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The Process of Designing and Revising a High-Quality Digital Math Curriculum For a Large Diverse Urban School District: Recommendations From a Math Designer

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THE PROCESS OF DESIGNING AND REVISING A HIGH-QUALITY DIGITAL MATH CURRICULUM FOR A LARGE DIVERSE URBAN SCHOOL DISTRICT: RECOMMENDATIONS FROM A MATH DESIGNER

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I certify that I am the sole author of this capstone. Any assistance received in the preparation of this capstone has been acknowledged and disclosed within it. Any sources utilized, including the use of data, ideas, and words, those quoted directly or paraphrased, have been cited. I certify that I have prepared this capstone according to program guidelines, as directed.

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Executive Summary

The purpose of this capstone was to explore the processes in attempting to design a culturally relevant, high-quality digital mathematics curriculum (DMC) and to provide recommendations for a strategic plan to evaluate the design and revision processes. The DMC initially aligned with three foundational frameworks, addressing the challenge of teachers implementing each framework individually. Continued research into the DMC design and revision processes with alignment to Teaching for Robust Understanding (TRU), Understanding by Design (UbD), and Universal Design for Learning (UDL) Frameworks could show the impact of a custom-built DMC for a large, diverse urban school district. Currently, no research has focused on DMC design and revision processes. Therefore, this paper was a means of exploring the perspective of one of the designers (myself), articulating the process of creating the program, and reflecting on its implementation.

This capstone utilizes a self-study method and employs a qualitative approach. The rationale for the methodology was to document firsthand knowledge from myself as the math curriculum designer at the center of the research and inquiry. The information resulted from self-reflection over two years and a total of 17 weekly self-reflection journal entries that provided insight into the experiences of a math designer and the need for a strategic plan to evaluate and revise the DMC's current design. The data gathered from these entries underwent coding into clusters with assigned indicators for specific themes. At present, the DMC is undergoing revision based on feedback from teachers, administrators, and students. There will be a need to evaluate the curriculum after the revisions to ensure the integrity of the initial build, so the design continues to align with the best practices in the equity rubric, content rubric, evidence guides, design guidebook, Teaching for Robust Understanding (TRU), Understanding by Design (UbD), and Universal Design for Learning (UDL).

This capstone could contribute to continuous improvement efforts by suggesting how to approach feedback and determine if it is actionable and evidence-based. The significance of this study is that it could show other major districts in the United States how to design and revise a curriculum to best serve teachers and students. Expanding this study and reporting the recommendations could support the entire district and show decision-makers how to solve issues related to the design and revision processes, potentially strengthening the program, and avoiding problems and pitfalls. Digital mathematics curriculum improvements could impact the quality of instruction and learning to closely reflect the needs and information from teachers, students, and administrators. A strategic plan for implementing the improvements in Year 3 could be a way to accelerate the revision processes and make larger and more meaningful changes based on the feedback.

This project produced four key recommended priorities to include in a strategic plan for DMC design and revision: communication, data analysis, increasing math experts, and school readiness and professional learning. The findings contributed to the knowledge base on how to design and revise a culturally relevant and high-quality DMC. A significant finding was the need to investigate DMC effectiveness. The broader implications relate to the continuous improvement of the DMC over time. Further research could indicate the factors impeding access to rigorous mathematics education. These conclusions could have significant applications regarding the rigor, accountability, and equitable access to mathematical knowledge students need to succeed in their chosen careers.

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Introduction

Overview

In the winter of 2019, administrators of a large, diverse urban school district in the U.S. Midwest sought to develop a digital mathematics curriculum (DMC) for over 500 PreK–12 schools. The DMC would provide services to over 300,000 students identified as approximately 75% low income and approximately 25% English learners (Illinois State Board of Education, n.d.). The purpose was to produce consistent district-wide expectations for learning across the district to serve all varieties of learners. The objective was to offer educators a high-quality, rigorous digital mathematics curriculum, ensuring universal accessibility and facilitating continuous updates and revisions. The development of the DMC occurred simultaneously with the establishment of the district-wide expectations. Therefore, the goal was to develop high-quality curricula options for teachers and students. In collaboration with the district and teacher reviewers, a team of curriculum developers designed the DMC to highlight student supports, rigor, mathematical practices, technology, engagement and representation, English learner supports, and cultural responsiveness and inclusion. The curriculum release for elementary and high schools in the district took place in the fall of 2021. Analysis occurred for insight into the designing and revising processes over the prior two years with an inside look at the math curriculum designer's experiences. There was a need to examine the math curriculum designer's experiences with designing and revising the DMC to develop the curriculum and inform future revisions.

In this district, school leaders and teachers select the math materials to implement the curricula for the school year. School leaders and teachers can implement programs from different publishing companies across grade levels, and teachers within the same school can teach with varying math texts and materials based on preference or budget. Teachers often spend hours developing and supplementing their math curricula to meet their students' needs. However, the process might look different across the district. School leaders must often decide between spending funds on new math materials or staying within budget.

This capstone project included information from one comprehensive self-reflection over the past two years (August 2020 - October 2022) and 17 weekly self-reflection journal entries recorded between November 2022-February 2023. The reflection and journal entries provided insight into the math designer's experiences and provided recommendations for a strategic plan to evaluate the current DMC design and revisions. The data from these entries underwent coding into clusters with assigned indicators for themes. The themes derived from the data provided insight into the math curriculum designer's experiences. The themes also provided effective learning opportunities for curriculum writers to modify and make the curriculum more relevant and meaningful by including cultural relevancy, differentiated supports, and rigor. Currently, teachers customize their purchased curricula based on common curriculum frameworks, such as Teaching for Robust Understanding (TRU; Schoenfeld & the Teaching for Robust Understanding Project, 2016), Understanding by Design (UbD; Wiggins & McTighe, 2005), and Universal Design for Learning (UDL; CAST, 2018). Initially aligned with the TRU, UbD, and UDL frameworks, the DMC enables teachers to implement these frameworks because it includes all three.

