ABSTRACT

Title of Capstone: AN EXPLORATION OF STRUCTURED DATA DISCOURSE AND STUDENT ENGAGEMENT IN ALGEBRA I, Jaime Bowers

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For the first time in 32 years, the national average scale score in mathematics dropped by seven points across the country in grades four and eight, according to the latest results of the National Assessment on Educational Progress (NAEP). The 2022 results in mathematics were staggering, in which "math performance fell for the first time in the history of the long-term trend assessments since its first administration in 1990 (Socol, 2022). This is an urgent reminder that education leaders must double down on and fully fund efforts to accelerate student learning" (Socol, 2022).

For this Doctoral Capstone in School System Leadership, two researchers worked collectively on a Problem of Practice (PoP) related to mathematics and the challenges in student achievement. The PoP statement, in alignment with the persistent downward trend in Algebra I performance, states: *"LMSD students are not meaningfully engaged in the Algebra I instructional classroom, resulting in a decrease of proficiency on state and district assessments"*. The researchers sought to answer two research questions: 1) Does the use of a student Algebra I Data-driven Protocol have an impact on teacher practice in engaging students in dialogue about Algebra I assessment data? 2) What are the teacher perceptions about the fidelity and use of a student Algebra I Data-driven Protocol?

The researchers proposed the implementation of one change idea; the collaborative creation and implementation of a student data-driven protocol in a subset of Algebra I classrooms. The researchers tested the change idea with three Algebra I teachers in their classrooms within LMSD. The intention was to examine a particular theory of improvement: *if students are active participants in reviewing their own data from district-administered assessments, then they would gain a better understanding of Algebra I*

content. This exploratory research study utilized the Improvement Science Plan Do Study Act (PDSA) approach and the incorporation of a change idea (Algebra I Data-driven Protocol), intended to improve one aspect of teacher practice, greater preparedness in data literacy.

This study found that even though at the beginning of the study, each of the three teachers felt that they were very comfortable reviewing data on their own and reviewing it with their students, all three teachers stated they felt even more comfortable in doing so after the study had concluded. This conclusion provided evidence for the researchers that the Aim Statement, *Teachers in select Algebra I classes will engage all students in a structured data participation activity, which will result in routine data discourse that was* able to be documented as an outcome. Each participating teacher saw the need and benefit of incorporating this into their instructional practice on a regular basis and strengthening their data literacy. Five next steps were identified as a result: 1) the researchers will discuss these findings with the secondary mathematics curriculum office and propose the addition of a larger pilot group before adding the data protocol to the Algebra I curriculum, 2) the researchers will advocate for more innovative strategies to engage students in the Algebra I classroom to be added to current curriculum and instruction, 3) revise the protocol to ensure its inclusion as a differentiated strategy to use with a variety of student groups from various assessment types, 4) continue to conduct further large-scale studies in which the data protocol is utilized in other mathematics classrooms in other select middle and high school classrooms through an organized pilot over the span of an entire school year, and 5) devise a plan for how to measure student achievement over time with incorporation of the data protocol in piloted mathematics classrooms in order to revisit the original PoP and Aim statement. The plan of action for future development of the findings will include steps to measure student achievement data at incremental points throughout the school year to determine effectiveness of the protocol.

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Capstone submitted to the Faculty of the Graduate School of the
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Preface

As practitioners in the field of public education, the researchers set out to explore a meaningful topic of interest to themselves as educators and past students who have experienced the same challenges this study attempts to address. Both researchers have experience and distinct roles with the school district at the center of this project, which illuminated a way to utilize their expertise and positionality. The unique experiences of both researchers add a strong foundational knowledge of evidence-based practices with respect to curriculum, accountability, and assessment within teaching and learning as well as to utilize the findings from this research study to explore district policy and practice.

Researcher one's role, as a supervisor for the school system, is to create, revise, monitor and implement curriculum. Researcher one works closely with teachers and schools on a regular basis through professional development, observation, and support as well as supporting content offices with the integration of standards into curriculum documents and other project-based learning units. Researcher two's role, a director in the school system, oversees district and state assessment and accountability through collection, utilization, and dissemination of data. Researcher two works closely with schools and central office partners to understand federal and state legislation, state accountability, and conduct professional learning opportunities to strengthen assessment and data literacy of district staff. Both researchers believe that data discourse and data comprehension play a pivotal role in instruction; this is paramount for understanding individual students' needs and tailoring teaching resources for assessing those needs. Although neither researcher has a strength in mathematics, each scholar chose to develop their own mindsets and positive viewpoints towards academic data and the stories data can tell. Ultimately both researchers recognize the power in aligning data points to make instructional decisions and plan for acceleration, remediation, and differentiation.

Both researchers wanted to select an issue outside of their sphere of influence which could have a larger impact on one challenge faced by a large metropolitan school district. The researchers had both developed similar problems of practice and therefore made the decision to combine their problems to conduct one exploratory research study to explore the topic. Once the collective problem of practice was developed, both researchers drafted a project plan that included the major components of the research study, then decisions were made for when each researcher would complete independent parts of the study or both researchers would collaboratively complete collective parts of the study. Both researchers have similar work habits, methods to organize and strategize work completion, a collective interest in low student performance in Algebra I, a desire to work as a partnership, and a shared timeline for completion of the exploratory study.

The researchers worked together, using a co-created fishbone diagram to determine seven focus areas and conducted research accordingly. In collaboration with the study's advisor, the research design and methods were discussed and selected. Each researcher worked independently to explore numerous topics within the literature review and then came together to examine the findings and construct the literature review as an iterative process. It was important for the researchers to read individually and then synthesize all gathered information to delineate what was needed to support the ideals and theories in the exploratory study. Sections one, two, and three were both independently and collectively written. Each subsection as part of the broader sections had parts written independently and then reviewed and synthesized holistically. The researchers wrote together, often in the same space, however also over the phone or through virtual meetings, using a shared document to ensure the writing was cohesive and constructed in unison. Additionally, during the editing process, the researchers individually reviewed the paper several times from start to finish. The four key tools utilized in the exploratory study were:

<table>
<tr><th>Measurement Tool</th><th>Created by</th><th>Measurement Tool Review Process</th></tr>
<tr><td>Algebra I Data-driven Protocol</td><td>Modified from an already existing district protocol</td><td rowspan="4">For each tool, both researchers reviewed shared notes from the empathy interviews, focus group, classroom observation and data protocol. All notes were color coded for commonalities and differences as well as synthesized to highlight main points.</td></tr>
<tr><td>Focus Group Questions</td><td rowspan="2">Co-written by both researchers</td></tr>
<tr><td>Empathy Interview Questions</td></tr>
<tr><td>Observation Checklist</td><td>Adapted by authors jointly based upon the National Council of Teachers of Mathematics, Assessment #6 Math Pedagogy, Math Pedagogical Observation Log.</td></tr>
</table>

The impact product, as a result of the research study was a co-collaborative presentation and slide deck of the study's overall findings shared with a group of educators at a state conference. The researchers individually and collaboratively completed and co-edited the slides as well as co-presented a 60-minute session. The resulting Capstone was co-authored and co-edited and is the intellectual property of both researchers.

Table of Contents

List of Tables and Figures

List of Abbreviations

Abbreviation	Definition
AP	Advanced Placement
ASD	Autism Spectrum Disorder
CCR	College and Career Readiness
CTE	Career and Technical Education
EL	English Learners
ESSA	Every Student Succeeds Act
FaRMS	Free and Reduced Meals
IB	International Baccalaureate
LMSD	Large Metropolitan School District
NAEP	National Assessment on Educational Progress
NCTM	National Council for Teachers of Mathematics
PDSA	Plan Do Study Act
PL	Professional Learning
PoP	Problem of Practice
STEM	Science, Technology, Engineering and Mathematics
SWD	Students With Disabilities
ToI	Theory of Improvement
UDL	Universal Design for Learning

Section 1

Introduction

In a pivotal moment for educational achievement, the 2022 National Assessment on Educational Progress (NAEP) revealed an alarming decline in the national average scale score in mathematics, marking the first such occurrence in thirty-two years. A drop of seven points in grades four and eight has raised significant concerns and prompted an urgent call to action from education leaders to address the decline in math performance. This Capstone engages in an exploration of the problems faced by students and educators in one Large Metropolitan School District (LMSD) in a mid-Atlantic state, with historical trends that point to low mathematical achievement. The research specifically focuses on Algebra I achievement in LMSD as a critical factor in a student's successful matriculation in high school.

This exploratory research study utilized the problem-solving approach, Improvement Science, which includes development of a Problem of Practice (PoP), Theory of Improvement (ToI) and use of the Plan-Do-Study-Act (PDSA) cycle to investigate achievement in Algebra I. in order to further focus understanding of the problem of low achievement, the researchers engaged in a curriculum audit of Algebra I, informal observations and interviews with teachers in several Algebra I classrooms during designated periods of instruction intended for discourse around student assessment data (referred to as Data-driven Practice Days). During the initial observations in the Algebra I classrooms the researchers noted the lack of structured learning activities that included student assessment data. This further focused the researcher's inquiry into the problem of low Algebra I performance and led to a more in-depth review of possible causes.

Supported by a Causal Systems Analysis and review of the potential factors contributing to low mathematics achievement, the researchers' identified the following specific PoP: *"LMSD middle and high school students are not meaningfully engaged in instruction in the Algebra I classroom".* This PoP led to a ToI that states: if students are active participants in reviewing their own data from district-administered assessments, then they would be more likely to engage in classroom instruction and would gain a better understanding of Algebra I content. In exploration of this theory, a change idea, the Algebra I Data-driven Protocol, was developed and implemented in a subset of Algebra I classrooms in LMSD. The Algebra I Data-driven Protocol was designed as a resource to guide students as they examine their proficiency levels in comparison to district, school, classroom, and individual data as well as areas for improvement. This change idea was implemented with three Algebra I teachers in their classrooms within LMSD on district designated Data-driven Practice Days in order to examine student engagement, which has a direct impact on student performance in mathematics.

The curriculum audit, classroom observations, and informal interviews heightened the awareness of the urgent need for intervention to address student disengagement on the Data-driven Practice Days. What's more, these observations prompted the researchers to recognize the PoP as a challenge for LMSD, in alignment with the persistent downward trend in Algebra I performance. Relevant state and LMSD achievement data were reviewed to confirm historical trends that indicate poor Algebra I achievement and the link between the PoP and ToI.

In the following sections of this capstone, the details of the study will be described. First, the importance of Algebra I will be briefly described through identification of the context of the problem and the historical challenges. These sections will be followed by an analysis of trend performance data at the state and district level to further define the challenges faced in Algebra I. In alignment with the Improvement Science process, a causal systems analysis (Fishbone) will be presented with the literature supporting potential causes of low mathematics achievement. Following the investigation of possible causal factors contributing to the low performance on Algebra I state summative assessments, the researchers developed a structured inquiry and the incorporation of a change idea (Algebra I Data-driven Protocol), intended to improve data literacy. The researchers explored the incorporation of the change idea and the impact it had on how students engaged in the Algebra I classroom. The study sought to answer two questions: 1) *Does the use of a student Algebra I Data-driven Protocol have an impact on teacher practice in engaging students in dialogue about Algebra I assessment data*? 2) *What are the teacher perceptions about the fidelity and use of a student Algebra I Data-driven Protocol*?

Importance of Algebra I

Algebra I, often revered as an essential course in the high school sequence of mathematics courses, has also been identified to determine success in either a college or career track. As a key component of higher-level mathematics, Algebra I deals with symbols and the rules for manipulating those symbols, which are used to represent numbers and quantities in mathematical formulae and equations (Saleh & Rahman, 2016). Algebra is also a set of skills that are essential and used in our everyday lives (Saleh & Rahman, 2016). In one study by Laby et al., conducted in a high school with mathematics students, it was determined that Algebra is a critical component on the pathway to postsecondary success and is often referred to as "both a gateway course as well as the gatekeeper course, which is a predictor course for success in college level mathematics and future career" (Laby et al., 2015, p. 1). Specifically, "for secondary students, Algebra I has long been viewed as a potential gateway to postsecondary success. However, for others, Algebra I often serves as a gatekeeper, becoming another obstacle to success in high school and beyond" (Laby et al., 2015, p. 1). Looking at the performance of freshmen in New Visions schools during the 2013-2014 school year (N= 13,288 total students studied), a significant number of students struggled with Algebra with an unsurprisingly lower course passage rate compared to all other core-courses (Laby et al., 2015, p. 1).

According to the National Mathematics Advisory Panel, Algebra is the language of higher-level mathematics, a passport for expanding postsecondary opportunities and a tool for confidently navigating the quantitative demands of daily life (National Mathematics Advisory Panel, 2008). Improving students' understanding of algebra has been a long-term educational priority in the United States: as shared by Student Achievement Partners report in Preparation for Success in Algebra, however, achieving this goal has been elusive (Geary, 2021).

Algebra I is particularly important to students in LMSD. The Algebra I assessment, a state required test for graduation and one factor that determines a student's path to on-time graduation and readiness for college and/or a career. As a result of students in LMSD who do not pass the course, they are prevented from embarking on other advanced courses and pathways such as Career and Technical Education (CTE), Advanced Placement (AP), International Baccalaureate (IB), and dual enrolment college courses, tInternational Baccalaureate (IB), and dual enrolment college courses, thereby limiting their options after high school. In addition, not passing the assessment and not earning a passing letter grade of "D" or better in Algebra I requires a student to retake the Algebra I course for credit recovery in another semester or summer school. Non-proficiency and a failing course grade directly relate to a student's inability to execute and employ algebraic thinking, which impacts their ability to meet the rigors of advanced mathematics and requirements of a future college or career placement. This leads to students being behind their peers and not able to take other higher level math courses to graduate on time. According to the policy brief Algebra and the Underprepared Learner, students who pass Algebra I by the end of ninth grade are “more likely to take advanced mathematics courses, graduate from high school, and succeed in college” (Stoelinga 2013, p. 1). Yet, persistent inequities in access to rigorous algebra due to issues of placement, preparation, and quality of instruction have kept the gate closed for a large proportion of students (Stoelings 2013).

Context of the Problem

In the following sections the researchers present information and data related to the current context of the problem of low achievement in Algebra I within LMSD. First, a review of the historic and current national, state, and local mathematics/Algebra I data that confirms the problem. Next, the analysis of some possible factors that have been shown to contribute to Algebra I achievement.

The journey into exploring the causes began by investigating segments of the already existing large body of material on mathematics education and student achievement. During the preliminary investigation the researchers collaboratively explored the current landscape of Algebra I in school buildings through interviews and observations to gain insight on the current status in the LMSD. The initial findings of the exploratory inquiry will be discussed as part of the causal systems and root cause analysis presented later in the Capstone and narrowed to focus on the causal factor explored.

The topic of student achievement in Algebra I was of particular interest for both researchers because of the topic’s omnipresence within the LMSD’s landscape. After identifying the problem of practice and possible causal factors, the researchers embarked on a study of the current and pervasive challenges in mathematics education and prompted a unique partnership to launch research about this long-standing problem and bring together differing perspectives on accountability and curriculum in LMSD.

Historic Challenges in Improving Mathematics Achievement

Improving student achievement in mathematics has been a concern in the United States of America since the early 1980s when international tests began showing U.S. students falling behind most developed countries in mathematics skills (Gningue et al., 2013). Many students in the United States do not obtain the knowledge and skills, particularly in science, technology, engineering, and mathematics

(STEM), which are required for success in the global marketplace of the 21st century (National Academy of Sciences, 2019). Mathematics skills of American students “have left a great deal to be desired and even after a decade of accountability reforms, the performance of U.S. students on mathematics assessments ranges from simply mediocre to extremely poor, depending on the type of test and grade level” (Schmidt, 2012, p. 133).

Improving assessment results requires high-quality mathematics education. According to the non-profit Achieve, Inc., high-quality mathematics instruction is not just for those who want to study mathematics and science in college, it is required for many postsecondary education programs and careers (Achieve, 2005). Achieve’s research went on to state that many students, especially those who are economically disadvantaged, English learners, racial or ethnic minority groups, are victims of low expectations for achievement in mathematics (NCTM, 2010). In addition, traditional practices of tracking certain student and service groups as part of the No Child Left Behind legislation have consistently disadvantaged these groups of students by relegating them to low-level mathematics classes (Schmidt et al., 2011). According to Schmidt et al., these remedial classes are based on repetition of mathematics skills with computational procedures year after year and cause underperforming students to fall further behind their peers in grade-level courses. Consequently, students are not exposed to significant mathematical substance or the types of cognitively demanding tasks that lead to higher achievement (Schmidt et al., 2011).

Impact of COVID Pandemic on Mathematics

The post-pandemic trend of declining student achievement and proficiency in mathematics on national, state, and district assessments sheds light on the successes and challenges of instruction and intervention efforts and the establishment of best practices to improve achievement outcomes. According to the Education Week article described earlier, gaps exist in student achievement as a result of the pandemic but, “Test scores are only one measure of the impact of the pandemic on students, and the pandemic had myriad impacts on students’ lives” (Goldhaber et al., 2022, p. 4). Furthermore, “ignoring the effects on test-based measures of learning would be a mistake. Even with their limitations, test scores are our best bet for understanding the big-picture effect of the pandemic on student achievement across the country” (Goldhaber et al., 2022, p. 4).

At the start of the 22', 23' and 24' school years, student achievement in LMSD continued to show lower than average proficiency rates compared to pre-pandemic school years, with larger relative declines in middle and high school mathematics. Achievement was lower for most student groups in those school years confirming that, "historically marginalized students and students in high-poverty schools were disproportionately impacted" as denoted in the state summative mathematics assessment proficiency rates (Lewis & Kuhfeld, 2021, p. 2). Student gains throughout and following the pandemic (from 2019 to 2023) lagged behind the average and prior trends of pre-pandemic growth not only in LMSD, but across all school districts in the study site.

The current national climate in mathematics performance, specifically Algebra I, has revealed the devastating toll the pandemic had on the education system. Lack of innovative teaching strategies to address the effects, according to Sawchuk and Sparks' (2020) work on assessing national mathematics trends, has caused a systemic shift in the way teaching and learning are both delivered and achieved. The pandemic exacerbated already existing challenges in instruction, ways students learn, and how student proficiency is measured. They further explained, "mathematics was [more] sensitive to pandemic-related schooling disruptions for several reasons:"

- unlike reading, mathematics is almost always formally learned at school. Parents are often less well-equipped to help their children with math, at a time when parent support can be even more crucial to student progress;
- broader stress and trauma related to the pandemic may worsen existing mathematics anxiety in some students, and math anxiety can exacerbate students' other stress while in class; and
- it can be more challenging for teachers to engage in effective mathematics instructional practices via remote platforms (Sawchuk & Sparks, 2020, p. 3).

Algebra I Achievement in Study State

In LMSD and the state, the current level of proficiency in Algebra I has shown a persistent negative trend in student performance. Ample data exists to support the lack of proficiency in passing the Algebra I course, as well as meeting expectations on state and district assessments (LMSD), 2023 Mathematics Assessment. With the introduction of the Common Core standards and the state's College and Career Ready standards in 2010, the rigor of content, expectations of conceptual understanding, and number of standards to not only learn but demonstrate mastery, has exponentially increased for students.

School districts across the study site's state are currently in the process of interpreting and implementing state legislation passed in 2022 exercising control over several important changes to school district governance, specifically CCR standard requirements. Algebra I requirements for graduation and CCR are now determined by specific cut scores denoted in state legislation regulation §7–205.1 (LMSD), 2022 State Education Policy. Students enrolled within districts in the study site's state public schools must meet the CCR standard between the end of their tenth-grade year and no later than the time the student graduates from high school. A student meets the CCR standard when he/she/they obtains the required cut scores on the state summative assessments, which is currently a 750 (Proficient) obtained in one high school level mathematics course (Algebra I, Geometry or Algebra II).

Each school district in the study site's state, in collaboration with the community colleges, must have developed and implemented by the 2022–2023 school year a program of study for students who have not met the CCR standard by the end of the tenth grade. LMSD's Algebra I data trend shows a low rate of student performance, which has declined over time. The implementation of the state's current legislation and statute regulating CCR requirements will most assuredly have a negative impact with respect to on-time graduation rate and students successfully meeting CCR standards across the districts in the study site, given the number of students who have not met the current policy's required score (LMSD, State Legislation Policy, 2023).

Table 1 and Figure 1 below highlight state mathematics assessment results from spring 2022 and 2023. In the figures below, the following four levels represent student performance scores: Performance Level 1 represents beginning learner status, Performance Level 2 represents developing learner status, Performance Level 3 represents proficient learner status, and Performance Level 4 represents distinguished learner status. These data are representative of a slight improvement in students' Algebra I proficiency across the study site, however, still reveal the existence of a gap in standard knowledge in Algebra I. Statewide, the percentage of students scoring proficient on the Algebra I test in SY 2022-2023 was 17%. Local school districts proficient scores ranged from a low of 6% to a high of 38%. LMSD student proficiency scores ranged from 0% to 10%, with an overall average proficiency rate of 7% district wide.

Table 1

Algebra I Assessment by Student Group State Summative Assessment, Spring 2023. Source: Study Site, State Department of Education Website

Student Proficiency Range 0% to 10%	Student Proficiency Range 11% to 20%	Student Proficiency Range 21% to 30%	Student Proficiency Range 31% to 40%
There were **6** Districts who scored in the 6% to 8% proficiency range.	There were **7** Districts who scored in the 11% to 18% proficiency range.	There were **10** Districts who scored in the 22% to 27% proficiency range.	There was **1** District who scored at the 38% proficiency range.

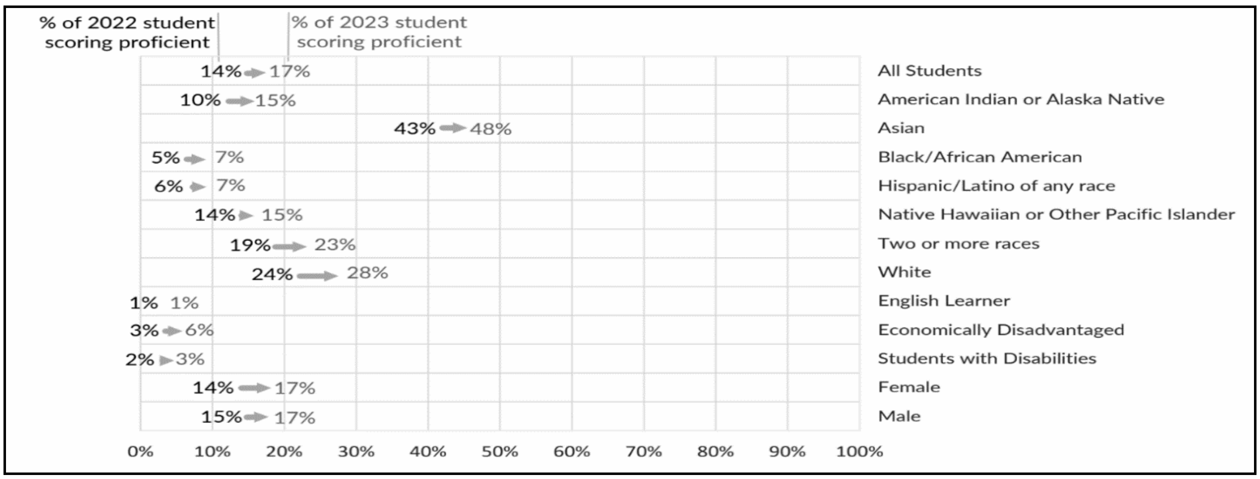


Figure 1: Algebra I Assessment Proficiency Growth by Student Group Spring 2022 to 2023
State Summative Assessment, Spring 2023.
Source: Study Site State Department of Education Website

Algebra I Achievement: State Performance

In LMSD and the state, the current level of proficiency in Algebra I has shown a persistent negative trend in student performance. Ample data exists to support the lack of proficiency in passing the Algebra I course, as well as meeting expectations on state and district assessments (LMSD), 2023 Mathematics Assessment. With the introduction of the Common Core standards and the state's College and Career Ready standards in 2010, the rigor of content, expectations of conceptual understanding, and number of standards to not only learn but demonstrate mastery, has exponentially increased for students.

