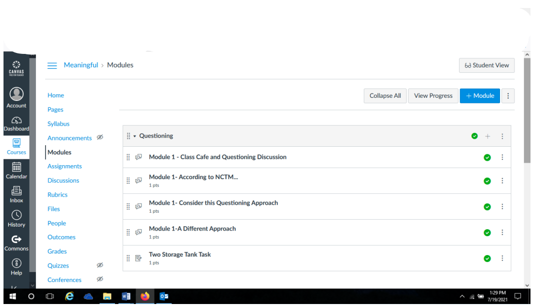

Outcomes

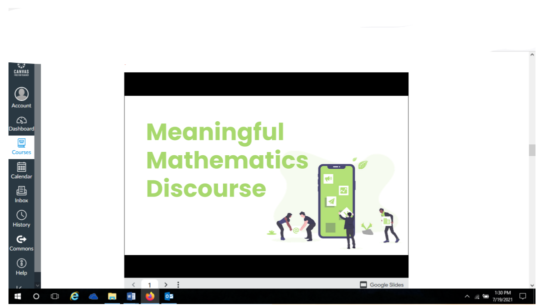

Thank you
for taking
this course
Contact:
Canvas messages
Teams by appointment only

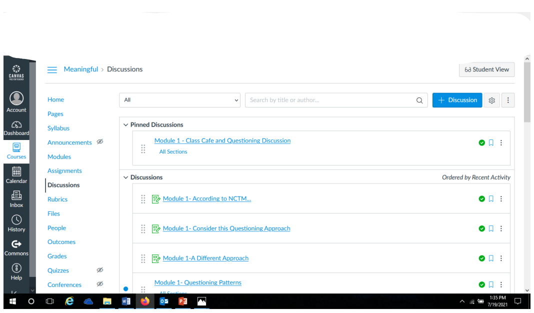
Week 1 Module

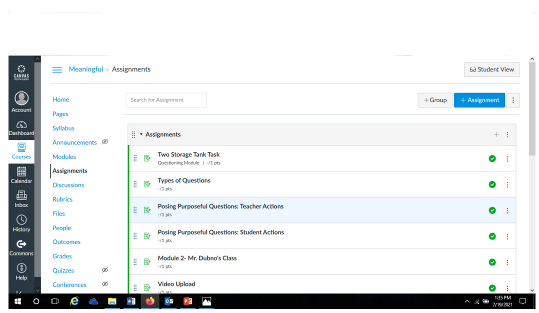








Introduction Transcript

Slide 1

Welcome to Week 1 Module 1 of the three-week course, Meaningful classroom discourse.

Slide 2

This week you will work both synchronously and asynchronously. Module 1, questioning will highlight your strategies you may have used to pose purposeful questions in your classroom. You will engage in class discussions and assignments and begin to think about your product, video analysis.

Slide 3

Module 1 is about questioning techniques and patterns used in classrooms. As you collaborate with your peers, be thinking about what learning experiences you want your students to have.

Slide 4

You will have access to the slides prior to starting this course.

Slide 5

You will engage and collaborate with peers through discussions.

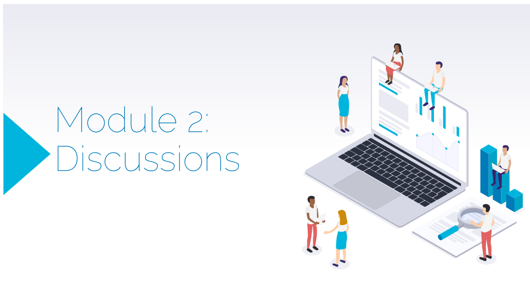
Slide 6

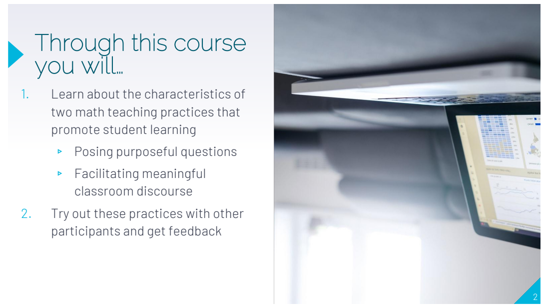
You will also complete short assignments throughout the modules