The purpose of this capstone was to focus on and provide recommendations for designing and revising the DMC. Teacher feedback contributed to a revision process to ensure the integrity of the initial build aligned with the three frameworks. There are many math curricula options available for purchase. Therefore, this project showed the impact and design and revision processes of a custom-built DMC for a large, diverse urban school district.

Definition of Key Terms

This literature review included the following terms:

Rigor: This shift involves application, procedural skill and fluency, and conceptual understanding (Achieve the Core, n.d.).

TRU: Teaching for Robust Understanding Framework is also known as the TRU Framework. The TRU framework in mathematics has five dimensions: content; cognitive demand; equitable access to content; agency, ownership, and identity; and formative assessment (Schoenfeld & the Teaching for Robust Understanding Project, 2016; see Figure 1).

UbD: Developed by Wiggins and McTighe (2005), UbD is a framework for viewing pedagogical approaches and maintaining their purpose, objectives, and curriculum design. The UbD emerged in response to addressing learning goals; determining sufficient evidence; and aligning the activities, experiences, and instruction to the learning goals (Bowen, 2017).

UDL: The Center for Applied Special Technology (CAST; 2018) produced the UDL framework. The goal was to develop a research-based framework for instruction and intervention for varied learners.

Literature Search Strategies

A computerized literature search occurred to collect relevant scholarly articles and research using ERIC, supplemented by the PsycInfo, Education Research Complete, and PsycArticles databases. The terms used to find articles were *mathematics, mathematics curriculum, curriculum frameworks, mathematics AND implementation, math curriculum AND implementation, math beliefs AND teachers, mathematics AND professional learning, mathematics practices, mathematics shifts*, and *mathematics standards*. Some sources provided information on theoretical frameworks and the history of mathematics education in the United States. The review included the most relevant articles, with the majority published in 2011 or later. Articles excluded from the search focused on students' mathematics achievement, mathematics anxiety, mathematics beliefs, self-efficacy, and mathematics scores; although these topics did not align with the literature review's purpose, they addressed mathematics achievement.

Literature Review

This literature review encompasses three crucial aspects: math curriculum, curriculum frameworks, and the future of math curriculum. It provides an in-depth analysis of multiple dimensions of math education, including curriculum, historical evolution, Common Core State Standards (CCSS), accountability measures, paradigm shifts, and instructional models. By weaving together these components, the review paints a comprehensive picture of math standards and pedagogy. In its second part, the review introduces the curriculum frameworks TRU, UbD, and UDL, instrumental in crafting the Digital Mathematics Curriculum (DMC). This approach demonstrates the connection between these diverse topics and their collective impact on shaping a modern, effective math curriculum.

Nevertheless, each of these frameworks – TRU, UbD, and UDL – present their unique set of challenges, whether it's the interpretation of guidelines, required time commitment, resistance to change, or determining what's essential for learning. Overcoming these challenges necessitates continuous research and effort to refine and evaluate the DMC, incorporating systematic revision processes and strategic planning based on the TRU framework.

With the beginning of online learning and the integration of technology into education, new complexities have emerged. The necessity for students to develop solid math competencies is heightened in this digital era, particularly from the elementary through middle school years (PreK–8). However, continual education reforms and shifts towards technology-centric teaching models have induced anxiety among teachers and students across the United States (Gautreau et al., 2016). Coincidentally, these constant changes have contributed to a shortage of teachers, especially in specialized areas like mathematics (Gautreau et al., 2016). Furthermore, teachers are expected to prepare students to excel in math on standardized tests in an increasingly digital context (Althauser, 2018). These evolving challenges underscore the importance of examining the future of math education, online learning, and the integration of technology, all of which are instrumental in shaping an effective, contemporary math curriculum.

Math Curriculum: Standards, Practices, and Shifts

Historical Background of Mathematics

The history of mathematics reflects the growth in the ways math curriculum was designed, emphasizing the development of standards, practices, and paradigm shifts over time. In *Math Wars* by Alan Schoenfeld (2004), mathematics education stakeholders and educators battled to determine the focus of instruction and master mathematics to ensure competition in the global market (Schoenfeld, 2004). In 1957, Soviet Union government leaders launched the Sputnik satellite, impacting mathematics curricula and surprising the United States (Schoenfeld, 2004). As a result, U.S. leaders began searching for ways to surpass the Soviet Union in mathematics. Educational leaders continued to change the mathematics curriculum in elementary and high schools to remain competitive with the USSR. The National Science Foundation (NSF) produced curricula with modern mathematics and science content. The mathematics curricula were known as the “new” math (Schoenfeld, 2004). An unintended consequence of the new curriculum was that teachers, parents, and students did not feel competent with the curriculum change and felt disenfranchised.

In response to this situation, Ronald Reagan’s administration published *A Nation at Risk* (1983), indicating the need for increased rigor in U.S. schools, particularly in mathematics, to address the economic crisis (National Commission on Excellence in Education, 1983). High-profile editors collaborated with publishers to develop curricula to support the cognitive revolution related to mathematic rigor. Rather than mere content mastery, the goal of the 1980s was perseverance (Schoenfeld, 2004). Currently, catalyzing change towards various barriers related to rigor leads to identifying the responsiveness of the curriculum implementation and student access (Huinker et al., 2020, p. 26). Rigor and relevancy are identified in *Catalyzing Change in Early Childhood and Elementary Mathematics* (2020) to transform current structures within mathematics education that will offer opportunity and access (Huinker et al., 2020).