School districts across the study site's state are currently in the process of interpreting and implementing state legislation passed in 2022 exercising control over several important changes to school district governance, specifically CCR standard requirements. Algebra I requirements for graduation and CCR are now determined by specific cut scores denoted in state legislation regulation §7–205.1 (LMSD), 2022 State Education Policy. Students enrolled within districts in the study site's state public schools must meet the CCR standard between the end of their tenth-grade year and no later than the time the student graduates from high school. A student meets the CCR standard when he/she/they obtains the required cut scores on the state summative assessments, which is currently a 750 (Proficient) obtained in one high school level mathematics course (Algebra I, Geometry or Algebra II).

Each school district in the study site's state, in collaboration with the community colleges, must have developed and implemented by the 2022–2023 school year a program of study for students who have not met the CCR standard by the end of the tenth grade. LMSD's Algebra I data trend shows a low rate of student performance, which has declined over time. The implementation of the state's current legislation and statute regulating CCR requirements will most assuredly have a negative impact with respect to on-time graduation rate and students successfully meeting CCR standards across the districts in the study site, given the number of students who have not met the current policy's required score (LMSD, State Legislation Policy, 2023).

The state has been demonstrating a steady decline in Algebra I scores since 2017 and has decreased from their highest rate of proficiency at 36.5% in 2017 to 14.4% in 2022. On the last two state summative Algebra I assessments administered in Spring 2022 and 2023, the statewide average proficient scores, 17.2% and 14.4%, were much lower than previous school years and highlight a decline of almost 10% from pre-pandemic proficiency. This decline speaks to the landscape of not only Algebra I, but mathematics in general, struggling to reclaim pre-pandemic levels of student proficiency. For specialized student and service groups such as students receiving Free and Reduced Meals (FaRMs), English Learners (EL) and Students with Disabilities (SWD), the decline of Algebra I proficiency was more drastic at the state level in 2022 and 2023. Table 2 highlights the single digit proficiency rates of all student groups, signaling that the most vulnerable populations of students in the study site need much more academic support and resources shifted towards those student groups if improvement is going to be achieved.

Table 2

Proficiency Level for Study Site Students Algebra I 2015-2023. Source: Study Site Report Card

Academic Year	% Proficient	% Proficient	% Proficient	% Proficient
	All Students	Free and Reduced Priced Meals	English Learners	Students with Disabilities
2023	17.2	6.5	1.4	3.3
2022	14.4	4.2	1.4	2.5
2019	27.2	11.1	3.1	4.4
2018	31.2	13.3	4.6	5.5
2017	36.5	16.6	5.6	8.2
2016	35.6	16.2	7.1	7.1
2015	31.3	13.1	6.2	5.2

LMSD Context

The topic of student achievement in Algebra I was of particular interest for both researchers because of the topic's omnipresence within the LMSD's landscape. LMSD, a school district of considerable size, serving nearly 130,000 students--nearly 70,000 in secondary schools. LMSD has approximately 215 schools, including traditional elementary, secondary, as well as Kindergarten through Eight, Specialty Programs, Public Charters, Academies and Early Literacy Centers. LMSD has a diverse student population that consists of approximately 95% Black and/or African American and Hispanic/Latino students. Approximately 10% of students receive special education services, 24% English Language services and over 60% are eligible to receive free and reduced priced meals. Each year, all students in grades three through twelve in LMSD are required by the Every Student Succeeds Act (ESSA), passed in 2015, to take a state summative assessment in reading and mathematics. Students enrolled in an Algebra I course take the Algebra I state assessment. This assessment is administered two times each school year, once in the fall for semesterized students and once in the spring for full year students. The assessment, which consists of three units and approximately 35 items, is the high school mathematics assessment used by the state to identify a student college and career ready (CCR). To be considered CCR in the LMSD's state, a student must achieve a minimum scale score of 750 on the Algebra I test, which is deemed Proficient. Historically, in comparison with other school districts in the state, LMSD students have not had a high rate of proficiency on the Algebra I state summative test.

Over the last seven years, LMSD's state summative assessment Algebra I proficiency scores have been statistically lower than other surrounding districts. According to 2023 state report card data, 92% of Algebra I students in LMSD were identified as either a "beginning and/or developing" performance level on the Algebra I end-of-course state assessment. The district implemented a number of interventions, however, despite the intent of the district's efforts, data continually shows the existence of a massive learning gap. The number of LMSD students who cannot meet state proficiency standards in Algebra I poses a significant challenge to the students and school system.

Algebra I Achievement: LMSD Performance

Following the pandemic, LMSD resumed providing face-to-face mathematics instruction for all students, however, all indications point to a sharp decline in student achievement in this major core content area based on district assessment results. The student achievement data presented in the table below (Table 5) illuminate the learning gaps and highlight the academic challenges students faced once they returned from virtual to face-to-face instruction. The results also draw attention to unsuccessful teacher practices utilized to help mitigate learning loss. During the 2020 and 2021 school years, there was limited longitudinal assessment data to indicate learning loss at the national, state and district levels.

Once LMSD returned from the pandemic, the first summative assessment was administered in the Spring of 2022 to assess learning loss and restore in-person teaching strategies and resources. In LMSD, students have historically performed statistically lower in the Algebra I end of course assessment, as compared to their counterparts around the state. Based on the state summative assessment Algebra I student performance proficiency rates between 2015 and 2023, the data show a steady decline historically for LMSD in students demonstrating proficiency as seen in Table 3. Respectively, in 2022 and 2023, the average LMSD percent proficient was 5.7% and 7.4%, declining by 2% from three years prior and almost 10% from its highest proficiency scores in 2016. Similarly to the state, specialized student and service groups such as students receiving Free and Reduced Meals (FaRMs), English Learners (EL) and Students with Disabilities (SWD) experienced decline in Algebra I proficiency in 2022 and 2023.

Table 3

Proficiency Level for LMSD Students Algebra I 2015-2023. Source: Study Site Report Card

Academic Year	**% Proficient**	**% Proficient**	**% Proficient**	**% Proficient**
	All Students	**Free and Reduced Priced Meals**	**English Learners**	**Students with Disabilities**
2023	7.4	5.5	≤ 5.0	≤ 5.0
2022	5.7	≤ 5.0	≤ 5.0	≤ 5.0
2019	9.7	7.5	≤ 5.0	≤ 5.0
2018	11.9	9.3	≤ 5.0	≤ 5.0
2017	15.6	12.3	≤ 5.0	≤ 5.0
2016	16.2	11.0	≤ 5.0	≤ 5.0
2015	15.0	10.0	≤ 5.0	≤ 5.0

LMSD also administered quarterly benchmark assessments in mathematics to K-12 students that yielded meaningful, timely, and individualized student performance data at the item and curriculum standard level. These data continued to highlight an all too familiar trend of low performance and, in several instances, regression from where students were academically pre-pandemic, specifically student achievement in mathematics for those students in the middle and high school grades. In school years 2020 and 2021, in the absence of a state summative assessment, LMSD administered their district-created benchmark assessments to establish a trend for comparison purposes.

On the LMSD Algebra I benchmark assessments, which are taken three times a year coinciding with quarters one, two, and four, students consistently perform well below the “meets expectations” level. The Algebra I district benchmark test measures what has been taught based on a foundational set of standards during a quarter’s worth of instruction. The “Meets Expectation” performance level is set at students achieving and demonstrating understanding of between 61% and 100% of the standards correctly on each benchmark. On the key domains taught within the Algebra I curriculum, there is little-to-no improvement from 2022 to 2023 of students demonstrating “meeting expectations” within Algebraic Functions, Modeling, Reasoning, or Statistics and Probability as seen in Figures 2, 3 and 4.

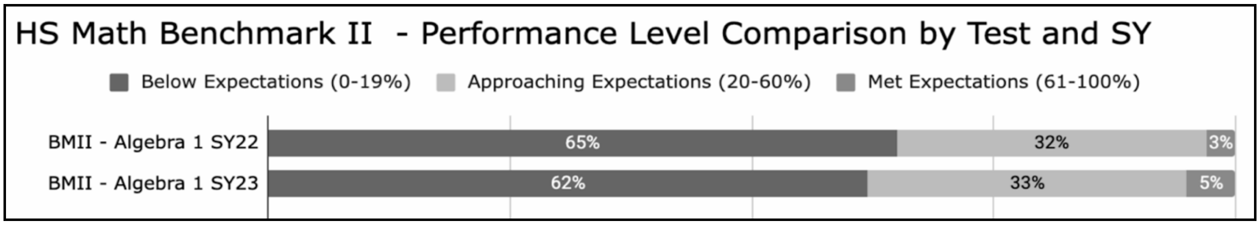


Figure 2: Algebra I Benchmark Data for LMSD SYs 2022-2023. Comparison by Test and SY.
Source: Study Site

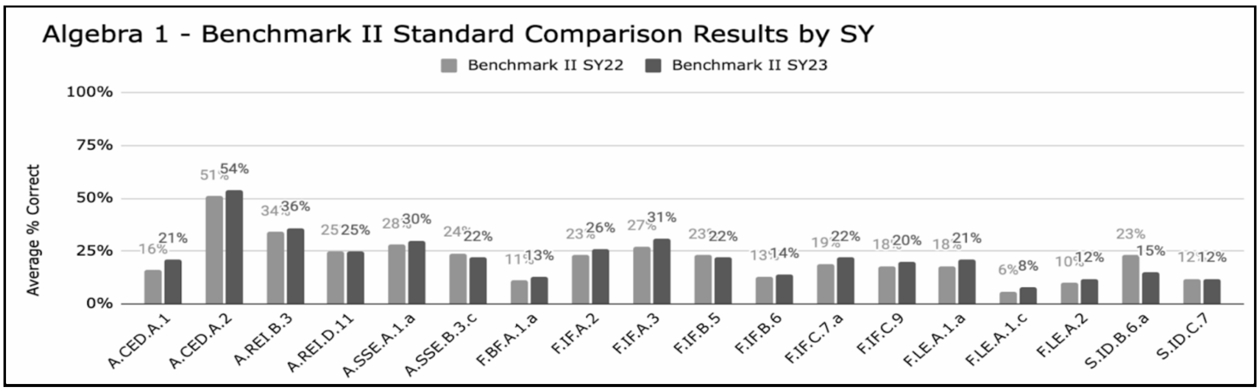


Figure 3: Algebra I Benchmark Data for LMSD SYs 2022-2023. Comparison Results by SY.
Source: Study Site

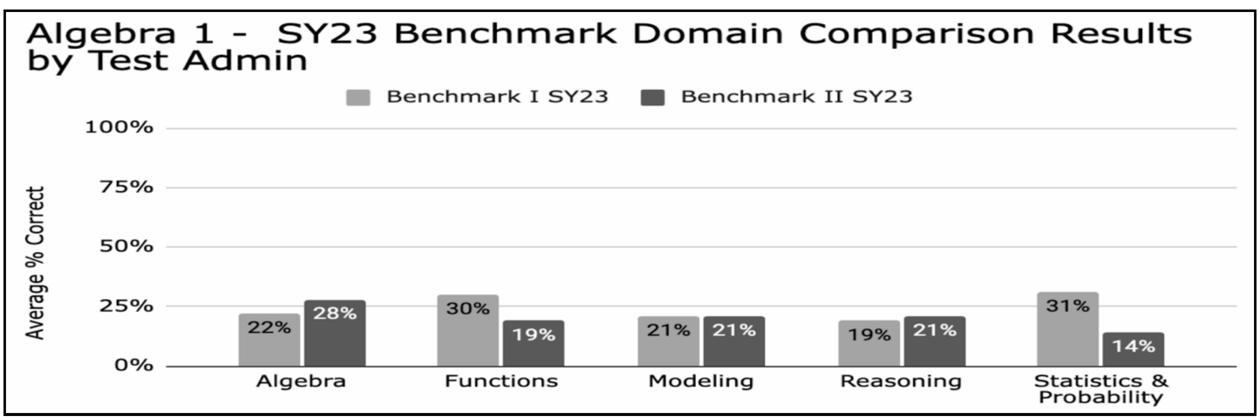


Figure 4: Algebra I Benchmark Data for LMSD SYs 2022-2023. Comparison Results by Test.
Source: Study Site

The state summative and district benchmark assessment data analysis illustrates the current challenges being faced with respect to interim and end of year Algebra I assessments. The data tables and figures provided evidence to support the trending pattern of student achievement on both summative state tests and district benchmark tests. State and district data point to a similar conclusion, more than three-quarters of the students in LMSD are not able to demonstrate their proficiency on standardized assessments. The data analysis is directly tied to the PoP because it illuminated the achievement gaps in proficiency in both the state and district context and the extent to which those gaps have been historically present.

Curriculum Audit

As noted in earlier, the researchers began to explore the problem of low performance in Algebra I through several actions to better understand the possible causes of low achievement. One activity was an audit of LMSD's Algebra 1 curriculum. In the Fall of 2022, the researchers conducted the curriculum audit to review an array of Algebra I curricular materials and resources in order to document the current state of the district's Algebra I instructional program. The Algebra I curriculum documents that were examined included the LMSD Major, Supporting, and Additional Content Standards, Course Syllabus, Course Sequence, and Lesson Foci to determine the quality of the materials and resources. Next, the researchers examined the district's assessment blueprints and test forms. These forms are similar in nature to the state assessment and test forms in terms of items and Item Analysis Reports to determine the quality of the assessments-to-standards taught. Finally, to analyze the Algebra I professional capacity building, the researchers examined the Algebra I curriculum and the district's professional learning sessions titles and descriptions to determine the quality and alignment. The materials were rated on eight dimensions in three components: Curriculum, Systems of Assessment, and Professional Capacity Building.

The eight dimensions provided a structure to evaluate the ways in which curricula, supports, assessments, and vision and mission are aligned in a coherent system of instruction. The dimensions assess the ways in which the three components are culturally relevant and demonstrate the capacity to evaluate the district's instructional system on a variety of criteria (Neumerski, C., EDUC 747, 2023). Table 4 below presents the ratings. According to the findings, LMSD exhibited limited academic opportunities as well as a gap in several areas of the mathematics curriculum.

Table 4

Distribution of rating for Curriculum Audit

Curriculum Audit			
Scale: 1 = no evidence of the dimension 2 = little evidence of the dimension 3 = moderate amount of evidence of the dimension 4 = moderately strong amount of evidence of the dimension 5 = strong evidence of the dimension	**Curriculum**	**Systems of Assessment**	**Professional Capacity Building (e.g. coaching, PD)**
1. Equity/Inclusivity	4	4	3
2. Cultural Relevance	2	2	2
3. Non-academic and behavioral supports	3	4	3
4. Academic supports	4	4	3
5. Technology	4	4	4
6. Developmentally appropriate understanding of student learning	2	3	3
7. Data collection that supports student achievement	5	5	2
8. Distributed Instructional Leadership	4	4	4

The lowest ratings identified as part of the audit was the district's lack of "developmentally appropriate understanding of student learning" in the component of curriculum and inclusion of "data collection to support student achievement" in the component of professional capacity building. The overall strengths and weaknesses of the audit are displayed in Table 5, however, based on the findings the researchers decided to concentrate on the lack of "data collection to support student achievement" in professional capacity building and build upon that weakness in the research study.

Table 5

Strengths and Weaknesses Identified from Curriculum Audit

Strengths	Weaknesses
• Data collection that supports student achievement within the Curriculum and Systems of Assessment. • Technology within the Curriculum, Systems of Assessment and Professional Capacity Building.	• Developmentally appropriate understanding of student learning within the Curriculum. • Lack of inclusion of data literacy skills and the under-utilization of performance data as leverage to marginalize performance gaps within Professional Capacity.

The curriculum audit was an important aspect to developing the PoP in examining LMSD's Algebra I program holistically. The audit contributed to the investigation by providing evidence of strengths and weaknesses within the curriculum, systems of assessment, and professional capacity building.

Preliminary Classroom Observations

In addition to the Curriculum Audit, the researchers continued the examination into the potential issues related to Algebra I, by conducting informal walkthroughs and interviews with six Algebra I teachers in four different schools in LMSD. The goal was to observe teachers leading students through differentiated group activities using disaggregated data from a district math assessment on a Data-driven Practice Day, which are designated class days defined in the district's Algebra I curriculum calendar. The researchers noted that these class periods were not being used by teachers to review assessment data or conduct small group instruction as intended and were instead being repurposed for make-up or catch-up. In addition, during the observations, the students were engaged in whole group lessons with minimal student-to-student or teacher-to-student discourse. In addition, the researchers observed students on their cell phones, sleeping, as well as being off task (e.g. talking to friends, sending chats, on non-curriculum-based websites), which highlighted the lack of engagement in Algebra I instruction. The researchers asked teachers to reflect upon the following: 1) knowledge of LMSD Algebra I Instructional Guidance Document (Scope and Sequence schedule), 2) understanding and purpose of the Data-driven Practice Days, and 3) awareness of a formalized structure to implement the Data-driven Practice Day. Two key summary points resulted from the observations and informal interviews: 1) Limited information was provided to teachers regarding the implementation of Data-driven Practice Days, which were written into the curriculum and daily instructional planning schedule. 2) The high school mathematics central office department had not created a formal template to infuse Data-driven Practice Days into the instructional program.

The synthesis of informal observation data led the researchers to first consider the importance of engaging students in data discourse and increasing teachers' data literacy among the teachers in order for them to facilitate the Data-driven Practice Days. The researchers envisioned a process or protocol that would outline specific expectations for what was to occur during the Data-driven Practice Days in order for teachers to make meaningful use of these purposeful pauses in the curriculum. The researchers also theorized that if students reviewed their assessment data on a regular basis, they would better understand who they were as learners, engage in organic dialogue with their peers, and gain a better understanding of Algebra I content. This, in turn, potentially allows students to advocate for their individualized learning needs, therefore, increasing the level of engagement within their Algebra I class.

Causal Systems Analysis

The journey into exploring the possible casual themes of low mathematics achievement began with the findings of the Curriculum Audit, informal classroom observations and interviews discussed above. Which defined the specific PoP: "*LMSD middle and high school students are not meaningfully engaged in the Algebra I instructional classroom*" investigating segments of the already existing large body of material on mathematics education and student achievement. During the preliminary investigation the researchers collaboratively explored the current landscape of Algebra I through a Curriculum Audit and in school buildings by conducting informal interviews and observations. The initial findings of the exploratory inquiry will be discussed as part of the causal systems and root cause analysis presented later in the Capstone and narrowed to focus on the causal theme and factor explored.

For this study, the researchers focused on a meaningful issue that the school district is currently facing due to the historically low student performance in one core content course and on the high-stakes assessment that have meaningful outcomes of passing successfully for all students. In exploration of the PoP, the researchers conducted a Causal Systems Analysis to develop a shared understanding of the specific problem and identify underlying root causes. In alignment with the PoP, the researchers conducted an exploration of perceived root causes leading to the decline of Algebra I scores among students within LMSD determined seven overall causal themes, illustrated in a Fishbone Diagram:

Assessment/Data Literacy, Curriculum, Instructional Practices, Students, Teacher Pedagogy, Math Mindset, and Attendance and Schedules. Within the seven causal themes, individual causal factors were identified that are symptoms within the confines of each theme. The seven causal themes and causal factors are listed in detail in Figure 5.

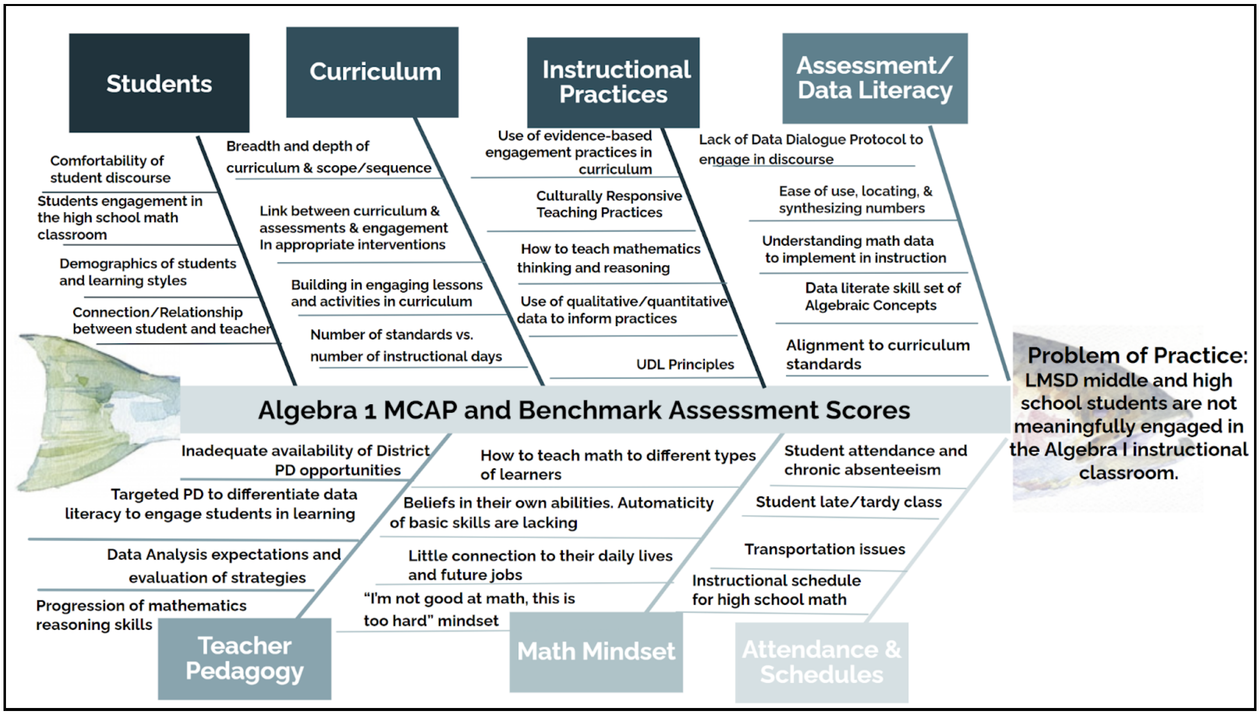


Figure 5: Fishbone Diagram for Problem of Practice

Through careful consideration of the PoP statement and the impact on student engagement, the researchers concluded that focusing on any one of the seven causal themes would lead to a better understanding of student engagement in Algebra I. Given the current state of mathematics achievement in LMSD, the status of Algebra I proficiency, and the wealth of research and data regarding challenges in student performance, the researchers explored all seven causal themes in the Fishbone Diagram that correlate to the problem of practice and the accompanying literature that were critical in addressing the causal factor. All seven causal themes are relevant issues to explore in LMSD, however, the researchers selected one theme, Assessment/Data Literacy as the focus of this study. The other six themes, while inclusive of student engagement factors, were not able to be analyzed in depth within the limitations of this Capstone.

The theme, Assessment/Data Literacy, and the identified factor “lack of data dialogue to engage in discourse” emerged as a result of the curriculum audit ratings and informal interviews and observations. The one driving force that led to the selection of this causal theme was the lack of teachers utilizing the Data-driven Practice days, as observed in the Algebra I classrooms, to engage students in dialogue about assessment data.

Review of Literature

In the following section, the researchers discuss the literature reviewed that supports the problem of practice. The researchers conducted a causal systems analysis which resulted in the aforementioned Fishbone Diagram (see Figure 5), which contained the problem of practice, seven causal themes (drivers) and causal factors of the themes. Given the enormous amount of literature and research regarding mathematical achievement Algebra I the researchers focused the review around five main questions which related directly to the contributing factors of the problem. The questions were: 1) What are the major challenges in teaching Algebra I? 2) What is engagement and what does that look like in the mathematics classroom? 3) How is discourse relevant in the mathematics classroom? 4) Why is it important to be assessment and data literate? And lastly, 5) What are effective strategies utilized in mathematics instruction as well as professional learning that can be used to increase engagement? The topics reviewed are: *Challenges in Achievement, Engagement, Discourse, Assessment and Data Literacy, Instructional Practices, and Professional Learning.* The topics and questions posed in conducting the literature review sought to provide insight into the problem, gain an understanding of the relevant research, and present this knowledge in an organized format.

Challenges in Algebra I Achievement

There has been much research conducted on Algebra I and the difficulty faced by students and schools on students passing and demonstrating proficiency in the course (Ichinose & Clinkenbeard, 2017, Schachter, 2013, and Boaler, 2013). Many of the studies, journal articles, and reports have grappled with the same basic problem–student difficulty with passing Algebra I (Ichinose & Clinkenbeard, 2017). As noted earlier, student performance in Algebra I nationally, as well as in LMSD, has had a steady and significant decline over the past 5 years.