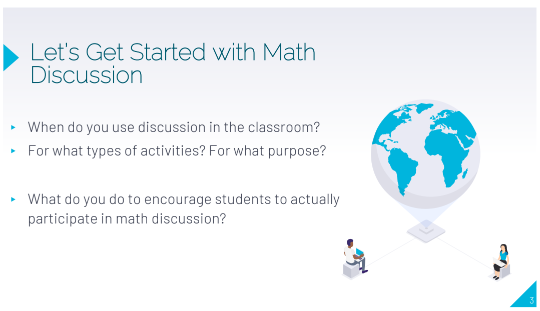
Slide 7

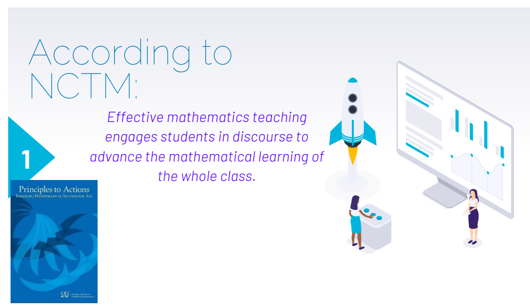
If you would like to contact me, the best way is to email me. I have provided the course URL and Microsoft Teams access for synchronous learning.

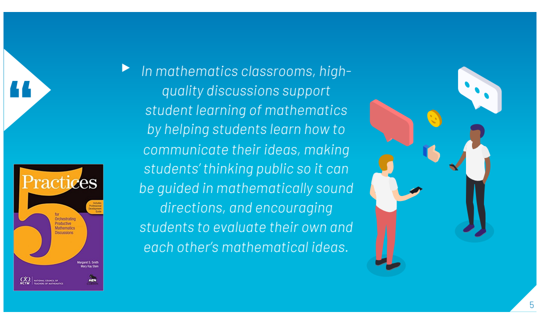
Week 2 Module 2

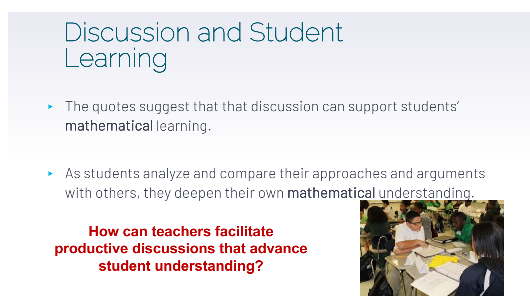


Week 2 Module 2 Transcript

Slide 2

During week 2 you will continue sharing your ideas about posing purposeful questions to your students. You will have an opportunity to discuss what you have tried and what impact it had on your students.

Slide 3

We will discuss the 5 practices for using student responses in discourse.

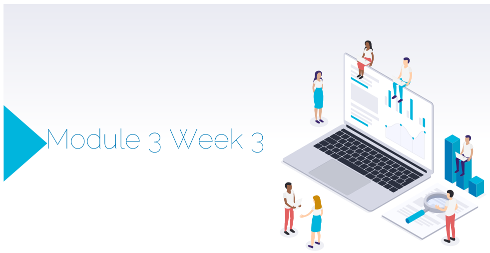
NCTM outlines 5 instructional practices that can encourage student sharing, comparison, and mathematical *learning*. They suggest a *planful* approach to discussion and mathematical development, rather than a simply “show and tell”.

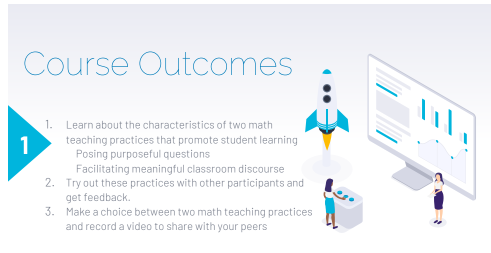
1. Anticipating – prior to the lesson, considering the various approaches you might see
2. Monitoring – as students work, pay attention to what they are doing and start to think about how the approaches connect *and* advance students’ mathematical understanding
3. Selecting – determine which approaches should be presented, and *why*. How would discussing those approaches advance student understanding. For example, unlike Mr. Crane, you might decide you want to be sure to go over an approach with an error to alleviate misconceptions that other students might harbor.
4. Sequencing – determine the order in which the approaches will be discussed. You might, for example, decide to go from least sophisticated to sophisticated so that students can see connections among approaches and advance their understanding.