Common Core State Standards and Mathematical Standards

Having explored the historical background of mathematics and the various efforts to improve curricula and instruction, it is important to recognize the significant impact of the Common Core State Standards and Mathematical Standards on contemporary education. These standards have sought to address the challenges and opportunities identified in previous decades. In 2009, CCSS emerged from the results of *The Opportunity Equation* commissioned by the Carnegie Corporation of New York and the Institute for Advanced Study (Tampio, 2017). Most state leaders adopted the Common Core standards between 2010 and 2011 to receive funds from the federal government. Common Core State Standards for Mathematics (CCSS-M) focuses on learning environments to support procedural fluency built on a conceptual understanding of mathematics (Hughes et al., 2019). However, creating a learning environment to foster skill fluency and a more profound level of thinking about mathematical concepts could be challenging. Many teachers believe in introducing students to mathematics in elementary school. This approach could include an environment focused on fluency and a conceptual understanding of principles.

The National Council of Teachers of Mathematics (NCTM) provided the most recent CCSS-M in 2014. The National Council of Teachers of Mathematics suggested using eight mathematics teaching practices to promote reasoning and problem-solving via high-leverage teaching practices. Teachers can use the teaching practices to create a learning environment that includes discourse and productive struggle. The eight mathematical teaching practices are: (a) make sense of problems and persevere in solving them, (b) reason abstractly and quantitatively, (c) construct viable arguments and critique the reasoning of others, (d) model with mathematics, (e) use appropriate tools strategically, (f) attend to precision, (g) look for and make use of structure, and (h) look for and express regularity in repeated reasoning (Common Core State Standards Initiative, 2019). The eight practices are means of creating pedagogical approaches in mathematics that enable students to rationalize and think abstractly.

Implementation of the Common Core State Standards for Mathematics

After understanding the development and objectives of the Common Core State Standards and Mathematical Standards, it is essential to examine how these standards are implemented in practice. The implementation of the Common Core State Standards for Mathematics provides insights into the successes, challenges, and opportunities associated with these standards. As U.S. leaders pushed forward with adopting the CCSS-M, leaders of other countries began to shift their focus to mathematics education. Higher-performing countries focused on fewer topics with depth and progression rather than many topics with shallow exposure (Alberti, 2013). As educators in other countries advanced with mathematics with fewer topics, those in the United States began developing the CCSS-M to achieve accomplishments similar to higher-performing countries. The CCSS-M implementation required an understanding of Three Core Shifts: (a) greater focus on fewer topics; (b) linking topics and thinking across grades; and (c) rigorous pursuit of conceptual understanding, procedural skill, and application (Alberti, 2013). The National Council of Teachers of Mathematics (NCTM) supported teachers with understanding and implementing the CCSS-M to ensure access to high-quality mathematics instruction that promoted rigor (*Supporting the Common Core State Standards for Mathematics - National Council of Teachers of Mathematics*, 2013).

Three Core Shifts. The first core shift, focus, requires curriculum and instruction to focus on topics in-depth for a narrower scope of topics per grade level. This shift is a means of improving mathematics education and encouraging teachers to approach the content with a focused lens and remove additional topics (Alberti, 2013). The Association for Supervision and Curriculum Development (2012) indicated that grade bands should focus on the following topics:

- Grades K–2: Concepts, skills, and problem-solving related to addition and subtraction
- Grades 3–5: Concepts, skills, and problem-solving related to multiplication and division of whole numbers and fractions
- Grade 6: Ratios and proportional relationships and early algebraic expressions and equations
- Grade 7: Ratios and proportional relationships and arithmetic of rational numbers
- Grade 8: Linear algebra

The second core shift, coherence, involves observing topic progression across grade levels. Educators can improve instruction with topics focused and linked across grade levels so students can build on skills continuously. Mathematics instruction should not be a list of disconnected topics; therefore, the second core shift focuses on vertical alignment (Alberti, 2013).

The third core shift, rigor, involves the rigorous pursuit of conceptual understanding, procedural skill, and application. Rigor does not involve making math more difficult or introducing newer topics in earlier grades (Alberti, 2013). Rigorous mathematics consists of authentic mathematical concepts that link three rigor aspects: conceptual understanding, procedural skill and fluency, and application (Alberti, 2013). Educators might emphasize fluency over conceptual understanding, but without conceptual understanding, fluency cannot occur. Therefore, mathematics teachers should consider procedures and concepts. However, there have been debates about whether to focus on understanding conceptually or robotically repeating steps (Blackburn, 2018).

Common Core State Standards for Mathematics and Teachers' Experiences

Following an investigation of the implementation of the Common Core State Standards for Mathematics, it is crucial to consider the experiences of teachers who are at the frontlines of applying these standards in their classrooms. Investigating the relationship between the Common Core State Standards for Mathematics and teachers' experiences sheds light on the practical implications of the standards and the various factors that influence their effectiveness in promoting high-quality mathematics education. Due to its widespread adoption, teachers implemented the CCSS-M standards within their classrooms to encourage rigor and depth in mathematics topics (Swars & Chestnutt, 2016). The purpose of the CCSS-M is to build conceptual understanding, procedural skills, and fluency and learn to transfer knowledge through problem-solving. Swars and Chestnutt (2016) conducted a mixed methods study to determine teachers' experiences and perspectives on implementing the CCSS-M. The authors analyzed data from a high-needs urban school, including information from surveys, questionnaires, and interviews with 73 teachers. The findings resulted in three major themes: familiarity with and preparation to use the standards, implementation of the new standards, and tensions associated with the new standards. Overall, teachers viewed the standards positively and believed they contributed to improving mathematics instruction in the United States. Still, the teachers expressed concerns about the time needed for professional learning on mathematical knowledge for teaching, interpreting, and responding to students' thinking, and facilitating mathematical discourse (Swars & Chestnutt, 2016).