What makes Algebra I such an important course for a high school student? “Four years of math in high school, with a strong foundation in algebra that builds from middle school, is key to higher education access” (Snipes & Finkelstein, 2015). In *Algebra and the Underprepared Learner* (2017), Timothy Stoelinga and James Lynn explain that “Algebra I has historically represented an important transition point in the learning of mathematics, requiring the use of generalized models, mathematical abstractions, and understandings of variables and symbols, all of which are particularly challenging for many students” (p.3).

Mathematics has long been the most failed subject in middle school and high school. According to Ron Schachter's work, in the national study *Solving Our Algebra Problem: Getting All Students through Algebra I to Improve Graduation Rates,* failing mathematics requirements is the reason cited by over 80% of high school dropouts that they gave up on school (Schachter, 2013). Specific to Algebra I, the study included the student's previous knowledge of the subject, the effectiveness of the instruction, and their motivation to work hard enough to succeed (Schachter, 2013). Many students, not just those in Algebra I, were surveyed and identified misconceptions with their “math ability” and had given up on the notion that they could ever truly succeed in math (Boaler, 2013). According to Schachter, nothing communicates low expectations to high school math students like asking them to work on digital math worksheets at an elementary level. If we allow them to do the same math work they did five years ago, they feel insulted (Schachter, 2013).

Similar to Schacter’s study, John Hattie’s research on visible learning that investigated student’s opinions, shared that “student expectations" were found to have the second highest effect on achievement with an effect size of 1.33 between the variables studied. The study concluded that these types of perceptions, coupled with the difficulty of the material and its reliance on prerequisite math skills from K-12 math classes, lead to many students failing Algebra I, often multiple times (Boaler, 2013).

The “Algebra for All” policy states that all students are required to take Algebra I by a designated grade level—typically eighth or ninth grade, and determines whether or not students are prepared for the content (Stoelinga, 2013). While policies such as “Algebra for All” are in alignment with the intention to increase the number of students who successfully complete Algebra I in a timely way, the evidence showed that for too many students, these policies by themselves have neither increased mathematics achievement nor advanced greater opportunity. Rather, the policies have often resulted in the watering down of Algebra I content and have significantly increased the number of students who fail the course (Stoelinga, 2013).

Engagement in Mathematics. Another factor examined linked to student achievement is engagement, defined as students' investment in and effort directed towards learning (Nyman, 2015). According to Strong et al. (1995) engagement occurs for students when they are energized by four goals—success, curiosity, originality, and satisfying relationships). Current and past findings of Winheller conclude that student engagement in mathematics can be gauged by the quality of learning and its connectedness with ‘confidence in’ and ‘liking mathematics’, which in turn predict students’ mathematics achievement (Winheller et al., 2013). The level of engagement with approach and persistence in mathematical learning tasks, aids in development of student achievement and related self-perceptions (Winheller et al). Also, students who are engaged exhibit three key characteristics: 1) they are attracted to their work, 2) they persist in their work despite challenges and obstacles, and 3) they take visible delight in accomplishing their work (Strong, 2005).

In addition, engagement in mathematics has also been described as utilization of alternative methods that go beyond the traditional means of instruction in order to engage students and meet them where they are in the classroom (Clark, 2015). When students are passively engaged in mathematics content, academic performance can be described, at best, as mediocre (Clark, 2015). Winheller’s notions about engagement in mathematics described ‘liking a subject [mathematics]’, ‘self-efficacy’ and ‘quality of school life’ as important predictors of academic performance. Quality of school life factors relate to whether the teacher or teaching rather than the learning environment makes the difference (Winheller et al., 2013).

Student engagement is a multidimensional construct, according to Maamin et al.(2022), that predicts learning performance in mathematics as well as has a significant relationship between cognitive engagement, affective engagement, behavioral engagement, and mathematical achievement.. Through this, motivation can be readily reported by learners, and these data are strongly related to a cluster of behaviors associated with learner achievement, including effective self-monitoring, goal setting, and work task completion behaviors (Beal et al., 2006). Moreover, Beal et al.’s theories on student engagement state that learner motivation and self-regulation are even stronger predictors of mathematics achievement than prior academic achievement or socioeconomic status and an analysis of learner engagement could improve the effectiveness of learning, in terms of pedagogical decisions to restrict access to help or to force learners to seek out and view help (Beal et al., 2006).

In contrast, Maamin et al. (2002) notes that there has been little research linking student engagement and mathematical achievement. Additionally, Maamin et al. who defined engagement behavior as doing work and obeying rules state that student engagement should be thought of as a multidimensional construct in three distinct dimensions, cognitive engagement, behavioral engagement, and effective engagement. Effective engagement involves students' emotions and cognitive engagement combines motivation and the use of strategies as well as a fluid concept that can help teachers understand and improve the achievement of low-performing students (Maamin et al.). Student engagement is significantly related to academic achievement and this relationship is evidenced by interactions between students and teachers.

Engaging Students in the Learning Environment. Research regarding student engagement and the pedagogy centered on how teachers can aid in the increase of active student involvement suggests that there are several strategies educators can employ to engage learners in the mathematics classroom (McGrath, 2019, Forbes, 2022, Hattie 2018, and Jordan, 2023). Key characteristics of effective and engaging lessons include: teacher proximity, increase of student dialogue, reduction of teacher talk, and the shift of learning ownership from teacher to student. Larson (2019) concluded that students should be "engaged in solving and discussing tasks that promote reasoning and problem solving" and that purposeful discussion or "math talk" among classmates and the teacher about underlying mathematical concepts will "emphasize conceptual understanding to their connection of skills with procedures, and problem-solving strategies" (paragraph 3). In other words, "students who communicate with their classmates and the teacher about their thinking, solution pathways, and insights into how they solved a problem—or how to analyze another student's solution—develop a deeper understanding of mathematics" (Larson, paragraph 3). Larson concludes that, "One way to generate more purposeful discourse is by asking math talk questions that encourage all students in the classroom to become engaged in the discussion and to explain and reflect on their thinking" (Larson, paragraph 4) and students also need to see “themselves as capable of participating in and being doers of mathematics” and that the math talk in the classroom should be intentional and purposeful which will help in building strong mathematical identities (Larson, paragraph 8).

In further support of Larson’s ideas, McGrath (2019) believed that students need to see themselves as their own teachers therefore, she recommends “reducing teacher talk, asking questions instead of providing explanations, observing students, and providing non-teacher scaffolds to engage students in their own learning” (paragraph 10). Teachers should purposefully focus on doing less so that students do more, therefore allowing the students to do the heavy lifting of learning (McGrath, 2019, p. 11). This is a notion also supported by John Hattie who states that “a classroom discussion creates an environment where everyone learns from each other" (Hattie et al., 2018, p. 4).

One large part of developing pedagogical understanding of student engagement is synthesizing a connection between student engagement and what students learn in mathematics classrooms (Jordan, 2023). In order to better acknowledge and conceptualize student engagement in the mathematics classroom and better know how to activate it, one must consider the four components described by Jordan: Social, Emotional, Behavioral, and Cognitive. The components describe: how the students are interacting with each other, on-task interactions between students, whom students choose to work with, how students are feeling, effective student responses, students’ outward behavior, body language, facial expressions, students’ mindset, and how students absorb the material. According to Jordan, “Student engagement is fundamentally inseparable from the learning that’s taking place in the classroom. To boost our students’ grasp of the material, [educators] must boost both student engagement and student talk in our classrooms” (p. 11). Teachers should “establish the expectation that students are supposed to think out loud together when working on things” (p. 12). Jordan further shares, teachers should not change what they teach, but how they teach it. Jordan’s suggestions include, **“**increasing student engagement and student talk, and to help facilitate more equitable classrooms by helping every student use their voice” (p. 14). Jordan concludes that, “the way forward in math education is in providing more meaningful and equitable classroom dialogue” (p. 17).

Importance of Classroom Discourse. Classroom discourse is an evidence-based strategy to engage students in classroom discussion, conversation or dialogues to share thoughts and ideas.

Specifically in mathematics, discourse should build upon and honor student thinking, and provide students with opportunities to share ideas, clarify understandings, develop convincing arguments, and advance the mathematical learning of the entire class" (Smith, et al. 2017). In other words, teachers must carefully consider what tasks provide meaningful opportunities to explore ideas, generate hypotheses, and promote questions within a collaborative environment. (Buchheister, et al. 2019, p. 204). Mathematical discourse allows teachers to engage students in meaningful conversations that "develop language to express ideas, represent evidence, and clarify their reasoning" (Staples, al. 2017, p. 38).

Mercer (1995) defines three categories of talk in classrooms: disputational talk, cumulative talk, and exploratory talk. Disputational talk centers on a dispute or has a competitive nature in which students debate on decisions. Cumulative talk is characterized by students agreeing with each other. According to Mercer, the most effective type of discussion is exploratory talk, which encompasses sharing knowledge, providing reasoning, challenging others' reasoning, providing alternate hypotheses, and joint consideration of all ideas.

In *Visible Learning for Mathematics* (2016), John Hattie shares that academic discourse and peer-to-peer collaboration help all students make learning gains in mathematics. According to Hattie, fostering math discussions would improve math language acquisition and learning and student-to-student and student-to-teacher dialogue positively influences student achievement.

> Less than 5 percent of class time is devoted to group discussion or to teacher student interactions that involve a meaningful discussion of ideas. Teachers love to talk, but unfortunately most of their talk, even when it calls for a student response, fosters lower-order learning (Hattie, p. 3).

Hattie's research found that classroom discussion had a large effect size of 0.82 between the variables studied, which he considered statistically significant based on sample size (Hattie, 2016). Hattie concluded that meaningful discourse in the mathematics classroom is a highly effective instructional strategy that, if implemented with fidelity, could yield up to two years of academic growth in one year's time (Hattie, 2016).

When teachers provide productive classroom discussions, “those that enable students to invent, create, imagine, take risks, and dig for deeper meanings [they] invite students to examine their thinking” (Wasserman, 2010, paragraph 1).

> By asking questions like, "tell me more," "I'm wondering how you figured that out?" Or "perhaps you have some data to support your idea," teachers are inviting students to further examine their thinking. These responses insist on clarity of thinking, on reflection about a position, and on examples and data to support an idea. The ensuing discussion is likely to build deeper understanding (Wasserman, paragraph 22).

As noted by Brantlinger (2013), his research demonstrates the difficulty in measuring students engaging in discourse in the mathematics classroom, but students’ mathematical contributions to classroom discourse can be coded as elaborate student engagement when their discourse interactions with peers is meaningful in length and content (Brantlinger, 2013). Brnalinger further states that students exhibit engagement when they act in ways that are on-task with instructional expectations (e.g., completed assigned problems) and actively participate in whole class or small group discourse (Brantlinger, 2013).

Assessment and Data Literacy. For more than a decade, the Every Student Succeeds Act (ESSA) has emphasized the importance of data in education and promoted the goal of using data for continuous improvement (ESSA, 2015). The ESSA moves education further along the path toward becoming the evidence-based and data-driven profession that policy makers have continually called for (ESSA, 2015). According to Mandinach (2016) one major contributing factor to a decline in proficiency achievement on standardized mathematics assessments is the level of assessment and data literacy of educators. Lucas (2021) states that assessments are “incredibly useful tools for educators in improving their practice, ensuring classroom time is maximized, and data is disaggregated, all of which exists when the nuances of assessment are fully grasped and used with fidelity” (p. 12). James Popham also found that “an enormous number of today's educators are *not* assessment literate; they simply do not understand the fundamental concepts and procedures of educational testing” (Popham, 2011, p. 267).

Assessment literacy among teachers is a theme within the PoP illustrated through several causal factors: mode of assessment used to test, misalignment to curriculum standards, testing the “right” skills, and reliability and validity of test forms and items. Evidence collected thus far suggests assessment literacy among teachers on high school mathematics tests is a crucial skill set for determining student growth and differentiating effective instruction styles. Assessment literacy is a key contributing factor that undergirds the need for this research study.

Lucas (2021) asserts that assessments can empower teachers and improve the teaching and learning process through the extrapolation of data when integrated and connected to instruction and curriculum. This, in turn, creates a cohesive mathematics classroom that supports learning goals, meaningful instructional opportunities, and greater chances for student growth and success (Lucas). Popham (2018) argues for a well-balanced assessment system containing an appropriate distribution of large-scale, benchmark, and formative assessments to pinpoint and target individual student strengths and challenges. Furthermore, “assessment literacy consists of an individual's understanding of the fundamental assessment concepts and procedures deemed likely to influence educational decisions” (p. 6) and if assessment literacy is low, it can lead to misidentification of successful or struggling schools and abandonment of successful strategies (Popham). To evaluate the effectiveness of teaching accurately, [educators] simply need to use tests that evidence indicates are appropriate for this evaluative function (Popham). The misapplication occurs when tests appropriate for one purpose are inappropriately used for another purpose. Not every educational test is all-purpose; there is no one size fits all model. It is “*always* necessary to collect convincing evidence that a test built specifically for one measurement mission is suitable for satisfying a different one” to effectively align assessment as part of the teaching and learning process (Popham, 2018, p. 7).

Data literacy among teachers is another contributing factor to the PoP, specifically teacher’s lack of awareness and routine use of data leading to informed instruction. According to “Diving into data: Developing the capacity for data literacy in teacher education”, studies have revealed several issues that impact data literacy. These include a lack of an established data collection, inconsistent use of data, location of and synthesis of data, fluency in data analysis skills and insufficient modeling of data literacy in everyday teaching (Dunlap, 2016). The expectation is that teachers' skills in data use will develop more effective classroom and instructional practices, which ultimately will lead to improved student performance (Mandinach, 2016). To synthesize the evidence surrounding data literacy, the three key conclusions drawn were: the use of data as analytic tools to confirm truths and refute myths is a necessity, data literacy is a prerequisite for making data-based decisions, and educators struggle to identify a data use purpose that is plausible, concrete, and measurable (Dunlap, 2016). Data use should also be a continuous, integrated part of practice that is frequent (Mandinach et al., 2015). Good teachers employ data-driven decision making, however, more work needs to be done to ensure that they know how to continuously, effectively and ethically use data--that is to help them to be data literate (Mandinach et al., 2015). In order to demonstrate true data literacy as a construct, teachers must demonstrate the following three domains of knowledge: data use for teaching (ability to use and analyze data), content knowledge (understanding of a specific topic or subject) and pedagogical content knowledge (apply knowledge of pedagogy in content area) (Mandinach et al., 2015).

Some of the most important barriers to achievement include data literacy and leadership. Although analysis and utilization of data is a key method of informing instructional practice in mathematics, research states “data literacy and competency still remain inconsistently and underwhelmingly utilized tools” in a teacher’s toolbox (Mandinach al., 2013, p.30). A strong need exists to build human capacity around data use and purpose, by putting in place step-by-step protocols to build new learning and sustain use of social construct knowledge (Dunlap, 2016). This type of collaborative data inquiry has been found to “increase collegial discourse and discussion,” thus leading to more meaningful data discussions about student learning (Mandinach, 2013). Evidence also highly suggests there exists “an inherent lack of confidence, foundational knowledge, and modeled skills/expectations” and “low data self-efficacy and data angst” amongst educators, which are highly contributing factors leading to mistrust in the data analysis process (Dunlap, 2016, p. 3). Depending on how confident teachers feel about their knowledge and skills in data analysis and data interpretation, the more likely they are to use data in their decision-making (U.S. Department of Education, 2008). Understanding the nature of teachers' proficiencies and difficulties in data use is important for “providing appropriate training and support to teachers, because they are expected to use student data as a basis for improving the effectiveness of their practice” (Means et al., 2011). Data-based decision-making can also make valuable contributions to increasing student learning and achievement using data to improve the quality of teaching and learning. (Schildkamp, 2019, p. 258).

Instructional Practices

Instructional pedagogy has strong connections to the problem of low Algebra achievement. Teachers of Algebra I as well as all secondary math teachers should have the instructional skills needed to engage their students in real world problems, discourse, and opportunities to explore before explanation (Ferlazzo, 2021). Pedagogical theory published by Seidenberg in 2017 indicates that instructional pedagogy consists of: available Professional Learning (PL) opportunities, targeted PL to differentiate assessment and data literacy strategies using data, expectations for data analysis and the evaluation of those strategies and progression of mathematical reasoning skills (Seidenberg, 2017). There was a continued emphasis that professional learning opportunities, specifically for teachers of mathematics, require a differentiation based on mathematical concepts and skills, practice-based needs of each participant, range of mathematical content being covered and pedagogical strategies (Seidenberg, 2017). Current differentiated instructional methods are being modeled for classroom teachers, but teachers are utilizing a variety of approaches without fundamentally understanding how to incorporate them and when (Seidenberg, 2017). If the desired outcome is meaningful student engagement in the mathematics classroom, lesson plans need to be developed in such a way to provide those opportunities. This begins with a strong foundation in educator professional development. Sound differentiated practices should consist of demonstration by an expert, practice with coaching, and correction until mastery is achieved, which is a key missing link as discovered by current findings (Seidenberg, 2017).

Professional Learning

Effective professional learning for math teachers should include techniques such as modeling, guided practice, and checks for understanding of the new skill, strategy, or practice. Professional learning should encompass “explicit modeling and guided opportunities are the optimal conditions for teachers to inform their practice as well as teacher professional development on how to translate data into understandable and manageable information that can inform instructional planning” (Datnow, 2015, p. 3). Standards in Algebra I are a discrete set of skills unique to the discipline and therefore should be demonstrated through professional learning in ways that teachers can view or experience the lessons as well as differentiated strategies and be able to replicate them in their classroom (Datnow). Teachers should strive to become “outcome-driven educators, who encompass the knowledge, skills, and mindsets about the profession of teaching, which is not a skill set that a teacher develops independently; rather, it is a mindset developed over time” (Salmacia, 2017, p. 16).

Summary of Literature Reviewed about Causal Factors

This literature review contained a sampling of both peer reviewed scientific studies and research on the several identified causal factors as well as internal school system evidence to support current practices, and implementation initiatives in LMSD that align with the ToI. The research-based evidence reviewed has illustrated several key points that align to the PoP. First, the level of engagement plays a pivotal role in determining success in an Algebra I course as well as to what extent current state and district assessment data are showing how expansive low achievement is and may continue to be (Winheller et al., 2013) and (LMSD), 2023 Mathematics Assessment. Second, the studies coincide with the ToI. The literature review contained a sampling of both peer reviewed scientific studies and research on the several identified causal factors as well as internal school system evidence to support current practices, and implementation initiatives in LMSD that align with the ToI, that meaningful engagement in the Algebra I instructional classroom will result in an increase of understanding Algebra I content. Third, the research presented in these sections has indicated that the lack of educator assessment data literacy, inadequate teacher training, feedback, evaluation of data, teacher pedagogy around data, and differentiated instruction supports the PoP that serves as the premise for this study. In the next section, the researchers will discuss the causal systems analysis, ToI, and how the change idea was developed.

Theory of Improvement

Based on the synthesis of the findings from the Causal Systems Analysis, Curriculum Audit, informal classroom observations, and interviews, it was concluded that the focal point of the researcher's improvement efforts would be to increase data literacy among Algebra 1 teachers to enhance student engagement in Algebra I. The researchers concluded that if teachers were able to lead students toward understanding their own performance and engage in student/teacher discourse centered on achievement, then students would gain a deeper understanding of Algebra and their own skills and knowledge. This would lead to improved engagement in their instruction and their performance. In addition, the change strategy would increase teacher data literacy and data pedagogy. Through development of the Algebra I

Data-driven Protocol, the researchers implemented a study to explore the Assessment and Data Literacy causal theme. If a teacher is able to engage students more deeply in their data, then students will take more ownership of their learning.

The ToI is: *if students are active participants in reviewing their own data from district-administered assessments, then they would gain a better understanding of Algebra I content.* This theory was explored through implementation of an Algebra I Data-driven Protocol. Teachers used the protocol to facilitate discussions about achievement data as one way to engage students in mathematics learning.

The partnership between the two researchers brought together two key divisions within the LMSD central office to fully explore the root causes leading up to the PoP and the ToI related to this identified problem. By infusing components of assessment and data literacy closely linked with the vast amount of data on national, state, and district assessments, the researchers isolated low student achievement in Algebra I in LMSD. The researchers examined this challenge and explored district policies, political context, and advocacy needed to tackle this perpetuating challenge in LMSD. Additionally, in reflecting upon past personal challenges as struggling students in high school mathematics courses, both researchers concluded that if student engagement was more of a focus during their time in the high school mathematics courses, perhaps the belief that they were “good at math” might have been further supported.

Driver Diagram

In direct alignment with the PoP statement, the Driver Diagram in Figure 6 has outlined the Aim statement, primary and secondary drivers as well as the change idea that was tested. The Driver Diagram (Aim statement, drivers and change idea) has outlined several impacting shifts that could lead to increased teacher capacity and deeper data literacy knowledge within LMSD.

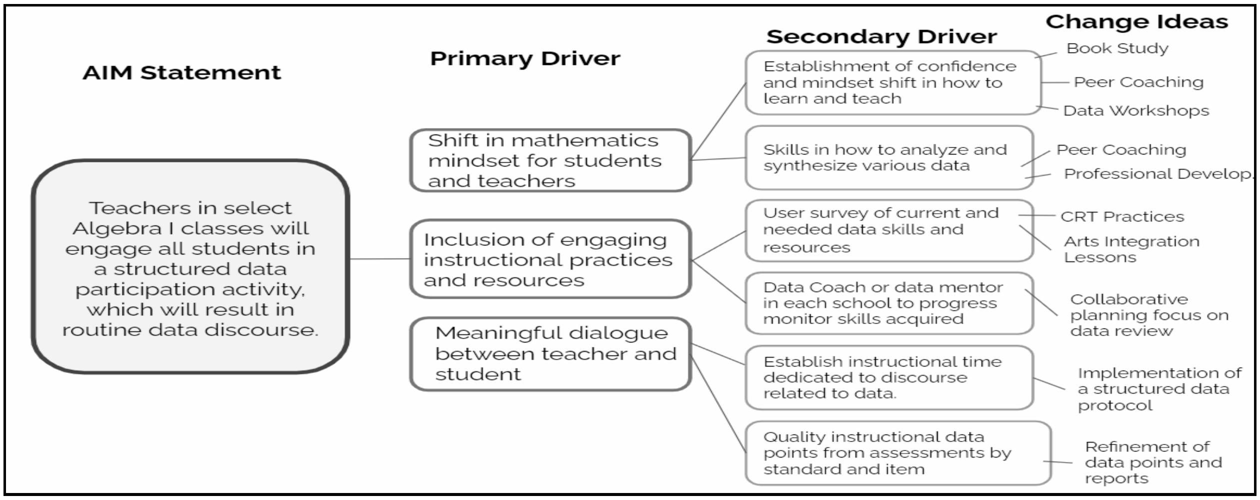


Figure 6: Algebra I Driver Diagram

The Primary Drivers each align with the Aim statement to identify the key leverage points that highlight areas of improvement. The three Primary Drivers highlight the importance of: 1) a shift in mathematics mindset, 2) the inclusion of instructional practices and resources as well as, 3) dialogue between teacher and students to improve instructional outcomes in literacy. The Primary Drivers identify three potential key areas of improvement that would shift teacher practices and include methodology for use of assessment data. Each of the identified Primary Drivers are one aspect in consideration for making a cultural shift in attitudes, motivation, understanding, and use of assessment data.

The Secondary Drivers each also align with the Aim statement to identify the areas required to utilize to achieve improvement. The six Secondary Drivers highlight the importance of: 1) confidence and mindset shift in how to instruct, 2) enhancement of skills in how to analyze and synthesize various data, 3) a user survey of current and needed data skills and resources, 4) incorporation of a Data Coach to progress monitor skills acquired, 5) establishment of dedicated instructional time, and 6) quality instructional data points.

The Secondary Drivers synthesize several change agents surrounding the theme of data literacy that pinpoint the relevance of data as an analytic tool to confirm truths and refute myths, act as a prerequisite for making data-based decisions, support the need to establish peer mentorship to progress monitor the process, and identify methods for assessment and data usage. The identification of these drivers signal that there are several areas of improvement within the system that would lend themselves toward forward thinking around the purpose and necessity for quality assessments and data training and resources.