5. Connecting – be sure to use questioning to support students in making *mathematical* connections across approaches and advancing their *mathematical* understanding. All along you are making sure to be accountable to the math.

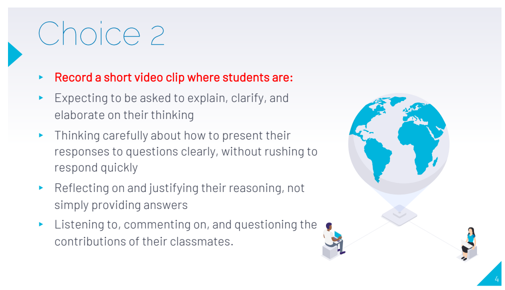
Note that the questioning skills you developed in the first module will play a strong role in supporting students to make connections among approaches.

# Module 3 Week 3








| Level | Teacher Role | Questioning | Explaining mathematical thinking |
|---|---|---|---|
| 1 | Teacher is at the front of the room and dominates the conversation | Teacher is the only questioner. Questions serve to keep students listening to the teacher. Students give short answers and respond to teacher only | Teacher questions focus on correctness. Students provide short answers-focused responses. Teacher may give answer |
| 2 | Teacher encourages the sharing of math ideas and directs students to talk to the class. | Teacher questions begin to focus on student thinking and less on answers. Only teacher asks questions | Teacher probes student’s thinking somewhat. One or two strategies may be elicited. Teacher may fill in the explanation. Students provide brief descriptions of their thinking in response to teacher probing. |
| 3 | Teacher facilitates conversation between students and encourages students to ask questions of one another. | Teacher asks probing questions and facilitates some student-to-student talk. Students asks questions of one another with prompting from the teacher | Teacher probes more deeply to learn about student thinking. Teacher elicits multiple strategies. Students respond to teacher probing and volunteer their thinking. Students begin to defend their answers. |
| 4 | Students carry the conversation themselves. Teacher only guides from the periphery of the conversation. Teacher waits for students to clarify thinking of others. | Students to student talk is student initiated. Students ask questions and listen to responses. Many questions ask “why” and call for justification. Teacher questions may still guide discourse. | Teacher follows student explanations closely. Teacher asks students to contrast strategies. Students defend and justify their answers with little prompting from the teacher. |

Module 3 Week 3 Transcript

Slide 2

During module 1 and 2, you learned about the characteristics of two mathematics teaching practices.

1. Posing purposeful questions
2. 2. Facilitating meaningful classroom discuss.
3. Make a choice between two math teaching practices and record a video to share with your peers

You collaborated with your peers through discussions and assignments. You shared your classroom experiences with each other.

Slide 3

You will select one video choice. Choice 1:

- Record a short video clip where you as a teacher are:
- Advancing student understanding by asking questions that build on, but do not take over or funnel, student thinking
- Making sure to ask questions that go beyond gathering information to probing thinking and requiring explanation and justification
- Asking intentional questions that make the mathematics more visible and accessible for student examination and discussion
- Allowing sufficient wait time so that more students can formulate and offer responses

Slide 4

Choice 2:

- Record a short video clip where students are:
- Expecting to be asked to explain, clarify, and elaborate on their thinking
- Thinking carefully about how to present their responses to questions clearly, without rushing to respond quickly
- Reflecting on and justifying their reasoning, not simply providing answers
- Listening to, commenting on, and questioning the contributions of their classmates.

Slide 5

During the synchronous meeting in week 3, you will share your video choice and explain the reason behind your choice. You and your teammates will use the video analysis rubric to determine your level from 1-4. Participants will have an opportunity to explain their reasoning for the scores.