Accountability and Shifts in Mathematics

After examining the connection between the Common Core State Standards for Mathematics and teachers' experiences, I'd like to turn attention to the broader context of accountability and the shifts in mathematics education. By exploring these aspects, we can gain a more comprehensive understanding of mathematics education and the ongoing evolution of teaching practices and expectations. The presentation of school mathematics varies in different countries, with the curricula reflecting ways of life and constructed and valued practices (Andrews, 2010). Mathematics is focused on skills and drills, timed content, memorization, collaborative talk, content-specific language, online competencies, and risk-taking behaviors. Progressive changes in approaching, teaching, and learning mathematics have resulted in several shifts in teaching focus, causing educators to review standardized test scores to identify the students above, on, or below grade level. Educators might set their expectations based on this information, limiting students' opportunities to learn and restricting teaching practices (Neumayer-DePiper, 2012). Why teachers look to standardized test scores to influence their teaching based on accountability. Teachers are held accountable for increasing math scores to represent their educational institutions. Families are likelier to enroll their children in schools well-represented in mathematics. In the eyes of parents and educational institutions, substantial math scores provide access to certain colleges, math majors, and careers in mathematics perceived as "successful."

Jacob et al. (2017) asked a group of teachers, "When do mathematics teachers judge their own teaching as 'good?'" (p. 461). The teachers gave different responses based on if they were mathematics or non-mathematics majors. Teachers' educational backgrounds can influence their perceptions of "good teaching" in mathematics. Non-mathematics major teachers tend to focus on skill mastery and formula competency, while mathematics major teachers prioritize creating a supportive learning environment that encourages risk-taking and provides feedback (Jacob et al., 2017). The culture of mathematics is shaped by both the educators teaching it and the students participating in it. In light of these different perspectives, when teaching math, educators should be mindful of how students feel about the content and why and strive to incorporate elements from both approaches to create a comprehensive and balanced educational experience.

Mathematical Teaching Models

Having discussed the accountability and shifts in mathematics education, it is essential to delve into the various mathematical teaching models that have emerged as a result of these changes. By examining these models, we can better comprehend how instructional approaches have adapted to accommodate the evolving expectations and demands in the field of mathematics education. A developed curriculum includes various scaffolding techniques for teaching mathematics. Russo (2020) suggested creating rigorous curriculum scaffolds by following the Launch, Explore, Discuss model (LED). The model provides opportunities for students to struggle productively with challenging mathematical tasks (Russo, 2020). Russo discussed the ideal amount of time and structure of the LED and noted that teachers should not model the tasks. Instead, teachers could pose the problems and answer clarifying questions before students move on to independent and partner time. As teachers push students to collaborate on the tasks, they ask students to express and explain their thinking. Rather than teachers modeling the tasks, students share thoughts, questions, ideas, and answers during the Discuss phase of the lesson. In the Discuss phase of the LED model, students view various approaches to a task instead of the teacher modeling an approach (Russo, 2020).

Curriculum Frameworks

After examining the development of math curriculum in the context of standards, practices, and shifts, I would like to discuss the role of curriculum frameworks. These frameworks provide a structured foundation for designing and implementing effective mathematics curricula to students and teachers. By understanding the connection between math curriculum and curriculum frameworks, one can better appreciate how educators and policymakers work together to create meaningful and coherent learning experiences for students. In this section, the focus will be on the Teaching for Robust Understanding (TRU), Understanding by Design (UbD), and Universal Design for Learning (UDL) frameworks. The purpose of examining these frameworks is to gain insights into the diverse approaches that can guide the development and implementation of effective mathematics curricula. Each of these frameworks conveys unique strategies while also sharing common goals in fostering meaningful and engaging learning experiences for students. By examining these frameworks and understanding their contributions to the field of curriculum design, educators and policymakers can make informed decisions when developing and implementing mathematics curricula that meet the diverse needs of students.

Teaching for Robust Understanding Framework in Mathematics

Having established the importance of curriculum frameworks in guiding the development and implementation of effective mathematics curricula, the Teaching for Robust Understanding (TRU) framework will be explored to express its unique features. The TRU framework in mathematics has five dimensions: content; cognitive demand; equitable access to content; agency, ownership, and identity; and formative assessment (Schoenfeld & the Teaching for Robust Understanding Project, 2016; see Figure 1). According to the TRU framework, classrooms that align with the five dimensions produce influential thinkers (Schoenfeld & the Teaching for Robust Understanding Project, 2016). The TRU framework includes a conversation guide related to mathematics (see Figure 1). The TRU framework community produced this framework to support teachers and coaches with professional development. Various professional development focuses on "best practices;" however, teachers need a professional development protocol that they can continuously build on as a community.

Dimension 1: The Content Mathematics

The first dimension of the TRU framework is mathematics content. The core questions in this dimension are “How do mathematical ideas from this unit/course develop in this lesson/lesson sequence? and “How can we create more meaningful connections?” (Schoenfeld & the Teaching for Robust Understanding Project, 2016, p. 4). The first dimension of the TRU framework is a means of ensuring students can work on mathematical issues to develop conceptual understanding and reasoning through problem-solving skills.

Dimension 2: Cognitive Demand

The second dimension of the TRU framework is cognitive demand. The core questions within this dimension are “What opportunities do students have to make their own sense of mathematical ideas?” and “How can we create more opportunities?” (Schoenfeld & the Teaching for Robust Understanding Project, 2016, p. 5). The goal of the second dimension of the TRU framework is for students to make sense of their mathematical ideas and develop deeper understanding and connections.