Change Idea

The selection of one change idea amongst the ten proposed options in the Driver Diagram was based on the timeframe available to conduct this study. The researchers determined the implementation of one change idea, the Algebra I Data-driven Protocol, separated into two steps to facilitate students reviewing and discussing assessment performance data. The Algebra I Data-driven Protocol was created to align with the selected causal theme from the fishbone, assessment and data literacy. The protocol was one method for teachers to utilize with students to address the lack of structure on Data-driven Practice Days, noted in the curriculum audit, informal observations, and interviews to incorporate assessment data. The protocol also provided a way for study participants to engage students in data driven instruction in alignment with the Aim statement in Figure 6.

Aim Statement

The Aim represents an ambitious yet achievable outcome statement. In evaluation of the current instructional practices observed and noted within LMSD, the Aim statement was drafted in alignment to a few persistent gaps, one being a general inconsistency of data driven best practices used by mathematics teachers to interpret and implement the organic use of data into the classroom setting. The limitation of this perceived gap being minimal opportunities for teachers to identify specific deficiencies for each learner and differentiate instruction based on identified need. Additionally, premature notions regarding data discourse or how to engage in organic, yet relevant, conversations about achievement data with students was also a limitation. A final limitation was a lack of a foundational data fluency skill set. During the informal observations, the researchers noted limited expertise in how to view data, how to interpret what the data is saying, how to disaggregate the data, and lastly, synthesize or triangulate data with other district data points to establish SMART goals, and make an actionable plan. To address the identified challenges within the LMSD's Algebra I instructional program, the Aim statement, in alignment to the PoP, identified a key focus area within the researcher's sphere of influence to target one perceived primary and secondary driver, which have been identified factors used to pinpoint an area to influence student proficiency. To achieve the Aim statement, Primary Driver, and Secondary Drivers, one specific change idea was selected to test in the four Algebra I classrooms (Figure 7).

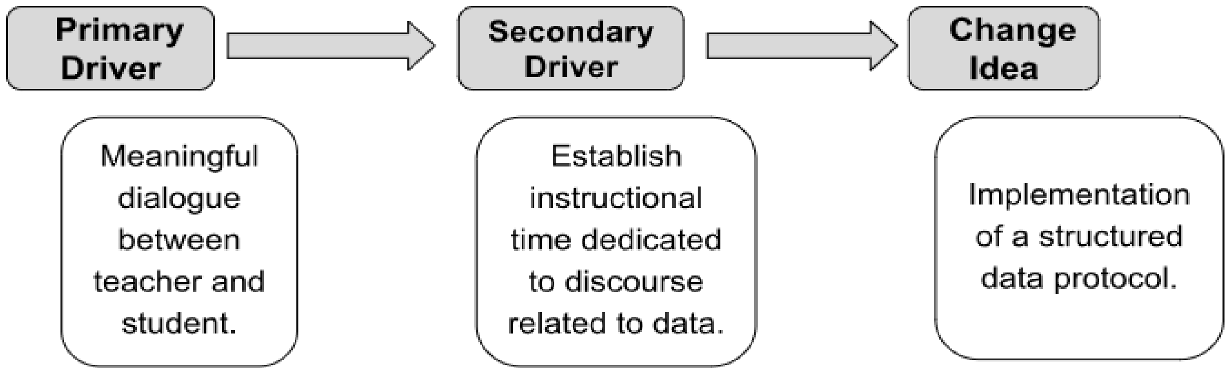


Figure 7: Research Study Process Model

The identified primary and secondary driver, as well as the change idea, were examined to determine what, if any, impact the introduction of these factors would have on teacher practice which might ultimately impact student achievement in Algebra I. Based on current student achievement data, paired with what has been identified as challenges, the Research Study Process Model details the implementation of a student Algebra I Data-driven Protocol to increase utilization of data discourse in the classroom. Next, the approach, design, and processes that were followed in this study, will be shared.

Section 2

Research Study Design and Methods

In this section, the researchers discuss the research study, design, and methodology of the study that supports the problem of practice and Aim statement. The researchers implemented one change idea: the use of a student Algebra I Data-driven Protocol in a subset of Algebra I classrooms to be tested with four Algebra I teachers. The intention was to examine a particular ToI: strategic use of the Algebra I Data-driven Protocol to facilitate discussions about achievement data would encourage students to engage in their assessment data. The design was exploratory and was guided by the following two research questions: 1) Does the use of a student Algebra I Data-driven Protocol have an impact on teacher practice in engaging students in dialogue about Algebra I assessment data? 2) What are the teacher perceptions about the fidelity and use of a student Algebra I Data-driven Protocol?

Study Methodology

The study methodology in the following sections describes the design of the research process. The exploratory research study consisted of a within-subject model (Bhandari, 2021), where in order to explore the inclusion of a change idea, comparisons and observations were made among the teachers who participate in all treatments of the study (e.g., perceptions from before and after conducting the PDSA cycle). The data collection process consisted of primary sources to gather first-hand knowledge from the study participants themselves, and the teachers (George, 2022). While teacher practice was the primary focal point of this study, the researchers also obtained limited anecdotal student comments and insights during the classroom observation process. The students' insight shed some light on the perceptions they exhibited and shared amongst one another regarding the inclusion of the change idea during instruction.

The exploratory research study was carried out in a strategic method as defined by George (2022). The following steps were implemented:

Step 1: Identification of a problem (Problem of Practice)

Step 2: Hypothesize a solution (Proposed Change Idea)

Step 3: Design the methodology (Identification of Measurement Instruments)

Step 4: Collect and analyze data (PDSA Cycle) and

Step 5: Avenues for future research (Impact Product)

As shown in Table 6, the research study and the measurement instruments that were utilized are outlined in four distinct phases as part of the research design and methodology.

Table 6

Research Study Phases

Phase	Research Design and Methods	Targeted Audience	Timeline
Phase 1	Development research tools: Student Algebra I Data-driven Protocol (Change Idea), Empathy Interview questions, Focus Group questions and Classroom Observation checklist.	Higher education and LMSD	30 days
Phase 2	Conduct virtual pre-implementation empathy interviews with teacher participants to understand the purpose and relevance of data driven dialogue to meaningfully engage students in Algebra I. Discuss the student Algebra I Data-driven Protocol and collect feedback regarding the design and purpose to incorporate into the final draft protocol.	Algebra I Teachers	30 days
Phase 3	Conduct a 60-day action research Plan-Do-Study-Act (PDSA) cycle with the student Algebra I Data-driven Protocol. In-person observations while the protocol was systematically utilized by the teacher participants during instruction.	Algebra I Teachers and Students	30 days
Phase 4	Conduct a virtual focus group with all teacher participants collectively to obtain teachers' perceptions regarding the use and evaluation of Algebra I Data-driven Protocol to engage students.	Algebra I Teachers	10 days

The structure of an exploratory design approach to measure the impact and evaluation of the research questions during the study was used based on the following factors:

- Variety of methods utilized to collect data- one 60-day PDSA cycle with inclusion of empathy interviews, classroom observations and a focus group;
- The sample population size - 115 students, four teachers (one middle school, two high schools, one kindergarten through grade eight school); and
- The inclusion of the tools of improvement science: problem of practice, fishbone, PDSA cycle, driver diagram, and Aim statement.

Plan-Do-Study-Act Cycle

A Plan-Do-Study-Act (PDSA) cycle, offers ways to solve problems through an inquiry-based framework, look deeply at problems and consider all possible and manageable solutions (PDSA Planning Guide, 2022). Each cycle is carried out in four distinct phases: Plan, Do, Study, and Act and engages the participants in a strategic framework to identify solutions and plan for future implementation. This four-part cycle focused the researchers on the change idea tested in the research study as part of the district's continuous improvement process (NYDOE Improvement Science Handbook, 2018) and possible scalable opportunities for the district in the future. PDSA was utilized as a model for testing and carrying out change through a series of iterative steps: Identify specific areas of need (Plan), Intervene to improve supports that address those needs (Do), Measure any changes that occur (Study), and Refine the intervention (Act) (Improvement Science Glossary, 2020). When using the PDSA cycle, it was imperative to include stakeholders (study participants) who provided meaningful feedback about the change idea (Improvement Science Glossary, 2020). Within Improvement Science, there are three main questions used to drive inquiry about improvement through the PDSA cycle: 1) What specifically are the researchers trying to accomplish and for whom? 2) What changes might the researchers introduce and why? and 3) How will the researchers know that a change is an improvement? (Improvement Science Glossary, 2020). The researchers implemented one 60-day PDSA cycle through disciplined inquiry, a process of testing and scaling one change idea that it is hypothesized to intentionally move LMSD away from more traditional "roll-out" of programs and initiatives that often scale fast and fail big (Principles of Improvement Science, 2020). The 60-day PDSA cycle was characterized by an approach to change that is iterative ("possibly wrong and definitely incomplete") and cyclical (start small and fail fast) (Principles of Improvement Science, 2020).

Algebra I Data-driven Protocol

To explore the ToI, the researchers developed and implemented one change idea: the Algebra I Data-driven Protocol with opportunities for student discourse. The researchers also gathered perception data about the usefulness of the protocol. The National Council for Teachers of Mathematics describes three features that establish protocols as an efficient learning tool: a process is clearly described, participants have well-defined roles, and a process is bound by time limits (NCTM, 2019). In education, dialogue protocols are structured guidelines developed to promote meaningful and efficient communication and learning (Hagit et.al. 2019). They are "vehicles for building the skills—and culture—necessary for collaborative work. Thus, using protocols often allows groups to build trust by actually doing substantive work together" (Southern Maine Partnership, 2017). In connection with "Data-driven Practice

Days", instructional days dedicated to the inclusion of data in the LMSD Algebra I curriculum, the protocol sought to provide a strategic method for teachers to encourage discourse among students. The Algebra I curriculum, a sequential calendar-paced document outlined one "Data-driven Practice Day" every two to three weeks, totaling roughly twenty-four throughout the school year. The days are intended to provide a purposeful pause in delivery of new content in order to refine, extend, and/or revise teaching and learning (LMSD, Algebra I Curriculum Guide 2023). Curricular guidance for the "Data-driven Practice Day" guides teachers through the process of building a lesson plan with the findings from district assessment data, focusing on improving any skill deficiencies, as well as providing extensions for students who have successfully demonstrated understanding of the standards (LMSD, Algebra I Curriculum Guide 2023).

As mentioned previously, from the findings in the curriculum audit and informal observations, it was noted that "Data-driven Practice Days'' were not being used as outlined in the curriculum and were instead being used for remediation of standards and skills or catching up with pacing in the curriculum. Algebra I teachers were unsure of how to use the "Data-driven Practice Days", therefore a formalized protocol was created, introduced, and explored in the study classrooms. In line with Hagit et al.'s best practices for exploratory discourse, the Algebra I Data-driven Protocol was developed to "encourage students to create arguments and respond to the arguments of their peers in a constructive way that also deepens their own understanding" (Hagit et.al. 2019). Protocols structure the work for the teacher because they provide a minute-to-minute guide on how to facilitate social learning and steer toward what kinds of questions are of interest (Hagit et.al. 2019).

The Algebra I Data-driven Protocol that the researchers designed was broken into two parts: a focus on overall data and a focus on standards. For step one, *Focus on Overall Data*, the teacher analyzes and organizes district assessment results (benchmark, common or milestone task) from the LMSD student information system in a student friendly data report format. The teacher then provides the data report to each student, focusing on district, school, classroom and student averages using the district assessment results. After reviewing these data with the class, students then begin the task of identifying the "noticings" and "wonderings" in a structured format (write onto a chart, type into a table, etc.) followed by answering two questions: 1) "*Overall, what are your thoughts about the scores above?"* and 2*) "What* *additional information is still needed?"* Students must discuss the "noticings" and "wonderings" in small or cooperative groups as well as thoughts regarding the two questions posed.

For step two, *Focus on Standards*, the teacher analyses and organizes district assessment standards and item analysis results (benchmark, common or milestone task) from the LMSD student information system in a student-friendly format. The goal of step two is to focus on the highest and lowest performing standards, narrow in on specific test items where they received low scores, and identify what strategies can be used to engage students in dialogue about their data. The teacher provides the data report to each student, focusing on lowest performing standards and corresponding items using the district assessment results. After reviewing the lowest performing standard and the item(s), students begin the task of identifying "what did the students understand" and "what were some common misconceptions" in a structured format (write onto a chart, type into a table, etc.). Students must discuss the "understandings" and "misconceptions" in small or cooperative groups as well as thoughts regarding the two questions posed.

Empathy Interviews

The first measure utilized within the 60-day PDSA cycle, empathy interviews, allowed the researchers to document the attitudes, behaviors, and beliefs of teacher participants prior to implementing the study. The interview responses provided qualitative participant data regarding thoughts and feelings around current instructional practices in the Algebra I classroom prior to study implementation. Empathy interviews are "one-on-one conversations that use open-ended questions to elicit stories about specific experiences that help uncover unacknowledged needs" (Nelsestuen & Smith, 2020, pp. 59-62). These "targeted conversations occur with a small sample of people to learn from their lived experiences and the power of this type of interview lies in the depth and color of the stories shared" (Bamford & Curry-Jahn, 2020). In order to conduct empathy interviews with fidelity, the researcher must "listen deeply to the stories and perspectives to uncover unacknowledged needs and simultaneously examine how [the researcher's] own identities, biases, values, and experiences influence how we make meaning of what others share" (Nelsestuen & Smith, 2020, pp. 59-62). Data collected from empathy interviews "can help create more human-centered improvement practices across school systems, uncover lived experience more accurately and help ensure that the diverse lived experiences of people are centered in decisions and actions." (Nelsestuen & Smith, 2020, pp. 59-62).

Classroom Observations

The second measure utilized within the 60-day PDSA cycle, classroom observation, was used to predetermine look-fors on a National Council of Teachers of Mathematics checklist, adapted to suit the purposes of this exploratory research study. This allowed the researchers to record information quickly about how both the teacher and students interacted during the student Algebra I Data-driven Protocol implementation days (NCTM, 2021). Furthermore, participant observation is also considered an approach to inquiry as well as a data-gathering method, both essential elements of qualitative studies (Marshall et al., 2022). The researchers used the teacher observation to assist in observing key behaviors of adult study participants relative to specific criteria. The researcher's role in structured interviews with a protocol (or in conducting a survey) was primarily to observe as a nonparticipant, as is the role while following a detailed interaction protocol or using questionnaires or scales (Marshall et al., 2022). The researchers also utilized an observation checklist to establish a structure for the classroom visit and also to provide a framework for the classroom observations. The checklist served as a contract of understanding between teacher and researchers, and as a result eased discomfort and angst among study participants by preliminarily establishing characteristics of lessons observed.

Focus Group

The third measure utilized within the 60-day PDSA cycle, a post-implementation focus group, enabled researchers to conduct one collective virtual focus group with the teacher participants to collect perceptions from the PDSA cycle to inform the *Study* and *Act* portions of the cycle. The researchers reviewed the teachers' responses to predetermined focus group questions related to the implementation of the data participation days (see Appendix D for questions). This allowed the researchers to elicit lessons learned and recommendations for improvement on the change idea. The researchers were able to more acutely understand teachers' reactions and consider bringing the student Algebra I Data-driven Protocol to a countywide scale. One particular strength of focus groups is that this method is socially oriented, learning from participants in an atmosphere more natural than a one-to-one interview (Marshall et al., 2022). This method was used to bring the teacher participants in the study together to debrief about their experience, talk with other Algebra I teachers at different schools to obtain ideas/support from their peers, and provide the researchers with insight about how the study could be altered, tweaked, and scaled to meet the needs of the Data-driven Practice Days. Having a research partner is essential for taking field notes on interactions and recording emotions, freeing the interviewer to ask questions, follow up, ensure that all participate, and intervene to facilitate the group (Marshall et al., 2022), therefore this method is perfect for the two-person team. The researchers felt this was a stronger data collection method than a post implementation survey, because teacher participants could dialogue about their experiences and be able to learn from one another.

PDSA Cycle Implementation

The selected measurement instruments within the PDSA cycle provided the link between the research study outcomes and the purpose, which was to explore the Algebra I Data-driven Protocol utilized during Data-driven Practice Days. The PDSA cycle, with the inclusion of the three measurement instruments, provided meaningful insight and evidence-based data to provide insight into the two research questions: 1) Does the use of a student Algebra I Data-driven Protocol have an impact on teacher practice in engaging students in dialogue about Algebra I assessment data? 2) What are the teacher perceptions about the fidelity and use of a student Algebra I Data-driven Protocol? Additionally, the documented evidence from the cycle provided concrete evidence to further suggest areas to explore in the future. Outlined in Table 7 are the four phases of the PDSA cycle addressed during the study and the measurement tools utilized during each phase.

Table 7

60-day PDSA cycle

Plan	• Conducted the pre-implementation empathy interviews; • Developed two research questions the researchers looked to answer through the exploratory this study; • Made predictions for each question; and • Determined what data will be collected to test predictions.
Do	• Conducted the implementation of the change idea; • Documented problems, challenges, or unexpected outcomes; • Collected and recorded information and data immediately after the change idea are implemented; and • Remained cognizant of the measurement tools meeting their intended purpose.

Study	• Utilized the observation checklist to note the change idea in action in classrooms; • Used the collective observations to begin to note data; • Discussed what was collected, what was observed, and what was not observed, but expected; • Conducted the post-implementation focus group; • Discussed any issues that were not anticipated; and • Analyzed the findings and evidence by comparing them to the predictions from the "PLAN" phase. Compared the change idea results to the research conducted as part of the "PLAN" phase. - What were the predictions - What were the results - What did you learn?
Act	• Determined overall quality of the cycle and measurement instruments; • Discussed and reflect on the outcomes of the PDSA cycle; • Identified what changes would need to be made to optimize improvement prior to starting a new cycle; • Discussed possible modifications to the change idea and decided the scope for a future cycle; and • Suggested possible impact products to further research.

Data Selection and Collection

The data collected encompassed a qualitative approach through the utilization of three measurement tools within one PDSA cycle to ensure the valid and reliable data were captured through a broad spectrum of methods. The following data points define what the researchers collected: pre-implementation empathy interview perception responses, post-implementation focus group feedback, and observational and anecdotal data from classroom visits. Each measurement tool provided evidence in streamlining the review of the research study's effectiveness and what the participants had to say about the inclusion of the Algebra I Data-driven Protocol. The teacher participant's experiences were documented throughout the feedback and perceptions provided by each individual from each of the measurement tools.

The following data points were identified and collected throughout the process to ensure the information was diversified throughout the collection study timeframe:

Table 8

Research Study Measurement Data Points

Empathy interviews	• Collected perceptions, feelings, thoughts, key phrases or language and the responses were coded through an in-depth review of the open-ended, qualitative responses. • Identified themes and commonalities, sorted into categories/groups using tags and color-coded responses - how participants thought or felt about student engagement and the change idea.

	• Asked several open-ended response items as well as opportunities to allow study participants to relay their own experiences. • Gathered initial thoughts regarding student engagement as well as gained a deeper understanding of each identified teacher's lived experience in the classroom and data utilization during instructional planning. • Provided overview of protocol directions, how to use it, and an opportunity to ask questions to confirm that they understood how it must be used to ensure fidelity.
Observational checklist	• Conducted classroom visits, one per participant. 60-90 minutes each. • Captured key behaviors and school site visit evidence while observing the identified classrooms on the implementation of the change idea and the noticeable behaviors and experiences during each visit. • Captured notes regarding observable teacher participant verbal and behavioral information on the observation checklist, displayed in the appendices section, as well as added reflection notes and lesson feedback following the observations to summarize the findings.
Focus group	• All study participants attended. • Asked for their feedback, lived experiences and reflections on the change idea and process as a whole. • Asked five to six informal, open-ended, and closed-ended questions and prompts. • Researchers captured statements made by the teacher participants on the notes capture form, displayed in the appendices section, as well as added reflection notes and feedback following the focus group to summarize the findings.

School and Subject Selection

To conduct the research study, the researchers opted to use a stratified sampling methodology to identify, select, and recruit teacher participants. The stratified process for purposes of this research study divided the population into strata groups by mathematics course characteristics. A school sample was taken from each of these strata using systematic sampling to identify each teacher participant. To successfully measure the impact of the Algebra I Data-driven Protocol, the researchers selected classroom teachers at four schools who currently taught at least one Algebra I section in either a LMSD middle school or high school. At the time of the study, LMSD had approximately fifty-four middle and high schools that had at least one Algebra I section. To calculate the systematic sample size, the researchers utilized a sampling formula to calculate the sample population size of the study: 8% to 10% of 54 middle and high schools, which yield a four to five school sample size. The researchers selected the minimum sample size [four] to gain a rough estimate of perception results for the research study and avoid dividing the participants into different groups during the analysis. This also enabled the researchers to base decisions on the research study results overall and avoid significant consequences and limit risk for participants (Bhattacherjee, 2012). This research study was an exploratory study, which generally requires a lesser sample size and did not require differentiation by control and treatment groups because every subject received the experimental treatment in the research study (Bhattacherjee, 2012).

Based on the sampling formula and use of a stratified sampling methodology, the researchers attempted to gain the participation of four Algebra I teachers. As shown in Table 9 below, based on strata groups identified using the stratified sampling methodology by mathematics course characteristics in LMSD, the schools identified were: one Middle School containing a general education population of eighth graders in Algebra I, one High School containing mixed grade level, Special Education students in Algebra I, one High School containing a general education population of ninth graders in Algebra I, and one Montessori K-8 School containing a general education population of eighth graders in Algebra I. The researchers reviewed each school selected for the following characteristics: demographics, socio-economic status, availability of Algebra courses and geographical location within LMSD to verify the utilization of the four schools for participation in the research study. The researchers also further verified grade levels (eighth grade vs. ninth grade), location within the county (north, south, central, etc.), variation in instructional approach (Montessori vs. traditional) and access to at least one section of Algebra I, all of which are largely reflective of the racial and socio-demographics of the LMSD school system.

In order to ensure participation variation within the schools selected with respect to instructional approaches, the researchers opted to add a Montessori school in the participating sample to represent a non-traditional program within LMSD. Montessori learning was founded upon “a method of education that is based on self-directed activity, hands-on learning and collaborative play with learning environments designed to meet the needs of children in a specific age range” (American Montessori Society, 2023). The Montessori experiential learning design in its classrooms lead to a “deeper understanding of language, mathematics, science, music, social interactions” (American Montessori Society, 2023). The philosophy behind Montessori education is that

> every material in the classroom supports an aspect of child development, creating a match between the child’s natural interests and the available activities. Children can learn through their own experience and at their own pace. They can respond at any moment to the natural curiosities

that exist in all humans and build a solid foundation for life-long learning (American Montessori Society, 2023).

It is the belief of the researchers that this type of instructional program lent itself to the inclusion of a student Algebra I Data-driven Protocol to allow for students in this environment to be collaborative, gain deeper understanding and engage in a strategy to learn through their own lived experiences, which are all in direct alignment with the Montessori philosophy of teaching and learning. The researchers gained a different perspective of how the student Algebra I Data-driven Protocol was effective within other non-traditional classroom settings as well as varying implementation methods by the classroom teacher by evaluating if the change idea was used as an established data-driven practice.

Enrollment

As shown in Table 9, the research study proposed including four sample schools with the following demographics and study inclusion rationale:

Table 9

Selection of Schools

School Code	Classroom Code	Demographic Population	Geographic Location	Number of Algebra Students	Rationale for Selection
0*	Classroom 0*	Students: 1,965 FaRMS: 80%	North County	700	Larger high school, high FaRMS and a Title 1 school.
1	Classroom 1	Students: 949 FaRMS: 83.5%	Central County	53	Larger middle school, high FaRMS.
2	Classroom 2	Students: 909 FaRMS: 59.5%	Central County	251	Medium sized high school located in the center of the county.
3	Classroom 3	Students: 504 FaRMS: 37.2%	North County	15	K-8 Program Specialty Program.

*Note: School did not participate in the research study.