Dimension 3: Equitable Access to Mathematics

Equitable access to mathematics is the third dimension of the TRU framework. The core questions within this dimension are “Who does and does not participate in the mathematical work of the class, and how?” and “How can we create more opportunities for each student to participate meaningfully?” (Schoenfeld & the Teaching for Robust Understanding Project, 2016, p. 7). The third dimension involves supporting all students’ access to the content by building on their strengths through various strategies and resources.

Dimension 4: Agency, Ownership, and Identity

The fourth dimension of the TRU framework is agency, ownership, and identity. The core questions in this dimension are “What opportunities do students have to see themselves and each other as powerful doers of mathematics?” and “How can we create more of these opportunities?” (Schoenfeld & the Teaching for Robust Understanding Project, 2016, p. 9). The goal of the TRU’s fourth dimension is to support students in building mathematical identities by engaging with mathematics meaningfully.

Dimension 5: Formative Assessment

The final dimension of the TRU framework is formative assessment. The core questions within this dimension are “What do we know about each student’s current mathematical thinking?” and “How can we build on it?” (Schoenfeld & the Teaching for Robust Understanding Project, 2016, p. 11). The fifth dimension involves revealing students’ understanding and providing them with opportunities to rethink misunderstandings through various activities and techniques.

Challenges of the Teaching for Robust Understanding Framework in Mathematics

Implementing the TRU Framework for teaching and learning mathematics poses significant challenges. Schoenfeld (2022) examined these challenges into three components: the math curriculum (Dimensions 1 and 5), the learning environment (Dimensions 2 and 3), and the math culture (Dimension 4). Concerning the math curriculum, teaching typically centers on standards and content. Schoenfeld (2022), however, posited that it's equally essential to consider mathematical beliefs, practices, and metacognition. The second challenge related to providing equitable access to content within schools and across districts, which is a factor of the learning environment. Often, students are not positioned in settings that cultivate mathematical identities and agency, particularly in the face of mathematical difficulties (Schoenfeld, 2022). The final challenge corresponds to the math culture, as per Dimension 4 of the TRU Framework. Schoenfeld (2022) pointed out that the classroom often mirrors the wider societal biases about math, leading to the reinforcement of negative associations with the math curriculum.

Figure 1

Teaching for Robust Understanding Math Scoring Rubric

Whole Class Activities: **L**aunch, Teacher **E**xposition, Whole Class **D**iscussion

On the score sheet, Circle one of ***L / E / D*** *if the episode is primarily of that type. If a* ***Launch*** *is primarily logistical, some dimensions may be labeled N/A.*

	The Mathematics	Cognitive Demand	Access to Mathematical Content	Agency, Authority, and Identity	Uses of Assessment
	How accurate, coherent, and well justified is the mathematical content?	*To what extent are students supported in grappling with and making sense of mathematical concepts?*	*To what extent does the teacher support access to the content of the lesson for all students?*	*To what extent are students the source of ideas and discussion of them? How are student contributions framed?*	*To what extent is students' mathematical thinking surfaced; to what extent does instruction build on student ideas when potentially valuable or address misunderstandings when they arise?*
1	Classroom activities are unfocused or skills-oriented, lacking opportunities for engagement with key grade level content (as specified in the Common Core Standards)	Classroom activities are structured so that students mostly apply memorized procedures and/or work routine exercises.	There is differential access to or participation in the mathematical content, and no apparent effort to address this issue.	The teacher initiates conversations. Students' speech turns are short (one sentence or less), and constrained by what the teacher says or does.	Student reasoning is not actively surfaced or pursued. Teacher actions are limited to corrective feedback or encouragement.
2	Activities are at grade level but are primarily skills-oriented, with few opportunities for making connections (e.g., between procedures and concepts) or for mathematical coherence (see glossary).	Classroom activities offer possibilities of conceptual richness or problem solving challenge, but teaching interactions tend to "scaffold away" the challenges, removing opportunities for productive struggle.	There is uneven access or participation, but the teacher makes some efforts to provide mathematical access to a wide range of students.	Students have a chance to explain some of their thinking, but the teacher is the primary driver of conversations and arbiter of correctness. In class discussions, student ideas are not explored or built upon.	The teacher refers to student thinking, perhaps even to common mistakes, but specific students' ideas are not built on (when potentially valuable) or used to address challenges (when problematic).
3	Classroom activities support meaningful connections between procedures, concepts and contexts (where appropriate) and provide opportunities for building a coherent view of mathematics.	The teacher's hints or scaffolds support students in productive struggle in building understandings and engaging in mathematical practices.	The teacher actively supports and to some degree achieves broad and meaningful mathematical participation; **OR** what appear to be established participation structures result in such engagement.	Students explain their ideas and reasoning. The teacher may ascribe ownership for students' ideas in exposition, **AND/OR** students respond to and build on each other's ideas.	The teacher solicits student thinking and subsequent instruction responds to those ideas, by building on productive beginnings or addressing emerging misunderstandings.

Note. From *An Introduction to the Teaching for robust understanding (TRU) Framework*, by A. H. Schoenfeld and the Teaching for Robust Understanding Project, 2016.

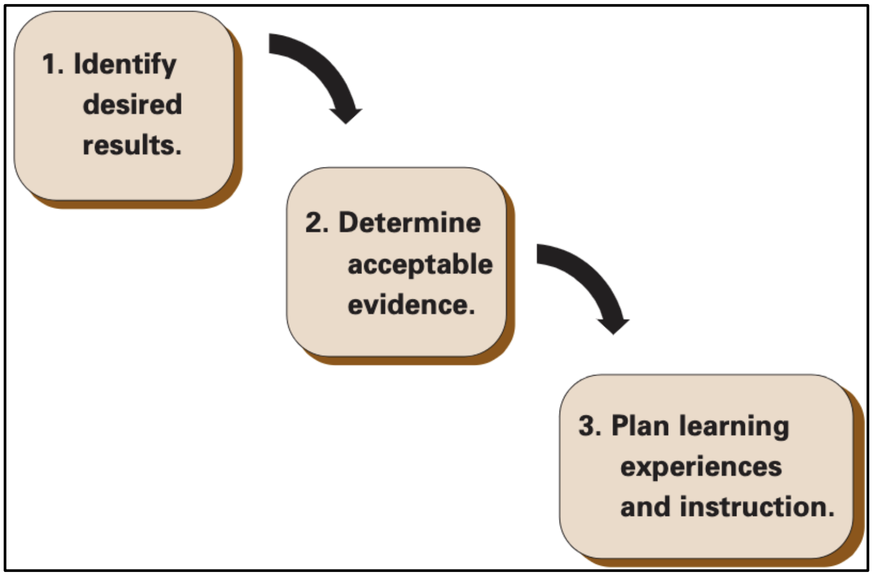
Understanding by Design Framework

Exploring further into the realm of instructional design, it becomes essential to acknowledge the similarities and differences between the TRU Framework and the UbD Framework, two influential approaches that aim to enhance the quality and effectiveness of teaching and learning experiences.
Developed by Wiggins and McTighe (2005), UbD is a framework for viewing pedagogical approaches and maintaining their purpose, objectives, and curriculum design. The UbD emerged in response to addressing learning goals; determining sufficient evidence; and aligning the activities, experiences, and instruction to the learning goals (Bowen, 2017). Furthermore, the UbD is a means of ensuring that the outcomes and skills align with the curriculum and assessments (Fuglei, 2018). Educators use the UbD framework to design lessons and units aligned with learning goals and assessments. The framework has three stages: identifying desired results, determining acceptable evidence, and planning learning experiences and instruction (see Figure 2). Ideally, a curriculum designed for teachers could include this framework to present learning activities and build toward the learning outcomes and assessments (Fuglei, 2018). In a study on the impact

of the UbD framework, Almasaeid (2017) found that student achievement scores increased with the UbD model of teaching.

Figure 2

Understanding by Design Learning Stages



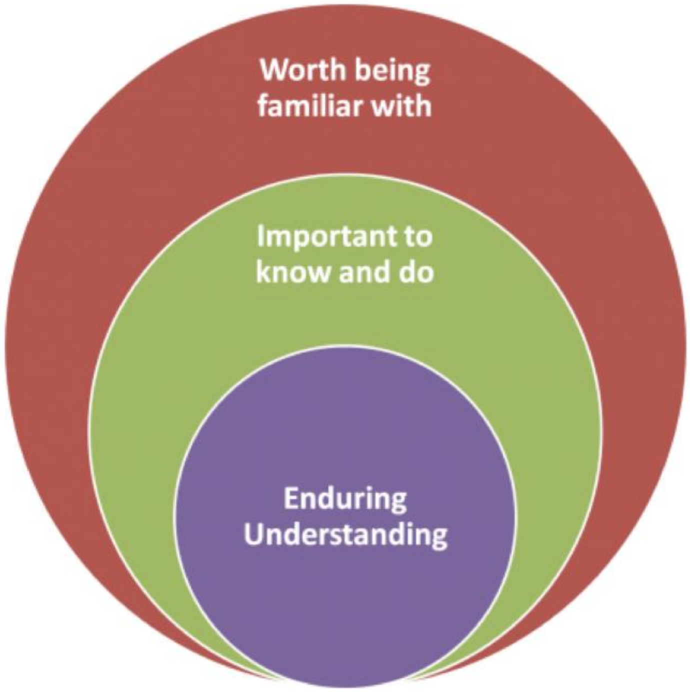
Note. From *Understanding by Design* (expanded 2nd ed), by G. Wiggins and J. McTighe, 2005. Copyright 2005 by ASCD.

Stage 1

The first stage of the UbD framework is to identify the desired results and learning goals (Bowen, 2017). Educators should consider what students will encounter; the skills and knowledge they must master; and the big ideas and important understanding they should obtain by the end of the lesson, unit, or course (Wiggins & McTighe, 2005). Educators can first narrow down the knowledge students could become familiar with (see Figure 3) to determine what the students should know and do. Finally, in the final phase, enduring understanding, educators identify learning goals based on the enduring understanding (Bowen, 2017).

Figure 3

Understanding by Design Stage 1



Note. From *Understanding by Design*, by R. S. Bowen, 2017. Copyright 2017 by Vanderbilt University Center for Teaching.

Stage 2

The second stage of the UbD framework involves assessments and performance tasks. Educators should consider how students will demonstrate their understanding throughout the lesson, unit, or course (Wiggins & McTighe, 2005). In the lesson, unit, or course, educators identify what shows students understand and have the proficiency necessary to match the learning goals and achieve enduring understanding. Examples of assessment methods that should match the learning goals of the lesson, unit, or course include term papers, quizzes, homework assignments, projects, and practice problems (Bowen, 2017).

Stage 3

The third stage of the UbD framework is to plan activities, experiences, and instruction that align with the learning goals of the lesson, unit, or course (Bowen, 2017). Educators should consider which knowledge and skills align with the learning goals and the activities necessary to support students. Materials, resources, and instruction should also align with the assessments and learning goals. Examples of instructional strategies in a lesson, unit, or course include group discussions, think-pair-shares, cooperative learning, note-taking, and problem-solving inquiries (Bowen, 2017).