Table 10

Classroom Demographics

	Classroom 1 Characteristics	Classroom 2 Characteristics	Classroom 3 Characteristics

Number of students	12 students	30 students	16 students
Gender	Female- 3 students Male- 9 students	Female: 18 students Male: 12 students	Female: 10 Male: 6
Grade level(s)	9th grade	8th grade	8th grade
Demographics	Black/African American-7 Hispanic/Latino- 2 White- 1 Asian- 0 Native Hawaiian/Pacific Islander- 0 American Indian/Alaskan Native- 0 Two or More Race- 3	Black/African American- 22 Hispanic/Latino- 6 White- 0 Asian- 0 Native Hawaiian/Pacific Islander- 0 American Indian/Alaskan Native- 0 Two or More Race- 2	Black/African American- 9 Hispanic/Latino- 4 White- 2 Asian- 0 Native Hawaiian/Pacific Islander- 0 American Indian/Alaskan Native- 0 Two or More Race- 1
IEP	All 12 students had IEPs	1 student had IEPs	0 student had IEPs
504 Plan	0 students had a 504 Plan	3 students had a 504 Plan	1 student had a 504 Plan
ESOL	0 students were ESOL	3 students were ESOL	1 student was ESOL

Classroom 1 was a medium sized traditional high school that is located in the central portion of the school system. Their enrollment at the time of the study was 909 students, and a Free and Reduced Meals (FaRMS) rate of almost 60%. The researchers observed a self-contained special education Algebra I high school class containing students diagnosed with Autism. The observation took place midday, during the school's third period. The classroom was set up with desks in small group clusters for students to work in cooperative pairs. The lesson observed was by Teacher A, who had over 30 years of teaching experience at the time of the observation, mainly within high school mathematics and special education.

Classroom 1: Additional Context

As part of the exploration conducted to identify the sample classrooms to participate in the research study, researchers identified that Classroom 1 consisted of a homogeneous group of students all diagnosed with Autism Spectrum Disorder (ASD). ASD is defined in medical terminology as a neurological and developmental condition that affects how those with autism interact with other people, including how they communicate, behave, and learn (Forbes, 2022). Since ASD is "so wide-ranging, there is not one particular method to instruct students with ASD in mathematics, as each child has his or her own preferred way of learning, with their own individual strengths and weaknesses" (McDougal, 2020 p.

2). In completion of Classroom 1 observations, several important findings were noted with respect to student interactions and reactions to the lesson. First, results showed students in Classroom 1 utilized more process time to internalize directions given by Teacher 1 to start the lesson's activities. Research on ASD states "many people with ASD struggle to process information quickly and often struggle in fast-paced, busy and noisy environments in a classroom. The amount of processing needed is likely to be considerably more than what may be assumed by teachers" (Forbes, 2022, paragraph 45).

The second finding was that students preferred to work in pairs rather than small cooperative groups. In reference to ASD cooperative grouping, students have difficulty processing oral information when multiple directions are given at once and may only hear the first or last word provided which leads to not internalizing the expectations leading to not understanding the assignment (Dubie, 2019). Therefore, students with ASD may form anxiety and sit quietly not attempting the work or may talk to partners about irrelevant topics (Dubie, 2019).

Third, students needed several methods of redirection in completing tasks, such as repeated and visible directions, teacher proximity, extended time and frequent use of breaks throughout the lesson. According to best practices with ASD students, visual representation and grouping are often beneficially used by children on the spectrum, as many of these students see and understand things physically and literally (Forbes, 2022). This strategy helps to display actual visual examples and pair them with verbal instructions for ASD students that are partially verbal or non-verbal (Forbes, 2022).

The final finding, in Classroom 1, was that students needed several more instances of scaffolding in order to complete tasks, such as visual cues, tactile manipulatives and constant verbal reminders. Overall research studies have found that "certain parts of the brain in children with ASD are activated when solving math problems, and that they tend to use different approaches when solving these problems when compared to students without autism" (Iuculano, et al., 2013). The study further concluded that children with ASD use scaffolded strategies such as decomposition when solving math problems, breaking down problems into smaller problems to find the answer" (Iuculano, et al., 2013). These findings were further considered when conclusions and next steps were drawn and what impact product could be created to better serve other student and service group populations.

Classroom 2 was a larger sized traditional middle school that is located in the central part of the school system. Their enrollment at the time of the study was 949 students and a FaRMS rate of over 83%. The classroom was an accelerated 8th grade Algebra I. The observation took place at the beginning of the school day, during the school's first period. The room was set up with desks in small group clusters for students to work in cooperative pairs. The lesson observed was by Teacher B, who had over 25 years of teaching experience at the time of the observation, in high school mathematics.

Classroom 3 was a K-8 Montessori school that is located in the northern end of the school system. Their enrollment at the time of the study was 504 students, and a FaRMS rate of almost 37%. The classroom the researchers observed was the only accelerated 8th Grade Algebra I class. The observation took place near the beginning of the school day, during the school's second period. The room was set up with desks in small group clusters for students to work in cooperative pairs. The lesson observed was by Teacher C, who had 7 years of teaching experience working at the time of the observation, in both middle and high school mathematics.

Challenges in School Selection

Due to unforeseen circumstances, one of the selected schools, a high school containing a general education population of ninth graders in Algebra I (Classroom 4), did not participate in the research study. The researchers did acquire written approval from the school's principal to be a part of the study; however, the participation of a teacher could not be obtained. There were numerous attempts during the school participation acquisition period to contact, through email, five different Algebra I teachers that currently work at the school. One study recruit declined due to a family death and another study recruit declined due to lack of time in their schedule to be a study recruit. The other three staff members, while receiving several email request invitations did not respond. Due to time constraints and the inability to identify another viable study participant, the researchers decided to no longer pursue any further participant study members from this school. In addition, the three research study methods and the strict timeline needed to be adhered to in collecting valid and reliable data, it was decided that no additional schools would be solicited to participate in the research study for this Capstone. Therefore, the research study was composed of three schools with one participating teacher from each school.

Participant Recruitment and Eligibility Criteria

The researchers embarked in a recruitment process to engage study participants. The participants of this study must have met the following eligibility criteria: Classroom teachers that instructed at least one section of Algebra I within a LMSD Kindergarten through grade eight or secondary school and had at least one year of teaching experience. The researchers began recruitment by, first, contacting each school's principal through email and stating the purpose, methods of data collection, and intended outcomes of the study as well as the implementation of a change idea. The researchers then solicited one Algebra I classroom teacher from each school to participate in the study. The participants were recruited via email through the use of their school district email addresses. Although it was not anticipated to use enrolled students as actual research study participants, the researchers needed to observe classrooms and discuss observation data with the identified classroom teachers on the instructional days. The researchers set up an initial virtual meeting to discuss the research study and discuss the proposed study change idea. Based on the identification and acceptance of three teachers within the identified schools, it is estimated that each Algebra I class size had a range of 30-35 students enrolled, with the exception of Classroom 3, totaling 16 students. This sampling strategy allowed the researchers to conduct several in depth observations during the 60-day PDSA cycle and provided the appropriate time for extended school site visits to appropriately observe and document inclusion of the change idea.

Procedures

Overall exploration of the Algebra I Data-driven Protocol implementation was critical in exploring the outcomes of the three measurement instruments and the anecdotal evidence collected. In order to accurately explore the implementation, the researchers analyzed qualitative data points, defined by research as "any non-numerical and unstructured data points" collected throughout the PDSA cycle among the three distinct phases of for characteristics of impact and growth toward the Aim statement, purpose, theory of practice and response to the suggested research questions (Medelyan, 2020, p. 9). Each of the qualitative data points collected during the PDSA cycle were examined to collect participant's experiences and reflections as well as to gain a deeper understanding of the participant's experience with the protocol. This method of qualitative data analysis is "the process of examining and interpreting qualitative data to understand what it represents" (Medelyan, 2020, p. 11). The data collected provided one aspect of the research study's impact on assessing the study's effectiveness and refuting or confirming what the field has concluded about the inclusion of a measurement instrument in targeting student engagement. The information gathered throughout the data collection phase was ultimately synthesized into a content analysis, which is defined as "the categorization, tagging and thematic analysis of qualitative data, which also includes combining the results of the analysis with behavioral data for deeper insights" (Medelyan, 2020, p. 17). The researchers coded the data manually instead of using an application or program to code responses. Due to the vast differences in coding qualitative data, the researchers felt they had a level of expertise in examining the raw data that software could not pinpoint.

The data collected also explored the potential of the protocol to address the problem of practice. More specifically, it allowed the researchers to explore the PDSA cycle and whether and under what conditions the change idea could be adopted at scale, be revised and investigated with a larger group of teachers, adapted or put through another PDSA cycle, or be abandoned and another change idea used. In *Learning to Improve*, the research on Improvement Science suggests that "implementation with fidelity" may not be effective when educators interpret it as doing the exact same thing in the exact same way in schools [and districts] that have dramatically different contexts and circumstances. When educators use evidence-based practices and adapt them to the unique needs and circumstances of students they teach, educators can begin to 'implement with integrity'" (Bryk, A.S., et al., 2015, pp. 208-209)

Following the data collection portion of the study, an in-depth analysis and evaluation on each set of data collected was conducted. Coding or "applying the process of analyzing qualitative text data by taking them apart to see what they yield before putting the data back together in a meaningful way" was applied to validate each piece of information gathered (Elliot, 2018, p. 1). This process served as the basis for reliability, application of a calculated method of descriptive statistics, and overall synthesis of the data to occur. Coding outlines a way of "indexing or mapping data, to provide an overview of disparate data that allows the researcher to make sense of them in relation to their research questions. Most simply, it can be a way of tagging data that are relevant to a particular point" (Elliot, 2018, p. 2).

Data Analysis of Findings

During the analysis and synthesis of the data, the researchers utilized a detailed data review process and coding methodology by including information from the measurement instruments in evaluation of the following variables: verbal responses from the pre-implementation empathy interviews and focus group, observable behaviors during the school site visits, and understanding breakthrough moments or moments of clarity documented following the PDSA cycle. A model of deductive coding was put in place, by using a process of "using a predefined set of codes, then assigning those codes to the new qualitative data. These codes may originate from previous research or known themes [the researchers] are interested in analyzing" (Medelyan, 2020, p. 19). Documentation of all study participant responses and behaviors observed provided valuable insight into the reliability of the measurement instruments as well as the validity of the responses to those instruments by way of a "coding frame, which represented the organizational structure of the themes in your research, via. a hierarchical coding frame, or organizing codes based on how each relates to one another" (Medelyan, 2020). The researchers reviewed collected data for feelings or thoughts regarding particular items, gaps, or missing questions that could have been posed as well as attitudes and behaviors of study participants regarding the change idea and PDSA cycle. The information gathered from all measurement instruments used in the study was thoughtfully taken into account when considering the following characteristics:

- The data collected fit the change idea and purpose of measurement instruments;
- The data was collected easily and without significant development of a new instrument or changes in current processes;
- Identification of the qualitative data gathered: i.e., number of minutes each teacher took to do "x", number of pieces of feedback each teacher shared, number of teachers who did not implement with fidelity the data protocol, etc;
- Data was analyzed for measurement purpose and impact of change idea;
- Overall results and link to what was expected to happen with the results by visualizing the change idea in practice;
- Identification of challenges or unexpected outcomes;
- Reflect on data collected during the phases of the PDSA cycle: Plan, Do, and Study to influence outcomes in the Act phase;
- Used to make informed and evidence-based conclusions as to how a research-based change idea might positively affect the problem of practice; and
- Included in reflections regarding the context specified in the research study and compare and link to actual school settings.

The researchers organized data from each of the PDSA cycle phases into tables, which displayed data from the pre-implementation empathy interviews, the classroom observations, and focus group to show the distribution of responses and organize the relationship or themes between the data. The researchers applied this method of coding [the qualitative research study data] to assign labels to words or phrases that represented important (and recurring) themes in each response. These labels used were words, phrases, or numbers that were easy to remember, skim, and organize. Coding qualitative research in this fashion, to find common themes and concepts, is part of thematic analysis, a method that extracts themes from text by analyzing the word and sentence structure (Medelyan, 2020). See Appendix F and G for examples of the color-coding methods used.

By creating visual representation of the thematic analysis of the data and placing the data in tables, it was more efficient to assess whether the data follow a skewed or normal distribution of responses and whether there were any outliers or missing information. The researchers were cognizant of all output data from the measurement tools and the significance levels, or the measure of strength utilizing the evidence from data collected to acknowledge or refute the initial theory of improvement. Improvement Science principles describe outcome data as "an essential component of how progress and success in schools is measured…the outcomes data, while essential, is not sufficient in helping us improve at scale. We must add a suite of other measures to answer [important] questions" (Bryk, A.S., et al., 2015).

The researchers also utilized a measure of central tendency most appropriate for this study to describe the most common values gleaned from the perspectives of the teacher participants during all three measurement instruments. The main measure of central tendency used, mode, was selected for its characteristic to organize most frequent values in a data set. This type of measure was utilized in the synthesis of coded responses given by teacher participants through organizing all stated responses and highlighting the frequency of those responses to summarize their ideas (see Appendices F and G). The distribution of results from the measurement instruments lent themselves to the use of mode as the primary means during the coding process, as that measure of central tendency represented the highest frequency of occurrence in the sample data. The distribution and frequency of outcome data and level of measurement guided the choices of data synthesis and statistical reporting.

Identification of Findings

The 60-day PDSA cycle was analyzed and coded based on each phase of the cycle; the goal was to review the organized data and gauge its relevance to the predicted ToI as outlined in Table 11.

Themes and commonalities were identified, and responses were sorted into categories using tags to group how the teachers, as post study participants, feelings and thoughts were about the cycle, inclusion of the student Algebra I Data-driven Protocol, and any next steps in utilization of the protocol in the future. The researchers compared the original ToI to what was synthesized in the findings, explored the summary of the findings, and identified next steps. Data from the PDSA cycle was coded with personal anecdotes and wonderings, as well as organized into frequency tables, color-coded, and categorized into groups to visually display the data. The coding structure, including characteristics such as effective and ineffective, was utilized to note an established practice within the classroom based on the inclusion of the protocol as well as to note an existing habit within the classroom based on the non-inclusion of the protocol. Next steps were to determine and identify any missteps or items that need further refinement to be conducted to the Algebra I Data-driven Protocol and fulfill the "act" portion of the PDSA cycle.

Table 11

Research Study Measurement Tools

Empathy interviews	• Empathy interview perception responses were analyzed through an in-depth review of the open-ended, qualitative responses. • Themes/commonalities were identified. • Responses sorted into categories or groups using tags how teachers thought or felt about student engagement and the change idea. • Interview responses were coded based on positive (effective), neutral and negative (ineffective) responses and placed on a scale. • Overall feedback added to summary tables.
Observational checklist	• Observational checklist responses reviewed and collectively discussed by the researchers at the conclusion of each school site visit. • Key behaviors on the checklist that were reviewed and analyzed were: implementation of the student Algebra I Data-driven Protocol, evidence of data discourse, evidence of differentiation, teacher affect and discourse style. • Data from the checklists were analyzed and coded based on the notes and examples of evidence collected while visiting the three identified classrooms utilizing the behaviors marked as being seen or missing on the observational checklist. • Notes collected from each visit were coded for positive, neutral, and negative evidence as well as analyzed for recurring themes that one or more teacher participants or students were observed doing or saying during the classroom visits. • Observations were tallied into identified themes, commonalities, and patterns within the classroom observations collectively and were synthesized into a summary. • Frequency tables, charts, and tables were used to display the data.

Focus Group	• Post study focus group's feedback and responses were analyzed and coded based on positive (effective), neutral and negative (in-effective) responses and placed on a scale. • Responses were also coded through an in-depth review of the open-ended, qualitative responses to the questions posed and additional feedback shared. • Themes and commonalities were identified, and responses were sorted into categories or groups using tags to group how the teachers, as post study participants, feelings and thoughts were about the process, inclusion of the student Algebra I Data-driven Protocol and any next steps in utilization of the change idea in the future. • Extended responses were analyzed for recurring themes that one or more study participants discussed during the focus group session.

Section 3

Overall Study Findings

The key findings of the exploratory research study have shed light on the initial problem of practice: *LMSD middle and high school students are not meaningfully engaged in the Algebra I instructional classroom* and supported the researcher's initial thoughts through data gleaned from the measurement tools. The researchers were able to successfully conduct a study to collect data in measurement of the change idea through one PDSA cycle for a period of 60-days through the implementation of empathy interviews, classroom observations, and a focus group. In reflecting on the intended purpose of the research study, the exploratory study targeted one specific change idea through teacher practice that led students through a data-driven practice activity in Algebra I classrooms. The collection of qualitative data in this study contributed to the researcher's increased understanding of one aspect of teacher practice in the Algebra I classroom. Through the findings of this study, it was theorized that exploration of one change idea would yield valuable information and insight into a singular method of enhancing teacher practice. It is the researchers' belief the change idea could be one reliable tool teachers add to their toolbox of strategies in achieving deeper engagement.

Given the current state of mathematics in LMSD and the challenges identified by state and district data in declining Algebra I student performance, the researchers sought to answer the following two questions: 1) *Does the use of a student Algebra I Data-driven Protocol have an impact on teacher practice in engaging students in dialogue about Algebra I assessment data*? 2) *What are the teacher perceptions about the fidelity and use of a student Algebra I Data-driven Protocol*? These two research questions positioned the researchers to utilize the data collected from the empathy interviews, classroom observations, and focus group to specifically measure the pre, during, and post notions and thoughts that the change idea could have some impact on teacher practice and that result could be measured.

The ToI stated that *if students are active participants in reviewing their own data from district-administered assessments, then they would gain a better understanding of Algebra I content.* Therefore, if students were active participants in reviewing their own data from district-administered assessments on a regular basis, they would gain a clearer insight into who they are as learners. The proceeding sections outline the overall key findings in the exploratory study and provide a detailed synthesis of each portion of the study's data collection and what was gleaned from the data once analyzed.

Empathy Interview Analysis

To analyze the data from the empathy interview question responses, the researchers utilized the notes and recordings captured from each participant and coded them for key ideas and overall themes. A synthesis of each of the three teacher participants' empathy interviews was compiled into an organized list in Table 12. Then, all three synopses were put into one document and coded using different colors for each response, highlighting commonalities and repeat ideas that emerged. Those were then merged into key categories based on the frequency of statements made. The three categories that emerged based on responses were: Comfort and Confidence Level, Challenges and Barriers, and Data Literacy and Discourse. These three categories align with the researchers' Aim statement, to perceive how the teacher participants engage all students in data participation activities by collecting pre-cycle perceptions regarding meaningful data discourse in the classroom through use of purposeful best practices. First, the researchers looked at teachers' comfort and confidence levels in teaching mathematics, preconceived feelings about math, student engagement, and how their students are engaged in their classroom. Second, the researchers looked for any challenges and barriers that emerged regarding engagement. Lastly, the researchers wanted to know how confident and comfortable the teachers were with looking at data and how confident they felt with facilitating conversations with students looking at data.

Table 12

Overall Key Findings from Empathy Interviews

Comfort and Confidence Level	• All three teachers feel very confident in their abilities to teach math and deliver the content of the Algebra I curriculum with strong foundations in how to effectively plan. • All three teachers use multiple strategies to engage students in their learning such as: using real world examples, moving around the classroom, providing one on one support, grouping students strategically based on skill level, and using student feedback to plan engaging lessons.
Challenges and Barriers	• All three teachers cited issues with technology as a barrier to engagement (i.e. lost or damaged computers or chargers, not enough graphic calculators or not knowing how to use the calculator effectively). • Two of the teachers said the curriculum is fast paced, "too long", and should be reorganized. They said that students need more time to practice with the text

	materials and more lessons that focus on real world connections should be provided.
Data Literacy and Discourse	• When the teachers were asked about their use of data and comfort level of how to access, analyze and utilize student assessment data, they were all able to provide examples about using data to create parallel questions, posting results in their grading management system, reviewing the data and leading class discussions, and flexibly grouping students based on assessment results. • None of the three teachers provided any specific feedback regarding their use of individual student's scores on the benchmark assessments in instructional planning, looking at overall district and school performance data or sharing overall noticings and wonderings to assist with improving future student performance (even though, data participation days were written into curriculum for teachers to utilize these skills during lesson planning and collaborative planning).

Empathy Interviews Summary

During the first phase of the PDSA cycle, conducting empathy interviews, the researchers noted that two of the teachers shared concerns regarding the curriculum and the sequence of standards. "The curriculum is too long" (Teacher A, 2023) and "the curriculum is fast paced" (Teacher C, 2023). They stated that the number and rigor of standards and the amount of time to teach them seems unattainable and the units within the curriculum are in need of review. These statements align to information received from the district's math office regarding curriculum pacing. Additionally, when the teachers were asked about their use of data and comfort level of how to access, analyze, and utilize student assessment data, all participants were able to provide examples about using data to create parallel questions, posting results in their grading management system, reviewing the data and leading class discussions, and flexibly grouping students based on assessment results. "I show them the data, their performance, I am constructing a data wall where students will see their progress. I [will] ask the students to track their own progress" (Teacher A, 2023). "I look for where they had the most difficulty, what standards, I provide more examples, more work, and address any misconceptions" (Teacher C, 2023). However, none of the teachers discussed analyzing personal, school, local, or state data with students in the past in order to help students better understand their personal data story and advocate for their needs.

Classroom Observation Analysis

To analyze the data from the classroom observations, the researchers began by looking for evidence of student engagement in the lesson. Then, they looked for evidence that the use of Step 1 (overall data) and Step 2 (standards and item analysis) of the Algebra I Data-driven Protocol were evident in the lesson. The researchers also looked for evidence of teacher practice, which reinforced engagement in their lesson. Lastly, in terms of coding the classroom observations into themes, the researchers considered the observable teacher characteristics and deemed those to be in one of two categories: effective or ineffective. Effective teaching was defined as, the involvement of aligning three major components of instruction: learning objectives, assessments, and instructional activities (Eberly Center, Carnegie Mellon University, 2023). Subsequently, *ineffective* was defined as the non-involvement of the three major components of instruction: learning objectives, assessments, or instructional activities. The effective coding structure was utilized to note observable practices within the classroom using the change idea through the lesson's learning objectives, assessing learning or inclusion in the lesson's instructional activities. The ineffective coding structure was utilized to note non- observable or non-evident practices within the classroom lesson's learning objectives, non-assessment of learning or non-inclusion in the lesson's instructional activities.

The following tables are synopses of the following four categories and effective and ineffective behaviors observed.

Table 13

Overall Key Findings from Classroom 1 Observations

Classroom 1	
Student engagement using the protocol	**Effective observation behaviors** - During the observation, the researchers noted equal effective and ineffective student engagement interactions while using the protocol.
Use of Step 1 of the data protocol (overall data)	**Ineffective observation behaviors** - The researchers observed one instance of Teacher A using Step 1 of the Data Protocol. **Ineffective observation behaviors** - While the teacher did discuss the increase in scores for the Benchmark 2 test, posted scores on the data wall in the front of the class and said that data will be reviewed again, students were not involved in the discussion of their performance results.
Use of Step 2 of the data protocol (standards)	**Ineffective observation behaviors** - The researchers observed one instance of Teacher A using Step 2 of the Data Protocol.
Teacher practice to reinforce engagement	**Effective observation behaviors** - There were many positive attempts to effectively engage students during the lesson (Kahoot, kinesthetic linear activity, urging students to Overall Key Findings from Classroom 2 Observations use their math toolbox (calculators and "Slope Man").

Table 14

Overall Key Findings from Classroom 2 Observations

Classroom 2	
Student engagement using the protocol	**Effective observation behaviors** - Each group captured very thoughtful insights on posters and shared with the rest of their peers for additional feedback.
Use of Step 1 of the data protocol (overall data)	**Not observed**
Use of Step 2 of the data protocol (standards)	**Ineffective observation behaviors** - Students minimally discussed the Benchmark 2 data as part of Step 1 of the data protocol. **Effective observation behaviors** - Students had meaningful feedback regarding what misconceptions they had about the items and what things were understood. **Effective observation behaviors** - Students were given ample time to engage in cooperative groups to complete their noticings and wonderings and the teacher engaged with students and was part of their dialogue while walking around to each of the 6 groups. **Effective observation behaviors** - Teacher B facilitated the cooperative groups initially, however, once students broke out into small groups, they began to have meaningful dialogue amongst themselves and made some insightful connections.
Teacher practice to reinforce engagement	**Effective observation behaviors** - Teacher was effective in allowing students to work cooperatively which should lead to heightened engagement of students in the lesson content?

Table 15

Overall Key Findings from Classroom 3 Observations

Classroom 3	
Student engagement using the protocol	**Effective observation behaviors** - Students made several statements about their data and had several follow up questions as a result of their data analysis.
Use of Step 1 of the data protocol (overall data)	**Effective observation behaviors** - Students spent the first half of the class diving into Step 1 of the data protocol and having a whole group discussion about their noticings and wonderings.