Challenges of the Understanding by Design Framework

Wiggins & McTighe (2005) identified several obstacles encountered when creating a curriculum using the Understanding by Design (UbD) Framework. The initial challenge involves a shift in teachers' perspectives: they should concentrate less on teaching elements and more on the expected learning outcomes. A second challenge presented in their book pertains to the focus on what is vital for learning

(Wiggins & McTighe, 2005, p. 207). Teachers are tasked with navigating standards and content to pinpoint what's essential for learning, which in turn guides their lesson design. The final challenge Wiggins & McTighe (2005) highlight is the need for designing comprehensive units that tackle all standards, as opposed to lessons targeting specific indicators. In order to construct an effective curriculum, standards must be examined and mapped out appropriately.

Universal Design for Learning Framework

As the literature review shifts from the UbD Framework to the UDL Framework, it is crucial to consider how these distinct instructional design approaches contribute to the development of engaging and inclusive learning environments that cater to diverse student needs. The Center for Applied Special Technology (CAST; 2018) produced the UDL framework. The goal was to develop a research-based framework for instruction and intervention for varied learners. The theories CAST (2018) used to develop the UDL framework include the zone of proximal development, scaffolding, and modeling. Included in the framework are the UDL Guidelines, which are informed by feedback and research. Presently, there are three principles in the UDL Guidelines: engagement, representation, and action and expression (CAST, 2018). Cornell University educators use the UDL framework to design courses; foster an inclusive learning environment; and offer students multiple opportunities to perceive, express, and comprehend their learning (Universal Design for Learning: Center for Teaching Innovation, n.d.).

Engagement

The first UDL guideline suggests providing multiple means of engagement to understand the "why" of learning (CAST, 2018). Educators could design their courses, units, and lessons with multiple means of engagement to make the learning meaningful to students. The three engagement guidelines are recruiting interest, sustaining effort and persistence, and self-regulation. The course, unit, or lesson could include the engagement checkpoints of individual choice, autonomy, relevance, collaboration, community, self-assessment, reflection, and authenticity. Engagement includes providing students with access to learning, multiple opportunities to build on their learning, and options to internalize their learning (CAST, 2018).

Representation

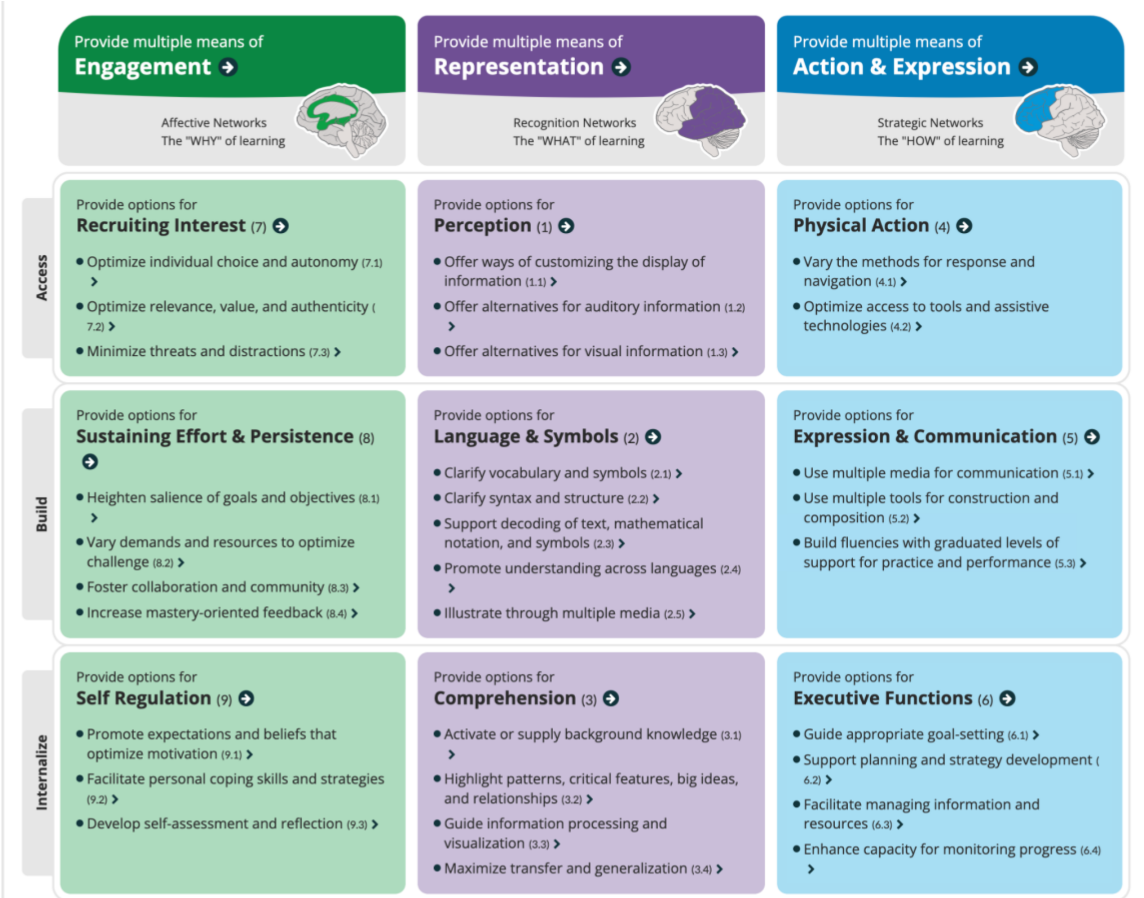
Following engagement, the UDL principle of representation focuses on the "what" of learning (CAST, 2018). Educators can design their courses, units, and lessons with multiple means of representation to provide learners with options to present their learning. The principle's three guidelines are perception, language and symbols, and comprehension. The course, unit, or lesson could include the following representation checkpoints: providing various ways to display information visually and auditorily, illustrating vocabulary through symbols and multiple media modes, and transferring knowledge by activating background knowledge (CAST, 2018).