	Effective observation behaviors - Students had intuitive questions about their data and came up with several hypotheses and possible next steps. **Effective observation behaviors -** Students began to hypothesize and problem solve for why their data looks better than data from their peers in other schools.
Use of Step 2 of the data protocol (standards)	**Not observed**
Teacher practice to reinforce engagement	**Effective observation behaviors** - Teacher C facilitated the conversation but the students took more control of their learning and dialog about the noticings and wonderings around their Benchmark 2 data.

Voice of Students

Even though this research study focused on teacher practice, an unintentional outcome was student-to-student and student-to-teacher dialogue captured while students worked cooperatively with their peers. The notation of what students said during the classroom observations was of interest to the researchers in gaining insight about the change idea through the lens of the students. While capturing anecdotal notes of the lesson characteristics, many student statements were noted that speak to their perceptions of the change idea. In synthesizing what students stated during the classroom observations, the researchers concluded most students appeared interested in the activity when it had direct correlation to the students themselves. In other words, the data protocol's two parts, a) use of real-time student data from a current assessment and b) low performing items from a current assessment gave context to what was being taught in class as well as how the students interacted with the data protocol.

During the observation of Step 1 of the data protocol, several student insights were recorded that expressed a curiosity about district, school, and classroom assessment data. Students responded with, "I thought our scores were pretty low, but then when compared to the county, they were not that bad," "Overall, I could have done better if I had applied myself," and "It surprised me that our school is 20% higher." The students showed curiosity and about the scores and wondered what might have happened if they took the test more seriously. These comments reflect students taking more ownership of their learning.

During the observation of Step 2 of the data protocol, additional student insights were recorded about how the student's showed understanding or lack of understanding of those concepts and standards. The importance of this idea will be referenced later in the focus group section; however one research study participant specifically focused their lesson around creating real world connections and context for students when learning new math concepts and standards. Students in this classroom responded with several remarks, “A student may have calculated the values of each function incorrectly,” “If students want to get full points they must get common factors and differences,” “There are three parts that need to be answered in the questions, the parts may confuse students, and they may not answer all the parts,” and “I had to look at this problem multiple times and try it a lot before I got the right answer.” These responses show that several students had an awareness that the problem may have multiple parts, they had to focus on all of the parts, and should attempt the question multiple times to get the correct answer.

Throughout the observation of the data protocol being implemented, many student questions and wonderings captured were also of note. Students responded with, “This [data] was surprising. What were the scores that made it drop at the other schools,” “Would test scores change for individual students or the whole district (students as a whole) if the test score was counted as a grade,” “If this is an actual grade would the whole county do better,” “Why do you not have to get a passing grade to ‘meet expectations.” and “Could virtual learning have played a role/had an impact on test scores?” This subsection of comments demonstrated keen questioning skills and their thoughts and beliefs about the importance of these tests. The students’ remarks reflected greater accountability and questions about the role the pandemic played in low performance outcomes.

In addition to verbal statements, the researchers also captured written student feedback while they participated in cooperative grouping in the lesson. In Appendix E: Student Response Posters, there are six examples of student *noticings, wonderings, and probable causes* related to Step 2 of the data protocol which review lowest performing items from current assessment results. These artifacts illustrate the individual and group perceptions of what students viewed as important things of note, questions they had about what misconceptions students had when responding to the lowest performing items and reasons why the items chosen by the teacher received low performing ratings.

Classroom Observations Summary

During the next phase of the PDSA cycle, conducting classroom observations, the researchers identified several trends from the anecdotal notes gathered while observing. Teacher C effectively implemented Step 1 of the Data Discourse Protocol by providing each student with a visual data set and allowed students to work in groups to identify noticings and wonderings. “Write down your overall thoughts about the Benchmark 2 scores and take a few minutes to write down your thoughts and then we will share your thoughts out loud” (Teacher C, 2023). Teacher B effectively implemented Step 2 by having students look at one problem, putting students in groups, and having them chart their noticings, wonderings, and probable causes of why each test item was incorrect by a majority of the students. The researchers observed a noticeable difference in students’ participation and in overall understanding of the content being delivered in the lesson for the students with disabilities class (Teacher A) in comparison to the other two regular education classes. Lastly, each teacher had multiple strategies to engage students in learning and students were able to demonstrate some form of engagement, whether it be physical, cognitive or both during all three lessons observed.

Focus Group Analysis

To analyze the data from the focus group, the researchers used a similar coding strategy as the empathy interviews to highlight statements and recorded notes collected during the virtual focus group session with all three teacher participants. Again, key ideas and overall themes were analyzed and synthesized to summarize overall perceptions. The synthesis of each of the three teacher participants' focus group responses were compiled, coded with different colors based on commonalities and ideas that emerged from all three teacher participants. Those were then merged into key categories based on the frequency of statements made. The three categories that emerged based on responses were: strengths in utilization of the data protocol, challenges or recommendations in utilization of the data protocol, and statements of confidence or empowerment in utilization of the data protocol. These three categories align with the initial research questions posed and provide direct insight into answering the effect of implementation using the student Algebra I Data-driven Protocol on teacher practice and the extent to which teacher participants experience empowerment and confidence after facilitating discourse with students about their assessment data.

Focus Group Summary

During this focus group phase of the PDSA cycle, the researchers identified several participant responses and questions about the process and flow of the PDSA cycle and data protocol. These ideas were synthesized into three distinct categories: strengths of the Algebra I Data-driven Protocol, challenges or recommendations of the Algebra I Data-driven Protocol, and participant statements of confidence or empowerment when utilizing the Algebra I Data-driven Protocol. Based on the synthesis of the focus group responses, the participants identified several strengths regarding positive aspects of the protocol and implementation process. Participants disclosed the protocol provided a means for engaging conversations to occur not only in their mathematics classes but other core content courses (e.g. reading, science, social studies) as well. Teacher B shared “the students were able to see what they should do in the future and see if they are on the right track. Which [answers] they can go over and change in the future.” The participants also noted the utilization of the protocol and its potential use with a variety of student groups with a level of differentiation or scaffolding applied to the group or class of students, particularly as a preparation technique for students in continued higher level math courses. Another strength mentioned was the protocol’s positive resources as part of the assessment cycle and utilized after every assessment. The protocol could be put in place to analyze prior years’ data for students to analyze at the beginning of the school year. Teacher C stated that “using data to be intentional, [so students could] create their own data displays to see their progress, and explaining and sharing their data was extremely relevant and there should be additional days in the Algebra I schedule for this type of activity.” This will establish an expectation on data analysis at the beginning of the school year which will support stronger data literacy throughout the year. All three teachers stated they had positive experiences with the data protocol and looked forward to using it again next school year. These statements relayed that the teachers found the protocol to be a useful tool and had potential to be used in other classroom settings.

As part of the synthesis of the focus group responses, several challenges or recommendations were also noted by the participants as they reflected on the use and implementation of the protocol. Participants shared this process was the first of its kind for each of them, to use a specific protocol to have students look at and analyze district benchmark data. The students in each of the participant’s respective classes had not reviewed benchmark data prior to this initiative, so there was a learning curve in how to implement both steps of the protocol as stated in the directions. It was shared that in order to build confidence in both the teacher participants as well as students in using the protocol, more frequent district assessment data analysis and utilization opportunities need to occur. Teacher A asked, “what additional school supports could be put in place to do this work with fidelity to assist the teacher of record in having support in completing the data analysis?” It was further shared that many schools have dedicated data coaches that can assist teachers in pulling data for the data discourse days, however all three participants noted they do not currently have access to a data coach at their current school to ask for guidance and help in accessing and downloading assessment data.

Another challenge described was students with special needs would need additional support and a modified version of the protocol to support their learning. It was suggested by one participant to “chunk the process and make it shorter, so that less class time was utilized.” This recommendation was also noted by both researchers while conducting the classroom observations, particularly in Classroom 1. The students were very much engaged in the lesson, however, the pacing of the lesson to incorporate both steps in the protocol appeared to be a challenge and Teacher A was not able to get through both steps of the protocol.

One recommendation made was for additional professional development in continuation of how to successfully implement data literacy instructional planning should be provided. Teacher A shared she “wanted to create more data walls for my students and the math department. This need will inform the professional development [our math department] will need to take.” Her perceived use of the protocol led her to think about additional ways the tool could be used and what professional learning could be developed and offered to assist her and her colleagues in improving their instruction. An additional comment shared, “the most important thing is to access the mathematical discourse data chats. We need some professional development on this in order for us to build data literacy, to learn how to analyze data, trends and patterns, talk about it, and ask questions.” The three teacher participants in the study showed enthusiasm for the learning that occurred from the implementation of the protocol and ways they could continue that learning.

Participant statements of confidence or empowerment when utilizing the Algebra I Data-driven Protocol were also collected and synthesized as part of the evaluation of the focus group feedback. The participants expressed their wishes to see themselves improve by implementing this process next school year now having one strategy for how to encourage student dialogue around their assessment results. The teachers were extremely motivated to create more data walls for their students and the math department to continue to encourage a data centered classroom. All three teacher participants agreed that in order to gain confidence over time and build their data literacy skills, the protocol should be more frequently used as part of the Algebra I curriculum throughout the school year. Teachers said this initial experience gave them more confidence and established a comfort level to support students in implementing data discourse days into their instruction because there was a structured protocol in place with expectations for how to implement it.

Teachers stated they felt this experience also created more awareness of what is going on (with their students' data) and their achievement. Teacher C shared “student accountability, reflection and engagement through the collaborative process” was an activity that should be conducted after every county assessment to allow a more in depth look at benchmark data and chunk and make data more understandable for other district assessments. Additional opportunities to utilize the protocol provide ways for “students to understand data and identify what to do next” (Teacher B, 2023). Furthermore, Teacher A concluded that “during discussion they [students] can list out challenging factors, identify the problem and the factors that align to a solution.” Through repeated use of the protocol, all three teacher participants indicated that they felt their students would greatly benefit and may begin to use the protocol with fidelity as a learning tool.

Overall, what do the data say?

In reflecting on the data synthesized from the qualitative measures (empathy interviews, classroom observations, focus group), the exploratory research study results yielded several outcomes. Preliminarily, the data discourse protocol, when utilized with fidelity, was regarded as effective teacher practice and defined as a useful method to engage students in meaningful dialogue. These findings are based on data collected from the three measurement tools, which revealed a similar trend across all, which was that the change idea was regarded as a useful instrument utilized in the mathematics classroom as part of the instructional cycle. The teachers also shared the urgent need for students to develop skills in data analysis and literacy in improvement of learning as well as feelings about the necessity of adequate training to successfully implement this type of important initiative. Based on the literature analysis conducted as part of this research, data use and “math talk” contributes to increased student learning and emphasizes conceptual understanding to their connection of skills with procedures, and problem-solving strategies (Larson, 2019 & Schildkamp 2019).

This exploratory research study confirms that if teachers provide opportunity and space for dialogue to meaningfully connect themselves to their learning, students will gain a better understanding about Algebra I content. A similar outcome was noted by researcher John Hattie in his study regarding academic discourse and peer-to-peer collaboration as being crucial aspects of increasing learning gains in mathematics (Hattie, 2016). His research further concluded that math discussions significantly improve math language acquisition and learning. The relationship of student-to-student, student-to-teacher, and the use of dialogue is a documented positive influence on student achievement (Hattie, 2016). In this Capstone, similar to Hattie’s work, students made insightful comments, asked thoughtful questions, and wrote carefully worded statements about the data they observed and analyzed using the Algebra I Data-driven protocol. These outcomes could lead to further research in LMSD to see if comparable results could be replicated.

The Algebra I Data-driven Protocol, with the incorporation of data analyzation, discourse, and reflection about lowest performing assessment items, provided an opportunity for data driven instruction by giving teachers an organized template to guide the process. Student engagement is fundamentally tied to the meaningful learning experiences that take place in the classroom and to enhance student’s ability to demonstrate proficiency in standards; educators must strive for ways to improve student engagement and student talk in classrooms (Jordan, 2023). Classroom routines should encourage students to think aloud when working on tasks, which will lead to facilitation of more equitable classrooms by helping every student find and use their voice (Jordan, 2023).

The overall synthesis of the three qualitative measures of data concluded that the participating teachers felt a strong need for this type of change idea and were confident in their ability to include this tool into their regular instruction. Each participant expressed their lived experiences, thoughts, and feelings regarding the need for impactful change and further work on their personal journey towards becoming more data literate and incorporating more math talk in their instruction.

In reference to the two research questions posed at the beginning of the capstone, the qualitative research and anecdotal evidence supported preliminary conclusions. With respect to question 1, *does the use of a student Algebra I Data-driven Protocol have an impact on teacher practice in engaging students in dialogue about Algebra I assessment data?*, participant feedback provided favorable results during the empathy interviews and anecdotal notes made during the classroom observations. Each of the three teacher participants' feedback responses spoke to comfort and confidence level, challenges, barriers, data literacy, and inclusion of discourse in their individual statements. The collection of these statements established a pattern of responses that were positive regarding the overall process and protocol. Teacher A stated that, "students should make their own action plan, that comes from them, not the teacher" and Teacher B added, "students need to be part of the conversation, what is going on and what happened as a result." Teacher C stated, "there is more student accountability, involvement, and collaboration. Being involved gives more sense of pride."

The anecdotal notes taken during each classroom observation lesson capture several instances of incorporation of the data protocol process and teachers' practices during the lesson in reinforcing student's cooperative grouping, dialogue, and critical thinking. In coding specific responses from teacher participants, one teacher was quoted in saying,

> the number one question I get from students is, "Why do we have to learn this, when are we ever going to use this in real life?" To which I respond by doing a lot of collaborative work with the kids, which has them challenge each other and come up with their own aha moments (Teacher C, 2023).

Furthermore, Teacher C shared that the change idea "motivated [the students] to see where they are in comparison to their peers. Students noted a significant difference in their scores because their scores went up" (Teacher C, 2023). Another teacher participant stated that the "Algebra I content is a struggle and there is a strong need to get to know the students--therefore- the art of asking questions, prompting and motivating them is key during instruction" (Teacher A, 2023).

The focus group explored question 2: *what are the teacher perceptions about the fidelity and use of a student Algebra I Data-driven Protocol?* Focus group findings revealed strengths in utilization of the data protocol, challenges, or recommendations in utilization of the data protocol, and statements of confidence or empowerment in utilization of the Algebra I Data-driven Protocol. The notes synthesized by the researchers during the focus group highlighted many examples of the three teacher participants sharing feelings of confidence in understanding the purpose of the change idea and its need for inclusion into the mathematics classroom. In coding specific responses from teacher participants, one teacher was quoted as saying,

> I am extremely motivated to create more data walls for my students and the math department in my school. This [use of data protocol] will also inform the professional development I need to take and ensure my team takes. The most important thing is to access the mathematical discourse data chats and how to use them with students. (Teacher B, 2023).

In addition, another teacher responded with,

> Fruitful conversations that come from the use of this data protocol, can be used in other content areas**,** including conversations focused on other standards. We can discuss why [student's] score/graph goes up and down and feel more comfortable talking about their scores. Students can further examine their own study habits to improve them (Teacher A, 2023).

The notion of the use of this protocol in a larger scale pilot, which could include the addition of other content areas, shed valuable insight for the researchers. Furthermore, all three teacher participants alluded to feelings of empowerment in putting the change idea into use not only in their Algebra I classes, on a more regular basis, but also considering inclusion of the change idea into other classes and contents as well. This directly relates to the idea of growing and fostering a "mathematics mindset" as was discussed in the literature review. Chapman and Mitchell (2018) reiterated that, "If we want students to recognize the satisfaction that comes from tackling and persevering through challenging mathematics problems, then teachers must also see themselves as mathematics learners" (p. 60).

The Algebra I Data-driven Protocol was perceived as a positive strategy within the three classrooms when used as prescribed in the lesson's learning objectives. Given that there is not consistent use of the Data-driven Practice days, responses collected from the Focus Group indicated the Algebra I Data-driven Protocol was a strategy that could be used as a means to improve teacher instructional capacity. Further larger-scale pilot studies would need to be conducted to test the initial theory that the change idea would have similar effects in other classrooms.

Study Summary

For some, Algebra I is “another obstacle to success in high school and beyond” (Laby et al., 2015). Due to Algebra being considered the foundation for higher-level mathematics, as reported by Student Achievement Partners in *Preparation for Success in Algebra,* improving students’ understanding of algebra has been a long-term educational priority in the United States, which has been difficult to achieve (Geary, 2021). As evidenced by the downward trend in 2022 and 2023 state summative assessment data, it is apparent that positive outcomes in performance data for this essential course continue to elude the LMSD school system. This study set out to explore one way that educators might engage students in Algebra I instruction, through a protocol allowing students to discover and unpack their own performance data, compare it to their peers, the district, and then the state. Additionally, the protocol pinpointed specific problems students collectively missed, to determine noticings, wonderings, and hypotheses, with an end goal to provide students with the opportunity to get to know their common pitfalls, and how to avoid them.

The researchers observed evidence of implementation of both Steps 1 and 2 of the data protocol in all three classrooms. Teachers provided opportunities for active participation in groups, encouraged students to answer questions, praised insightful comments about the data or questions and encouraged their discoveries with the class. The teachers further supported the researcher’s observations during the focus group, where they discussed similar noticings. Teacher A said, “the students were accepting of their scores and not as shy to talk about their scores.” Teacher C said that this process allowed for “student accountability, reflection and engagement through the collaborative process.” These teacher reflections mirror the observations of both researchers, supporting the notion that teachers perceived or believed that the protocol allowed for deeper engagement into student data and reflection on their performance.

Even though at the beginning of the study, each of the three teachers felt that they were very comfortable reviewing data on their own and reviewing it with their students, all three teachers stated they felt even more comfortable in doing so after the study had concluded. These statements provided evidence for the researchers that the Aim Statement, *Teachers in select Algebra I classes will engage all* *students in a structured data participation activity, which will result in routine data discourse that was* able to be documented as an outcome. Each participating teacher saw the need and benefit of incorporating this into their instructional practice on a regular basis and strengthening their data literacy. Data literacy–the ability to read, understand, communicate, and analyze information from data and put it into context–is a vital skill that helps create a cohesive mathematics classroom that supports learning goals, meaningful instructional opportunities, and greater chances for student growth and success (Lucas, 2021).

Implications

For the purposes of this study, the researchers identified implications of a short term, intermediate, and long-term nature, which should be considered when attempting to validate and interpret the overall findings. The researchers identified four main implications in direct relation to the findings. The first implication, limited opportunities to review individualized performance and achievement data on an ongoing basis in mathematics classrooms. The teacher participants utilized data during instruction during the study observation period, when given an organized format and structure (Algebra I Data-driven Protocol) and scheduled time was established. However, instances of teachers incorporating analysis of data was solely observed on a singular visit and not able to be captured in future lessons. It was also noted that teachers shared during the interviews and focus group that this practice was not utilized on a regular basis. The teacher responses led the researchers to note this type of ongoing data driven instruction has the potential to impact students' level of engagement in the classroom and would therefore be beneficial to incorporate more often. Additional data driven instruction would further teacher’s professional learning and allow them to measure over time the benefits of this type of instruction to build their own data literacy. While reflecting on the implementation of the change idea in the classrooms visited, the researchers also concluded that teachers provided instruction for students to isolate trends and patterns in the misconceptions about assessment items, errors made in responding to assessment items which could lead to prevention from occurring. This level of instruction also provides additional advocacy opportunities for teacher-student interactions to enhance instructional delivery methods and data driven instruction to better individualize instruction and meet all learning styles. Essentially, teachers and students would communicate more often and more effectively regarding academic achievement.

The second implication was the realization to collaboratively discuss the Algebra I Data-Driven Protocol with specialized educators with expertise in Special Education regarding modifications to more appropriately meet the needs of students with disabilities. After observing Teacher A, the researchers noted several modifications the teacher made to focus the lesson on the learners and leave out certain aspects of the protocol that were not appropriate for the group of students. This modification of the protocol would take into consideration Universal Design for Learning (UDL) principles, a framework that improves and optimizes instruction and resources for learners based on the science of how students learn. The inclusion of UDL principles establishes a set of recommendations that can be applied to the change idea to ensure all learners can access and participate in meaningful, challenging learning opportunities. After observing Teacher A, the researchers noted several modifications the teacher made to focus the lesson on the learners and leave out certain aspects of the protocol that were not appropriate for the group of students. These observations led the researchers to conclude that the protocol is not well-suited, as currently written, for students with moderate to severe cognitive disabilities, including ASD. A modified version of this protocol could allow students to examine their data in a different yet meaningful way, determine where errors occurred in response to assessment items, and brainstorm with the teacher on how to prevent those in the future. The expertise of a Special Education educator could shed light on ways in which the protocol could be adapted to align with best practices in educating students with disabilities and incorporate ways in which the change idea could be flexibly used based on the learners in any classroom. While not part of the sample population utilized in this study, similar implications would also need to be considered for other student group populations such as English learners.

Thirdly, in future larger-scale piloting of this data tool, professional development should be provided so that teachers have the opportunity to engage with the protocol, put into practice with peers, and participate in a calibration of understanding so the protocol can be implemented with fidelity based on participant feedback provided. More specifically, participant feedback collected during the focus group expressed an interest in further professional learning opportunities to improve their pedagogy and practice in better understanding data protocols and how to use data organically in the classroom. Teacher A stated, “this will also inform the professional development we need to take. The most important thing is to access the mathematical discourse “data chats”’. Teacher C stated, “We need some professional development on this, [specifically] teachers building data literacy, learning how to analyze data, trends, patterns, talking, [and] asking questions."

The final implication noted was that while the intention for each teacher to fully implement the protocol into one lesson, it was not fully observed within the timeframe of this study. What was observed was the successful inclusion of Steps 1 and 2 in two different classrooms leading the researchers to hypothesize if the two lessons from Teachers B and C were combined, the protocol would have been used with greater fidelity. During the classroom observations, it was noted that Teacher C completed Step 1 of the data protocol and teacher B completed section Step 2, however neither teacher fully implemented both parts of the change idea. If the two lessons were combined to occur on the same day or two days in a row, perhaps the learning would have been more powerful and impactful. Students in both Classroom 2 and 3 potentially would have been able to move from data analysis to problem solving, which would solidify their learning for the next iteration of the protocol used. In both Classroom 2 and 3, Steps 1 and 2 of the protocol were successfully implemented irrespectively of one another, however the students were deeply engaged in completing the tasks even though only half the protocol was used. Students appeared to have had a personal investment in analyzing and talking about their own performance data and how they fared in comparison to their peers in both classrooms regardless of both parts of the protocol being used.

Why Study was Relevant, Meaningful, Usable, and Timely

The information gleaned from the study regarding curriculum pacing was in line with previous information provided by the high school math office. In the empathy interviews the researchers conducted during the prewriting stage, the math office shared with the researchers that teachers felt the curriculum was too much and that many teachers did not successfully teach Unit 4, which is located in Quarter 4. The teachers confirmed this same feeling by stating that the "curriculum is too long for Algebra I" (Teacher A, 2023) and that the "curriculum moves pretty fast" (Teacher C, 2023). Additionally, teachers discussed the fact that the structure and sequence of the units within the curriculum should be reevaluated due to timing. Teachers felt that some of the concepts should be taught earlier in the year.

> The curriculum is too long for Algebra I, the quadratic formula must be taught for Algebra 2, not for Algebra I because when you teach the quadratic formula, you have to teach how to derive it. It is too soon, they are not ready for it (Teacher A, 2023).

The study participants were excited to continue the use of the data protocol in their instruction for next school year. They specifically stated that they had "fruitful conversations and that [this protocol] can be used in other content areas" (Teacher A, 2023). "The entire team might utilize this in other classes as well, not just math" and "I used this in all of my [math] classes" (Teacher C, 2023). By allowing the teachers to discuss their experience and overall impressions, they intuitively began to share how they already had or would scale this for next year. Not only would these study participants scale this to other content areas, but they also said students should complete this protocol "after every county assessment" and to "chunk and make smaller for common assessments" and "for each benchmark make it more in depth" (Teacher C, 2023). The teachers also wished to see dedicated time to administer these data driven practice days added to the curriculum to ensure continuity in instruction.

Research Study Limitations

The researchers identified several limitations, or areas of challenge, which were viewed as variables that potentially skewed the results, outcomes, or overall synthesis of the study data and conclusions. While it was both researcher's goal to minimize the range of scope of limitations where possible, the research process presented several challenges that cannot go without mention. These potential shortcomings are also important for the researchers to acknowledge, understand and be able to explain how these may have influenced the overall research findings. While the research study may have had multiple limitations, the following section will discuss only those limitations that directly relate to the research theory, questions, and theory of practice (Dudovskiy, 2022). Although "limitations address the potential weaknesses of a study, documenting them actually strengthens a study by identifying problems before other researchers or reviewers find them" (Price and Muran, 2018).

Furthermore, identification of the study's limitations shows that "the researchers have considered the impact of research weakness thoroughly and have an in-depth understanding of the research topic" (Dudovskiy, 2022). Since all studies face limitations, being honest and detailing the limitations will prove to be a useful exercise in identification of next steps. The limitations of the research study have been defined in terms of six key areas: research problem statement and Aim, training verification, implementation of data collection method, sample size, lack of previous research studies on topic and scope of findings and conclusions.

First, limitation one, the formulation of a research PoP and Aim statement that could be investigated in the research study's designated timeframe was a challenge. The composition of the PoP and the Aim statement established at the beginning of the research study were broad due to it being very early on in the Capstone and difficult to measure. The PoP statement, *LMSD middle and high school students are not meaningfully engaged in the Algebra I instructional classroom,* was not able to be fully explored due to restraints on the number of PDSA cycles conducted. One 60-day cycle did not yield enough evidence to draw definitive conclusions. Similarly, the Aim statement, *Teachers in select Algebra I classes will engage all students in a structured data participation activity, which will result in routine data discourse*, was observed. Teacher A modified the data protocol and teachers B and C completed one part of it. In no scenario was it fully implemented as intended. In both PoP and Aim instances, the length of time established to conduct the study and synthesize the results collected were key hindrances in proving the PoP or Aim statement to be true or measurable within the first phase of the research study. If the researchers were to reformulate the research PoP and Aim and develop measurable outcomes, the level of focus of the study could be increased to limit the inclusion of assessment results and full study participant engagement.

As stated in the Literature review, effective teacher training should mirror teaching by using techniques, such as, modeling, guided practice, and checks for understanding of the new skill, strategy, or practice (Datnow, 2015, p. 2). However, due to time constraints, limitation two was short training sessions prior to implementation and observation of the protocol that were provided. Given the small sample size of participants, individual one-on-one training was provided at the end of each empathy interview to familiarize each participant with Step 1 and 2 of the protocol. While each participant was provided an overview and an opportunity to ask questions, limited calibration of understanding was able to be met due to this method of delivery. In a future larger-scale version of this study, more strategic professional development will need to be provided so the protocol can be implemented with fidelity.

Limitation three, the implementation process of a PDSA cycle with accurate data collection and synthesis of the data was limited due to the lack of experience with these methods. Due in part to the lack of researcher's extensive experience in primary data collection, it was concluded that the nature of data collection and synthesis of the data was flawed. Two key aspects of the implementation process and synthesis of the data identified as challenges were: the inability to incorporate a PDSA cycle with fidelity firsthand and a lack of experience coding research study data. Not having complete control and only being process observers of the classroom implementation of the change idea, it was difficult to ensure the Plan and Do portions of the PDSA cycle were properly planned for execution. Furthermore, once the PDSA cycle was conducted and process data was collected, it was deemed a challenging task to decide on a coding method as well as code the data to reflect what had accurately occurred in order to be able to write about it. After having gone through one trial run of this process, when the researchers engage in a similar endeavor in the future, it will become much easier to establish criteria and routines to adhere to in implementing a change idea in a PDSA cycle as well as what details and focus points to acknowledge in coding the results.

Next, limitation four, the research study's minimum sample size was documented as a potential hindrance in collecting sufficient data to make informed conclusions. In any research study, the sample size is dependent on the nature of the research problem and questions attempting to be proven or disproven. If the sample size is too small, testing design, measurement tools and statistical analysis can be compromised and potentially not able to identify significant relationships between data sets and conclusions drawn. The researchers grappled with establishing a reasonable sample size and weighed several factors in determining the final sample size to be used in this study. While a larger sample size could have generated more accurate results, the researchers decided to limit the sample size of this study to four study participants for a variety of reasons including: time of school year, participant engagement, intrusion of end of year classroom routines, and district testing schedule for end of year state summative assessments taking place. Being an exploratory research study, it mainly focused on the collection of qualitative data which led the researchers to believe the smaller sample size was of less importance in a qualitative study as compared to sample size being a greater factor in quantitative study. This particular research study was established as a short-term study with four study participants originally designated, even though only three study participants were actively enrolled. However, the researchers did conclude that the limited sample size, mainly the fourth school opting not to be an active part of study, may have minimized the data able to be collected. This was a cause for concern because the fourth school was a general education classroom in a high school and the lack of data from this classroom environment limited the researcher's ability to observe the change idea.

Limitation five, a lack of previous studies in the research area was another area of concern due to the insubstantial reading material and research study conclusions on the specific area of focus in this research study. A broad literature review focused on depth and breadth of a study topic is an important part of any research because it helps to identify the past and current works that have been conducted thus far in the research area. Literature review findings can be used as the foundation for the researcher to be built upon in achieving the research objectives (Dudovskiy, 2022). The researchers concluded that while there was sufficient literature on student engagement, mathematics, Algebra, and teacher pedagogy, there was limited research found on student discourse in an Algebra classroom with incorporation of a data protocol. In evaluating the current educational landscape, this research study's focus is decidedly more contemporary and a current topic about which the literature is ever evolving. The limited availability of research on student discourse in Algebra I classrooms utilizing a protocol is also lacking with respect to comparison of similar school districts with LMSD's student body size, race, ethnicity, socioeconomic status, and service group make-up.

Finally, limitation six, assessing the scope of the research study's findings. This particular characteristic is a limitation of the research study due to its narrow focal point stemming from the researchers'

> lack of experience in conducting research and producing academic papers of such a large magnitude, which lead to the scope and depth of discussions in the research paper being compromised on many levels as compared to the works of experienced scholars (Dudovskiy, 2022).

This limitation presents two challenges identified by the researchers: one challenge being the level of scholarly writing about a new topic of interest and secondly, the pinpointing of one particular topic of personal interest versus being a topic of interest to the academic community at large. The researchers' sole reason for focusing on one content, Algebra I as test case classrooms, was due to the LMSD's current and past performance in this course and the desire to change the outcomes for the future. The lack of past experiences by both researchers in conducting, synthesizing, and writing about one topic to make a lasting impact on a school district may have an impact on the way the data was synthesized, findings were discussed, and summaries were made. Should the researchers engage in continued studies in this area of focus, using the knowledge, skills and experiences gained during this first attempt, the outcomes would assuredly be more detailed, thoughtful, and impactful for LMSD.

Validity of Research Study

Based on the positionality of both researchers, it was also concluded that there could have been internal threats to the validity of the data collected. While there are many affordances of the leadership positions within the school system of focus, the researchers were cognizant to protect the anonymity and confidentiality of responses and anecdotal observations. However, both researchers are currently assigned administrative roles in the district, which have evaluative responsibilities assigned to them. The position of the Director could have had some unintended consequences while assuming the role of a researcher in the study classrooms. Teachers may feel uncomfortable sharing negative aspects of the protocol implementation or data that may paint them in an unfavorable light. During recording empathy interviews and focus groups, teachers may have held back some of their true feelings so the researchers may not be able to see the whole picture. While the supervisor position is an evaluative position, it is unlikely that this position would ever be asked to evaluate a math teacher. However, there might be some apprehension on the part of the teacher that either researcher may share sensitive information about what is happening in the classroom that may not pertain to the study (i.e. classroom management and behaviors) with administration. The researchers addressed these drawbacks or constraints in two ways. First, the researchers assured the teachers both verbally and in writing that no information would be shared with their administration that is outside of the scope of this project. Secondly, the use of pseudonyms were used instead of real names in the final Capstone.

Next Steps

Reflecting on the data methods and findings, there are several next steps that have been identified to continue with future work on the protocol. Along with the findings, one key question regarding next steps is, what can be done with these research findings to impact teaching practices in Algebra I in the LMSD. In pinpointing what next steps would be most impactful, five key considerations for further work have been discerned from the analysis of all findings and established as future courses of action and determined to answer the key question posed above.

In the first identified next step, the researchers will discuss these findings with the secondary mathematics curriculum office and propose the addition of a larger pilot group before adding the data protocol to the Algebra I curriculum. Currently, within the curriculum, there are twenty data driven practice days in which the expectation is for teachers to utilize data drawn from formative assessments and teacher observations to identify the level of support students need. With the addition of a formalized data protocol, teachers will be able to build their lesson plan with the findings from district assessment data, focusing on improving any skill deficiencies, as well as providing extensions for students who have successfully demonstrated understanding of the standards.

In step two, the researchers will advocate for more innovative strategies to engage students in the Algebra I classroom to be added to current curriculum and instruction. The researchers needed to narrow down their scope and utilized a data protocol for the purposes of this study, but there are multiple other strategies that warrant further research. Utilizing other engagement strategies like Arts Integration, Project Based Learning, and student led lessons, further research could be conducted on their usefulness and impact on student performance. A partnership between the math and fine arts offices, for example, to discuss creative engagement strategies, may yield additional opportunities to include additional change ideas into the curriculum.

Next step three, review the data protocol as it is currently outlined and use the findings collected during the classroom observations and focus group to make suggested edits to both steps 1 and 2 of the protocol. In reviewing the findings from the classroom observations, it was determined that the protocol should undergo a review to ensure its inclusion as a differentiated strategy to use with a variety of student groups from various assessment types. The recommended instructional model for the data driven practice days is to differentiate instruction with small-group rotations based on student need. The suggested activities for small group rotations include teacher-led instruction, collaborative work, and independent technology activity. Through creation of versatile protocols that can be used with various student needs, students with disabilities, English learners, and accelerated and remedial learners; this tool can serve all student needs and create a learner focused resource when planning for instruction.

Next step four, the researchers will continue to conduct further large-scale studies in which the data protocol is utilized in other mathematics classrooms in other select middle and high school classrooms through an organized pilot over the span of an entire school year. While the findings from this study led to several important ideas, the study results must be replicated in other classrooms to determine if scalability is possible. One way in which scalability can be determined is if the study's change idea can be implemented in a similar fashion in identified other classrooms with similar outcomes.

Last and final step, devise a plan for how to measure student achievement over time with incorporation of the data protocol in piloted mathematics classrooms in order to revisit the original PoP and Aim statement. One limitation or challenge identified above alluded to the fact that the composition of the PoP and the Aim statement established at the beginning of the research study were broad and difficult to measure. With the findings of the study being analyzed, a logical next step will be to assess the future of this protocol in implementation of a variety of classrooms over a given school year as well as analyze the assessment measures and student performance. The plan of action for future development of the findings will include steps to measure student achievement data at incremental points throughout the school year to determine effectiveness of the protocol and either prove or disprove the PoP and Aim statement.

Appendices

Appendix A

Pre-implementation Research Study Empathy Interview Questions

Thank you for your participation in this research study's pre-implementation empathy interview. We would love for you to share feedback about your thoughts and feelings around student engagement pertaining to the students in your Algebra I classroom. We appreciate your feedback.

1. How would you describe how you feel about teaching mathematics? Please discuss your comfort level in lesson planning for your mathematics classroom.

2. How would you describe how you feel about engaging students in mathematics? Tell us about your current and past experiences with engaging students in the Algebra I classroom.

3. Please share your thoughts on how engaged your students are in your Algebra I classroom. How do you measure the students' engagement?

4. Can you share with us what types of instructional tools you utilize to engage students in our Algebra I classroom. (Share some of the below examples if needed)

   - **Technology applications**
   - **Paper-back Text TextBooks**
     - **Online Textbooks**
     - **Technology devices (laptop, iPad, cell phone)**
     - **Activities and Games**
   - **Office hours**
   - **Before or after school reteaching**
   - **Enrichment activities**

5. Please share your comfort level of access to, analysis and utilization of student assessment data in the Algebra I classroom.

6. Please share your comfort level and inclusion of data discourse or dialogue about student assessment data in the Algebra I classroom.

7. Please discuss your feelings on planning for and conducting engaging lessons in your Algebra I classroom.

8. Tell us about what has been successful and what has been a challenge in engaging students in the Algebra I classroom.

9. From a perspective of a classroom teacher, what is the biggest disconnect that has and still is affecting student engagement?

10. Compare a professional learning experience where you used student achievement data and one where you did not use student achievement data either in the planning of the lesson or during the implementation of the lesson.

11. How has the shift in providing more access and in-depth student achievement data to our school communities affected classroom performance and students' academic progress?

12. Share the DRAFT student Algebra I Data-driven Protocol and ask for feedback, suggestions, or deletions to the template. React to our proposed student Algebra I Data-driven Protocol. How would you add to/edit this protocol to use with your Algebra I students?

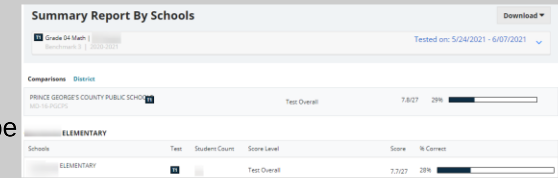
Appendix B

Algebra I Common Assessment/Benchmark Data Analysis Protocol

Assessment: ___________________ Date(s) of Administration: _________

Grade/Team: ____________ Content:_________________

STEP 1: Focus on Overall Data



Report Needed:
Pearson Access < Report Builder
Choose: Grade, Subject, Academic Year, Test Administration, Report Type (SUMMARY), Score Type (Score, % Correct, Count), HOW (By School)

Resource: Dynamic Reporting in Report Building, Pg. 2

	Count	Score	% Correct
LMSD			
School Average			
Classroom Average			
Student/s Average			

****% Correct Statement= ______% is the average performance on this test based on all possible points.*

Noticings (evidence-based statements)	Wonderings
•	•

Think abouts:
- *Overall, what are your thoughts about the scores above?*
- *What additional information is still needed*

STEP 2: Focus on Standards

ELEMENTARY					
Schools	Test	Student Count	Score Level	Score	% Correct
ELEMENTARY	T1		Test Overall	7.7/27	28%
	T1		4.G.A.1	0.7/2	34%
	T1		4.G.A.2	0.5/1	49%
	T1		4.MD.A.2	0.1/1	12%
	T1		4.MD.A.3	0.1/1	8%

<u>Report Needed:</u>
Pearson Access < Report Builder
Choose: Grade, Subject, Academic Year, Test Administration, Report Type (SUMMARY), Score Type (Score, % Correct, Count), **Level 4 (Standard)**, HOW (By School)
Resource: [Dynamic Reporting in Report Building, Pg. 2]

Part A: Look up the three most problematic standards, then reflect on the questions below. Use the three standards to differentiate your Algebra I students into small groups.

Standard Analysis	Highest Performing Standards		Lowest Performing Standards		
	Standards	Item #s	Standards	Items #s	[Language of the Standard] (Math)

****% Correct Statement = _____% is the average performance on this standard based on all possible points.*

A: Where are each of the standards found in the curriculum? ([Link to Curriculum Documents], click on CFPG for the grade level, see "Mathematics Year at a Glance")

B: From your lowest performing standard from above, analyze the item(s) with the chart below:

Item #	What do the students understand?	What were some common misconceptions?	#/name(s) of student(s) with misconception
	•	•	•
	•	•	•

C: Based on your item analysis and student responses, what instructional strategies, math tools and representations, and resources will be used to address misconceptions? How will students re-engage with the content? (Resource: Math Toolkit (see Re-engagement pp. 22-23))

D: Based on the analysis, what strategies can you use to engage in dialogue with each of the three differentiated groups about their data?

Next Steps: Based on the above analysis (misconceptions, student samples, number of students, etc.) What Will You Do Differently for the next Lesson focusing on data?

What engagement activity (i.e Math Talk, learning center, Data Participation Day, etc.) will you implement to address the most problematic standards in the classroom? Link to Math Toolkit	How will you measure the effectiveness of the activity (i.e. journal, exit ticket, warm-up, etc)?	Date of Implementation

Appendix C

Algebra I: Observation Checklist[1]

(Prefill this table in advance)

School: (use A, B, C, D, E)	(there is a corresponding chart the researchers will keep password protected that will identify schools)
Number of students:	
Genders:	
Grade level(s):	
Demographics:	
IEP:	
504:	
ESOL:	

Instructional Setting

- Individual instruction
- Whole group instruction
- Small group instruction
- Number of students in a small group _____.
- Composition
- Topics and concepts covered / discussed _______.
- Teacher delivering content
- Tools for instruction ___________.
- Data Protocol used (how much was used? Circle: 25%, 50%, 75%, 100%)
- Student discourse with teacher
- Student discourse with other students
- Plan created
- Feedback discussed / implemented
- Assessment (formal / informal)
- Closure / Wrap up / Next steps discussed

[1] Adapted from National Council of Teachers of Mathematics, Assessment #6 Math Pedagogy, Math Pedagogical Observation Log. https://www.coursehero.com/file/81651019/NCTM-Assessment-6-Pedagogy-Observe-F20-Copydocx/

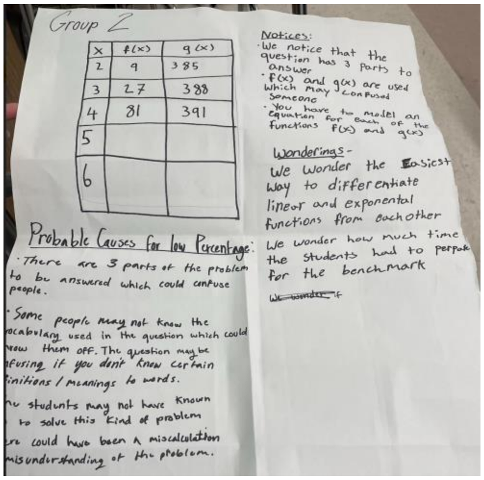
Appendix D

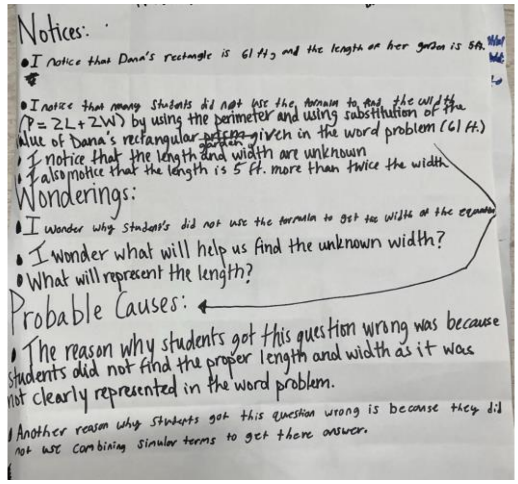
Algebra I: Focus Group Questions

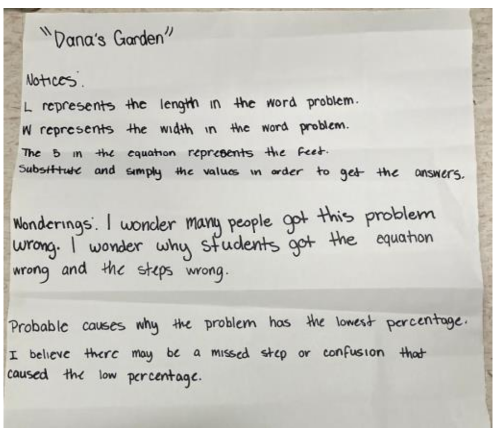
1. What are your overall impressions of how the three Data-driven Practice Days went?
2. Tell us about your experiences about Data-driven Practice Days:
    a. What went well?
    b. What would you change for next time?
    c. Thinking about planning for next school year, if you could plan/change one thing about Data-driven Practice Days, what would it be?
3. What do you better understand about your perceptions of discussing data with students?
4. What do you think students better understand about their own data?
5. Do you feel these Data-driven Practice Days are a good use of class time? Why or why not?

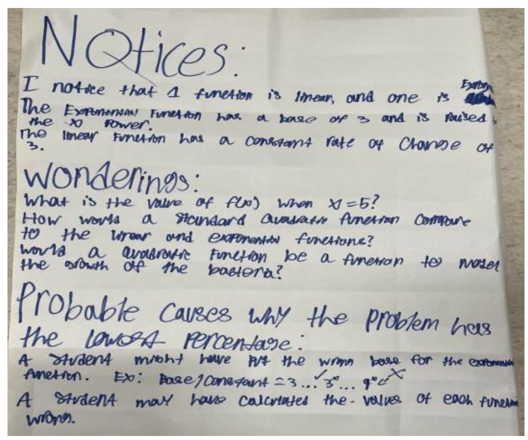
Appendix E

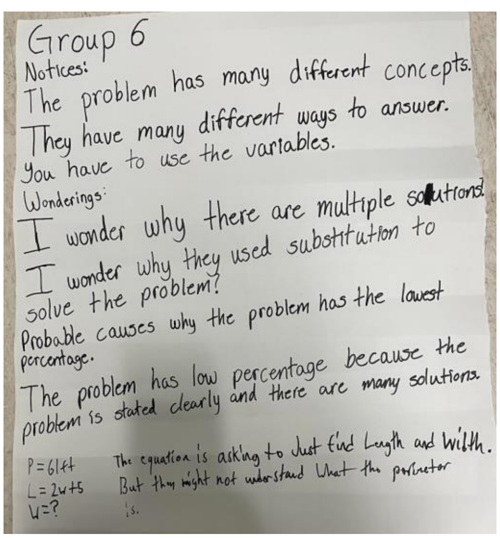
Student Response Posters

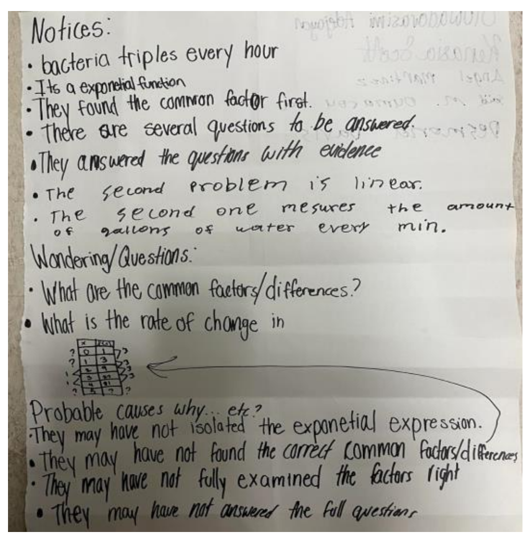












Appendix F

Observation Analysis Coding and Synthesis

Classroom 1

Student engagement during the lesson	**Effective observation behaviors -** During the observation, the researchers noted equal effective and ineffective student engagement interactions.
Use of Step 1 of the data protocol (overall data)	**Ineffective observation behaviors** - The researchers observed one instance of Teacher A using Step 1 of the Data Protocol. **Ineffective observation behaviors** - While the teacher did discuss the increase in scores for the Benchmark 2 test, posted scores on the data wall in the front of the class and said that data will be reviewed again, students were not involved in the discussion of their performance results.
Use of Step 2 of the data protocol (standards)	**Ineffective observation behaviors** - The researchers observed one instance of Teacher A using Step 2 of the Data Protocol.
Teacher practice to reinforce engagement	**Effective observation behaviors -** There were many positive attempts to effectively engage students during the lesson (Kahoot, kinesthetic linear activity, urging students to use their math toolbox (calculators and "Slope Man")

Teacher A Observation Analysis
- Modification of Data Protocol based on specialized population of students due to lack of effective or ineffective incorporation of protocol
- What impact did the lesson planning and outcomes have to do with the student group population?
- While students were "on task", the researchers feel that their "disability" may have impacted the flow of the lesson.

Classroom 2

Student engagement during the lesson	**Effective observation behaviors -** Each group captured very thoughtful insights on posters and shared with the rest of their peers for additional feedback.
Use of Step 1 of the data protocol (overall data)	**Not observed**
Use of Step 2 of the data protocol (standards)	**Ineffective observation behaviors** - Students minimally discussed the Benchmark 2 data as part of Step 1 of the data protocol. **Effective observation behaviors -** Students had meaningful feedback regarding what misconceptions they had about the items and what things were understood.

	Effective observation behaviors - Students were given ample time to engage in cooperative groups to complete their noticings and wonderings and the teacher engaged with students and was part of their dialogue in walking around to each of the 6 groups. **Effective observation behaviors** - Teacher B facilitated the cooperative groups initially, however, once students broke out into small groups began to have meaningful dialogue amongst themselves and made some insightful connections.
Teacher practice to reinforce engagement	**Effective observation behaviors** - Teacher was effective in allowing students to work cooperatively which should lead to heightened engagement of students in the lesson content?

Teacher B Observation Analysis

- "A student may have calculated the values of each function incorrectly." If they calculated the functions correctly by examining their calculations
- "A student may have put the wrong base for the function in the model."
- "Students did not answer both sides of the graph" - students not answering the whole question will make them get the answer wrong and not get the full points.
- "If a student wants to get full points- student must get common factor and difference"
- "There are 3 parts that need to be answered in the questions and the parts may confuse students and they may not answer all the parts."

Classroom 3

Student engagement during the lesson	**Effective observation behaviors** - Students made several statements about their data and had several follow up questions as a result of their data analysis.
Use of Step 1 of the data protocol (overall data)	**Effective observation behaviors** - Students spent the first half of the class diving into Step 1 of the data protocol and having a whole group discussion about their noticings and wonderings. **Effective observation behaviors** - Students had intuitive questions about their data and came up with several hypotheses and possible next steps. **Effective observation behaviors -** Students began to hypothesize and problem solve for why their data looks better than data from their peers in other schools.
Use of Step 2 of the data protocol (standards)	**Not observed**
Teacher practice to reinforce engagement	**Effective observation behaviors** - Teacher C facilitated the conversation but the students took more control of their learning

	and dialog about the noticings and wonderings around their Benchmark 2 data.

Teacher C Observation Analysis

- Students made the following statements:
    - I thought our scores were pretty low, but then when compared to the county, they were not that bad.
    - Overall I could have done better if I had applied myself.
    - It surprised me that our school is 20% higher.
    - PGCPS is leaning towards our test scores going down
- Students asked the following questions:
    - This (data) was surprising. What were the scores that made it drop at the other schools?
    - What are the schools with the highest scores?
    - Would test scores change for individual students or the whole district (students as a whole) if the test score was counted as a grade?" "If this is an actual grade would the whole county do better?" (greater accountability)
    - Why do you not have to get a passing grade in "meet expectations" Why do you not have to get above a "D"
    - Could virtual learning have played a role/had an impact on test scores? It was easy for you to cheat, there was no hands-on learning for students who needed it and office hours were not as helpful.

Appendix G

Algebra I: Focus Group Coding Sample and Key Findings

1. What were your overall impressions of the data protocol?

Teacher A- fruitful conversations that lead to the and **can be used in other contents areas.** Conversations focused on other standards. Discuss why their score/graph goes down and the students were accepting of their scores and not as shy to talk about their scores. Students can further examine their study habits.

Teacher B- the students were able to see what they should do in the future and see if they are on the right track. Which things they can go over and change in the future.

Teacher C - motivated them and see where they are in comparison to their peers. Significant difference in scores. Their scores went up. **Did this with all of his classes**. The entire team **might utilize this in other classes as well, not just math. Use in other disciplines as well.** Build in days into the curriculum to do this. The kids never really saw the benchmarks.

2. Tell us about your experience with the data participation day?

a. What went well?

b. What would you change for next time?

c. Thinking about planning for next school year, if you could plan/change one thing about data participation days, what would it be?

Teacher A- using data to be intentional, create their own data to see their progress. Explain and share their data. More days in the schedule for this. After the assessments. After all 4 in unit 1.

Teacher B- do after every assessment. To analyze what needs to be reinforced. Prep for state test. Makes me more aware of what is going on and their achievement. I want to discuss the hardest problems so that they are aware of what is going on in the class. This is a great help to them, not only a passing grade, **this is to help them continue to Alg 2**.

Teacher C - student accountability, reflection and engagement through the collaborative process. Do after every county assessment, more in depth for benchmarks, chunk and make smaller for common assessments. For each benchmark make it more in depth.

Schools will have state data - September. Use that data to talk to your new students about?

Teacher A- new students, use the cumulative assessment as the diagnostic test.

Teacher B- different factors for why not getting the answers. They are not reading the problem, thought it was multiple choice. Why they did not get the correct solution for some problems.

Teacher C - will have the same students, so will review this data with them.

Multi-steps - observation that her students made, sometimes only did the first step.

Key:

Strengths in utilization of the data protocol

Challenges or recommendations in utilization of the data protocol

Confidence or empowerment in utilization of the data protocol.

Overall Key Findings from Focus Group

Strengths of Protocol	• The data protocol provided engaging conversations that can be carried over into all math classes and other contents (e.g. reading, science, social studies).

	• Utilization with a variety of classes (high performing, low performing, students with disabilities). • This protocol should become part of the assessment cycle and utilized after every assessment. • The data protocol prepares students for continued higher level math courses. • Use prior years' data for students to analyze at the beginning of the school year. This will establish an expectation on data analysis at the beginning of the school year which will support stronger data literacy throughout the year. • Students will be able to take greater ownership of their learning and how to better advocate for their needs.
Challenges or Recommendations of Protocol	• Build days into the curriculum to implement the data protocol. • The students never really saw the benchmark data prior to this initiative. • For more frequent common assessments, chunk the process and make it shorter, so that less class time is utilized. • Students with special needs will need additional support and a modified version of this protocol. • Schools that have dedicated data coaches, should assist teachers in pulling data for these discourse days. • What additional school supports can be put in place to do this work with fidelity? Only the teacher of record is currently responsible for doing the data analysis. • Professional development will be needed for teachers to build data literacy. Teachers need to learn how to analyze, trend, pattern, talk and ask questions about data.
Statements of Confidence or Empowerment	• Teachers said they now have more confidence and a comfort level to support students in implementing data discourse days into their instruction. • They wanted to see themselves improve with this process by the same time next school year. • They were extremely motivated to create more data walls for their students and the math department. • Teachers felt that they were more aware of what is going on (with their students' data) and their achievement.

References

Achieve, Inc. (2005). Rising to the challenge: Are high school graduates prepared for college and work? Washington, DC: Peter D. Hart Research Associates.

American Montessori Society. (2023). Retrieved January 15, 2023 from https://amshq.org/About-Montessori/What-Is-Montessori

Bamford, G., & Curry-Jahn, T. [Jeff Utecht]. (2020, May 20). *Design for resilience framework for the future of schools* [Video]. Vimeo. https://vimeo.com/420906415

Beal, Carole R. Lei Qu, & Hyokyeong Lee. (2006). *Classifying Learner Engagement Through Integration of Multiple Data Sources.* Information Sciences Institute, University of Southern California.

Bhandari, Pritha. (2021). *Within-Subjects Design: Explanation, Approaches and Examples.* Retrieved from https://www.scribbr.com/methodology/within-subjects-design/.

Bhattacherjee, Anol. (2012) *Social Science Research: Principles, Methods, and Practices*. University of South Florida. Global Text Project, Retrieved from http://scholarcommons.usf.edu/oa_textbooks/3/.

Boaler, J. (2013). *Ability and Mathematics: The Mindset Revolution that Is Reshaping Education*. FORUM: For Promoting 3-19 Comprehensive Education, 55(1), 143–152.

Boaler, J. (2015). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching.* John Wiley & Sons.

Brantlinger, Andrew. (2014). *Critical mathematics discourse in a high school classroom: examining patterns of student engagement and resistance.* Educational Studies Mathematics, 85:201–220 DOI 10.1007/s10649-013-9506-2.

Brown, L., & Seeley, C. (2010). Contemporary curriculum issues: Transitions from Middle School to High School: Crossing the Bridge. *Mathematics Teaching in the Middle School,* 15(6), 354-358. Retrieved from http://www.jstor.org.brockport.idm.oclc.org/stable/41183036

Bryk, A.S., et al (2015). *Learning to Improve: How America's Schools Can Get Better at Getting Better* (Boston, MA: Harvard Education Press).

Buchheister, Kelley, Jackson, Christa and Taylor, Cynthia E. . (2019). What, How, Who: Developing Mathematical Discourse. *Mathematics Teaching in the Middle School*, *24*(4), 202–209. https://doi.org/10.5951/mathteacmiddscho.24.4.0202

Chapman, Sue and Mitchell, Mary (2018). *Mindset for Math: Coaching Cycle Empowers Students and Teachers*. Learning Forward. 39(5), 60-64.

Clark, Kevin R. (2015). *The Effects of the Flipped Model of Instruction on Student Engagement and Performance in the Secondary Mathematics Classroom.* Journal of Educators Online, 12(1). 91-115.

Datnow, Amanda and Hubbard, Lea. (2015). Teachers' Use of Assessment Data to Inform Instruction: Lessons From the Past and Prospects for the Future. *Teachers College Record,* 117 (4), 1-26.

Deming, Edwards. (1993). Foundation and history of the PDSA cycle - The W. Edwards Deming Institute. https://deming.org/wp-content/uploads/2020/06/PDSA_History_Ron_Moen.pdf

Dubie, M. (2019) Group work in a general education classroom for students with asd. Retrieved from group-work-in-a-general-education-classroom-for-students-with-asd

Dudovskiy, John. (2022). *The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance* (6th edition). Business Research Methodology.

Dunlap, Karen; Piro, Jody S. (2016). Diving into data: Developing the capacity for data literacy in teacher education. *Cogent Education*, 3(1), 1-14.

Dweck, C. (2007). *Mindset: The new psychology of success*. New York, NY: Ballantine Books.

Elementary and Secondary School Emergency Relief Fund tracker. National Conference of State Legislators. (2022, January 25). Retrieved November 20, 2022, from https://www.ncsl.org/ncsl-in-dc/standing-committees/education/cares-act-elementary-and-secondary-school-emergency-relief-fund-tracker.aspx

Elliott, Victoria. (2018). *Thinking about the Coding Process in Qualitative Data Analysis.* The Qualitative Report. 23 (11), 1-14.

Every Student Succeeds Act. (2015). S. 1177. http://1.usa. gov/1 LpbN69

Ferlazzo, L. (2021, July 12). Four teacher-recommended instructional strategies for math (opinion). https://www.edweek.org/teaching-learning/opinion-four-teacher-recommended-instructional-strategies-for-math/2021/07

Forbes, Hillary. (2022) How Autism May Affect Students' Understanding Of Math And What Teachers Can Do To Help. Third Space Learning. Retrieved from https://thirdspacelearning.com/us/blog/autism-math/

Geary, David. C, Ph. D. (2021). *Preparation for Success in Algebra: Exploring Math Education Relationships by Analyzing Large Data Sets.* Retrieved June 12, 2022, from https://achievethecore.org/content/upload/EMERALDS%20Report%20In-Brief%20June%202021.pdf

George, Tegan. (2022). *Exploratory Research* | *Definition, Guide, & Examples.* Retrieved January 15, 2023, from *https://www.scribbr.com/methodology/exploratory-research /.*

Gningue, Serigne M.; Peach, Roger; and Schroder, Barbara (2013) *Developing Effective Mathematics Teaching: Assessing Content and Pedagogical Knowledge, Student-Centered Teaching, and Student Engagement*, The Mathematics Enthusiast: Vol. 10 : No. 3 , Article 6.

Goldhaber, Dan, Mceachin, Andrew and Morton, Emily. (2022) *The Pandemic's Toll on Academic Growth Wasn't Uniform. Recovery Efforts Can't Be Either,* News Release. EdWeek.

GreatSchools Staff (2013) *Why is algebra so important?* Parenting. Retrieved June 12, 2022, from https://www.greatschools.org/gk/articles/why-algebra/

Hagit Sela, Nicole Davis, & Jennifer Hulse. (2019). Making Math Social with Dialogue Protocols. *Mathematics Teaching in the Middle School*, *24*(4), 226–233. https://doi.org/10.5951/mathteacmiddscho.24.4.0226

Hattie, J., Fisher, D., Frey, N., Gojak, L. M., Moore, S. D., and Mellman, W. (2016). *Visible learning for mathematics, grades K–12: What works best to optimize student learning*. Thousand Oaks, CA: Corwin.

Hattie, J. (2018). How powerful is student dialogue? [Video file]. Retrieved from https://vimeo.com/254282799

Ichinose, Cherie and Clinkenbeard, Jennifer. (2016). *Flipping College Algebra: Effects on Student Engagement and Achievement.* Learning Assistance Review, 21(1), 115-129.

Iuculano,Teresa, Rosenberg-Lee, Miriam, Supekar, Kaustubh, Lynch, Charles J., Khouzam, Amirah, Phillips, Jennifer, Uddin, Lucina Q, and Menon, Vinod. (2014). Brain organization underlying superior mathematical abilities in children with autism. National Library of Medicine. Indiana University. 1;75(3):223-30. doi: 10.1016/j.biopsych.2013.06.018.

Improvement Science Handbook- Empowering NYC educators to make progress on critical issues that stand in the way of student success. (2018). New York City Department of Education. Continuous Learning.

Improvement Science Glossary. (2020). College of Education: Center for Educational Innovation and Improvement, University of Maryland.

Intensified algebra: UT dana center. The University of Texas Dana Center. (n.d.). Retrieved August 29, 2022, from https://www.utdanacenter.org/our-work/k-12-education/k-12-education-curricular-resources/course-materials/dana-centeragile-mind-course-programs/high-school-programs/intensified-algebra

Jordan, Rachel. (2023). The Power of Student Talk in the K12 Math Classroom. TeachFX. Retrieved from: https://teachfx.com/blog-3/the-power-of-student-talk-in-the-k12-math-classroom

Laby, Erik, West, Russell, and Voloch, Daniel. (2015) *Algebra as a Gatewaykeeper to Post-Secondary Success.* New Visions for Public Schools. Retrieved from*:* https://www.newvisions.org/blog/entry/algebra-as-a-gatewaykeeper-to-post-secondary-success

Larson, Matthew. (2019) Math Talk Moves: Engaging Students Through Discussion in the Math Classroom. Houghton Mifflin Harcourt. Retrieved from: https://www.hmhco.com/blog/talk-moves-engaging-students-through-discussion-in-the-math-classroom

Lewis, Karyn and Kuhfeld, Megan. (2022) *Learning during COVID-19: An update on student achievement and growth.* Center for School and Student Progress. NWEA.

Liu, Jing and Loeb, Susanna. (2019). Measuring the Impact of Teachers on Student Attendance in Secondary School. The Journal of Human Resources, 56(2), 343-379.

Lucas, Bill. (2021) Rethinking assessment in education: The case for change. *Centre for Strategic Education*, 1-44.

Maamin, M.; Maat, S.M.; H. Iksan, Z. (2022) *The Influence of Student Engagement on Mathematical Achievement among Secondary School Students*. Mathematics, 10, 41. https://doi.org/10.3390/math10010041

Mandinach, Ellen B. and Gummer, Edith S. (2013). A Systemic View of Implementing Data Literacy in Educator Preparation. *Education Northwest and the National Science Foundation,* 42(1), 30-37.

Mandinach, E. B., Parton, B. M., Gummer, E. S., & Anderson, R. (2015). Ethical and appropriate data use requires data literacy. *The Phi Delta Kappan*, *96*(5), 25–28. http://www.jstor.org/stable/24375781

Mandinach, E.B. & Gummer, E.S. (2016). Data literacy for educators: Making it count in preparation and practice. New York, NY: Teachers College Press.

Margolius, M., Doyle Lynch, A., Hynes, M., Flanagan, S., & Pufall Jones, E. (2020, August 31). *What drives learning: Young people's perspectives on the importance of relationships, belonging, and agency. results from a 2020 survey of High School Youth.* Center for Promise. https://eric.ed.gov/?id=ED617364

Marshall, C., Rossman, G. B., & Blanco, G. L. (2022). *Designing qualitative research, Seventh edition*. SAGE.

Marope, Dr. Mmantsetsa. (2019). *Exploring STEM Competences for the 21st Century.* National Academy of Sciences. In-Progress Reflection No. 30.

McDougal, Emily, Riby, Deborah M. and Hanley, Mary. (2020). Teacher insights into the barriers and facilitators of learning in autism. *Science Direct*. Retrieved from: https://www.sciencedirect.com/science/article/pii/S1750946720301641

McGrath, Shannon. (2019). Talk Less So Students Learn More: Productive struggle is important for students to retain what they learn. *Edutopia*. Retrieved from: https://www.edutopia.org/article/talk-less-so-students-learn-more/

Means, Barbara; Chen, Eva; DeBarger, Angela; Padilla, Christine. (2011) *Teachers' Ability to Use Data to Inform Instruction: Challenges and Supports.* Office of Planning, Evaluation and Policy Development, US Department of Education.

Medelyan, Alyona, PhD. (2020) *Coding Qualitative Data: How to Code Qualitative Research*. Natural Language Processing & Machine Learning. Retrieved from: https://getthematic.com/insights/coding-qualitative-data/

Mehta, J. & Fine, S. (2019). *In search of deeper learning: The quest to remake the American high school.* Cambridge, MA: Harvard University Press.

Mercer, N. (1995). *The guided construction of knowledge: Talk amongst teachers and learners*. Clevedon, UK: Multilingual Matters.

National Association of Secondary School Principals. NASSP. (2022, November 11). Retrieved November 20, 2022, from https://www.nassp.org/

National Conference on Student Assessment. (2022). Retrieved November 20, 2022, from https://ncsa.ccsso.org/

National Council of Teachers of Mathematics. (2010). Principles to actions: Ensuring mathematical success for all. Reston, VA: National Council of Teachers of Mathematics.

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

National Council of Teachers of Mathematics. (2021). NCTM Assessment #6 Math Pedagogy Math Pedagogical Observation Log. Retrieved December 12, 2022, from https://www.coursehero.com/file/81651019/NCTM-Assessment-6-Pedagogy-Observe-F20-Copydocx/

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the national mathematics advisory panel*. Washington, DC: U.S. Department of Education. Retrieved from: https://files.eric.ed.gov/fulltext/ED500486.pdf.

Nelsestuen, Kari and Smith, Julie. (2020). *Empathy Interviews.* The Learning Professional, 41(5), 59-62.

Neumerski, C., (2023) EDUC747, Instructional Improvement for School Leaders, *Rubric: Key Assessment 2: Analysis of Instructional Coherence: Curriculum, Assessments, and Professional Capacity,* University of Maryland.

Nyman, Rimma. (2015). *Indicators of student engagement:What teachers notice during introductory algebra lessons. DOI:10.13140/RG.2.1.2934.7688.*

LMSD/UMD School Improvement NIC Improvement Science and PDSA Planning Guide. (2022). 1.2.

Popham, James W. (2011). Assessment Literacy Overlooked: A Teacher Educator's Confession *The Teacher Educator*, 46(4), 265-273.

Popham, James W. (2018). Assessment Literacy for Educators in a Hurry. *ASCD; Illustrated edition,* 1-26.

Price, James H. and Judy Murnan. "Research Limitations and the Necessity of Reporting Them." *American Journal of Health Education* 35 (2004): 66-67; Theofanidis, Dimitrios and Antigoni Fountouki. "Limitations and Delimitations in the Research Process." *Perioperative Nursing* 7 (September-December 2018): 155-163.

Principal leadership. NASSP. (2020, April 15). Retrieved November 20, 2022, from https://www.nassp.org/publication/principal-leadership/

Principles of Improvement Science. (2020). College of Education: Center for Educational Innovation and Improvement, University of Maryland.

Saleh, Salmiza; Rahman, Muhamad Asyrah Abdul. (2016). *A Study of Students' Achievement in Algebra: Considering the Effect of Gender and Types of Schools.* European Journal of STEM Education, 1(1).19-26.

Salmacia, Kaycee Ann. (2017). Developing Outcome-Driven, Data-Literate Teachers *ProQuest Dissertations Publishing* 1-174.

Saphier, J. (2017). High expectations teaching: How we persuade students to believe and act on "smart is something you can get." Thousand Oaks, CA: Corwin.

Sawchuk, Stephen and Sparks, Sarah D. (2020). *Kids Are Behind in Math Because of COVID-19. Here's What Research Says Could Help. Education Week.*

Schachter, Ron. (2013). *Solving Our Algebra Problem: Getting All Students through Algebra I to Improve Graduation Rates.* District Administration, 49(5). 43-46.

Schmidt, William H. (2012). *At the Precipice: The Story of Mathematics Education in the United States, Peabody Journal of Education, 87:1, 133-156, DOI: 10.1080/0161956X.2012.642280*

Schmidt, W. H., Cogan, L. S., Houang, R. T., & McKnight, C. C. (2011). Content coverage differences across districts/states: A persisting challenge for U.S. education policy. American Journal of Education, 117(3), 399–427.

Schildkamp, Kim. (2019) Data-based decision-making for school improvement: Research insights and gaps, Educational Research, 61:3, 257-273, DOI:10.1080/00131881.2019.1625716

Seidenberg, M. (2017). Language at the Speed of Sight: How We Read, Why so Many Can't, and What Can Be Done about It. New York: Basic Books

Smith, Margaret S., Michael D. Steele, and Mary Lynn Raith. 2017. *Taking Action: Implementing Effective Mathematics Teaching Practices*. Reston, VA: National Council of Teachers of Mathematics.

Snipes, Jason and Finkelstein, Neal.(2015) *Opening a Gateway to College Access: Algebra at the Right Time.* Regional Education Laboratory West. Retrieved from: https://www.wested.org/wp-content/uploads/2015/08/ED559739.pdf

Socol, A. R. (2022, September 29). *NAEP results show dismal learning loss due to pandemic. what can be done?* The Education Trust. Retrieved November 20, 2022, from https://edtrust.org/the-equity-line/naep-results-show-dismal-learning-loss-due-to-pandemic-what-can-be-done/?utm_medium=email&utm_source=equityexpress&utm_campaign=assessments&emci=83f0cf96-cd2a-ed11-ae83-281878b83d8a&emdi=469f7b0e-e92a-ed11-ae83-281878b83d8a&ceid=193363

Southern Maine Partnership. 2017. “A Rationale for Protocols.” http://schoolreforminitiative.org/doc/rationale_for_protocols.pdf

Staples, Megan, and Sherryl King. 2017. “Eliciting, Supporting, and Guiding the Math: Three Key Functions of the Teacher's Role in Facilitating Meaningful Mathematical Discourse.” In Enhancing Classroom Practice with Research behind Principles to Actions, edited by Denise A. Spangler and Jeffrey J. Wanko, pp. 37–18. Reston, VA: National Council of Teachers of Mathematics.

Stoelinga, T., & Lynn, J. (2013, June). *Algebra and The Underprepared Learner*. Scribd. Retrieved from: https://www.scribd.com/document/149829802/Algebra-and-the-Underprepared-Learner.

Strong, Richard, Silver, Harvey F., and Robinson, Amy. (1995). *Strengthening Student Engagement: What Do Students Want. ASCD. 53(1).*

Student Achievement Partners Report. (2021). *Preparation for Success in Algebra: Exploring Mathematics Relationships by Analyzing Large Data Sets*. Retrieved from: https://achievethecore.org/content/upload/EMERALDS%20Report%20In-Brief%20June%202021.pdf

Study site State Department of Education (2022). Early Fall Assessment Student Performance. Study site state board of education meeting, February 2022.

Study site State Department of Education (2018). Mathematics Algebra I. Study site college-and career-ready curriculum framework.

Study site State Department of Education. (2019). *Welcome to the* Study site *Report Card.* Study site State Department of Education.

Teaching Principles - Eberly Center - Carnegie Mellon University (2023). https://www.cmu.edu/teaching/principles/teaching.html#:~:text=Effective%20teaching%20involves%20aligning%20the,leads%20to%20a%20better%20course.

Wassermann, S. (2010). Effective Classroom Discussions. Educational Leadership, 67(5). Retrieved from http://www.ascd.org/publications/educational-leadership/feb10/vol67/num05/Effective-Classroom-Discussions.aspx

WeTeachNYC. (2018). NYCDOE Improvement Science Handbook. WeTeachNYC. https://www.weteachnyc.org/resources/resource/nycdoe-improvement-science-handbook/.

Winheller, Sandra, Hattie, John A., Brown, Gavin T. L. (2013) *In the study Factors influencing early adolescents' mathematics achievement: High-quality teaching rather than relationships.* Learning Environment Reserve. 16:49–69 DOI 10.1007/s10984-012-9106-6

Write for ASCD. ASCD. (2022). Retrieved November 20, 2022, from https://www.ascd.org/write-for-ascd#writeForAccordion