Action and Expression

The last principle of the UDL Guidelines is action and expression, which addresses the "how" of learning (CAST, 2018). Educators could design their courses, units, and lessons with multiple means of action and representation to provide learners with options to guide the learning environment and share their learning. Three guidelines under the principle are physical action, expression and communication, and executive functions. The course, unit, or lesson could include the action and expression checkpoints of various ways to interact with materials and learning tools, multiple means of communication, opportunities to set goals, and strategic plans to manage information and monitor progress made (CAST, 2018).

Figure 4

Universal Design for Learning Stages



Note. From *Universal Design for Learning Guidelines Version 2.2*, by the Center for Applied Special Technology, 2018.

Challenges of the Universal Design for Learning Framework

Several challenges arise when attempting to align a curriculum with the Universal Design for Learning (UDL) Framework. Lachheb et al. (2021) outlined three primary difficulties associated with adhering to this framework: the interpretation of the UDL Guidelines, the time commitment required, and resistance to following the guidelines coupled with design failures. The initial challenge relates to the interpretation of the UDL Guidelines, which are broadly defined and subject to diverse interpretations. This ambiguity can lead to inconsistent practices that may deviate from the intended spirit of the UDL Guidelines (Lachheb et al., 2021). The second challenge pertains to the time investment necessary for proper implementation within instruction. Lachheb et al. (2021) emphasized the time needed for ideation and iterative adjustment of the various supports provided by the UDL Guidelines. The final challenge involves resistance to adhering to the guidelines, which can be linked to established teaching philosophies and practices. Although many teachers aim to incorporate multiple means of expression in teaching and learning, it can inadvertently result in inequitable practice if the teaching materials don't meet a certain standard (Lachheb et al., 2021).

Future of Math Curriculum

Online Learning

As education develops, the transition from traditional curriculum implementation to the integration of digital curriculum has become a pivotal step in a more active and engaging learning experience for students. Engelbrecht, Llinares, and Borba (2020) conducted a study examining how the digital revolution has affected teaching practices, student learning, and the mathematics education landscape. Their research focused on the potential of the Internet to facilitate collaborative learning, improve resource accessibility, and foster global connections (Engelbrecht et al., 2020, p. 830). However, the authors also emphasized the need to address potential challenges, including digital divides that create disparities in access to technology and online resources (Engelbrecht et al., 2020, p. 835). Moreover, the study underscored the importance of teacher training to effectively incorporate digital tools into the mathematics curriculum. The authors emphasized the significance of understanding and addressing these complexities to successfully integrate the Internet into mathematics education, fostering a more inclusive, stimulating, and dynamic learning environment (Engelbrecht et al., 2020, p. 840). The researchers also delved into the realm of blended learning, which merges online and face-to-face instruction, to offer a comprehensive educational experience to students. They found that the online part of blended learning is pivotal in customizing education to cater to the specific needs of each student. The study identified three critical areas for innovation in mathematics education: principles for designing new settings, facilitating social interaction and knowledge construction, and utilizing tools and resources (Engelbrecht et al., 2020, p. 829).

In a separate study by Mayer in 2019, the author offers a comprehensive review of thirty years of research on online learning. The study outlined the progress, discoveries, and trends in online learning over the past few decades. Mayer (2019) discussed various elements, including instructional design, multimedia learning, and the relative effectiveness of online learning compared to conventional face-to-face instruction. The study offered insights into the progression of online learning, proving to be an essential resource for educators, researchers, and practitioners. One significant finding was related to understanding the science of learning online, highlighting the necessity for future research on how to enhance the online learning environment concerning learner motivation and metacognition (Mayer, 2019, p. 157). The study also emphasized the importance of instructional design, the need for designing principles relating to games, simulations, and other forms of media (Mayer, 2019, p. 157). Overall, the study advocated for a thorough understanding of the mechanisms of online learning and tailoring this knowledge to the way educators structure online instruction (Mayer, 2019).

In a final article related to online learning, Borba (2021) highlighted the potential impacts of the COVID-19 pandemic on three crucial aspects of mathematics education: the application of digital technology, the philosophy underlying mathematics education, and the field of critical mathematics education (Borba, 2021). Borba initially discussed the role of digital technology in mathematics education, especially how it had evolved due to the introduction of innovative tools within the educational setting. It's important to address unique challenges posed by mathematics education in this increasingly digital environment. Borba emphasized the urgency of examining how online mathematics education affects children, particularly in light of the key roles home environments and discrepancies in digital access play as education pivots to the online space (Borba, 2021).

Integrating Technology

Having explored the realm of online learning, it becomes clear that the process of integrating technology into educational practices is of critical importance. In an era defined by digital connectivity and innovation, the classroom environment is no exception. Matos et al. (2019) delved into the challenges educators face in this endeavor, focusing on the adoption of technology in the curriculum and its harmonization with teaching methodologies. Matos et al. (2019) outlined the obstacles that teachers face when incorporating technology into curriculum and aligning it with their teaching methods. The authors proposed a structure for technology integration to mitigate these challenges. Usually, the curriculum provides a roadmap for educators to follow in order to effectively meet the course objectives (Matos et al., 2019, p. 5). As technology develops, the manner in which information is utilized also advances, which has repercussions on both the employment of technology and the curriculum. Matos et al. (2019) argue for an emphasis on school practices when introducing technology into the curriculum. One highlighted area in the article was the development of teacher competencies, which can be bolstered by strengthening teacher education programs related to technology and skills necessary for the 21st century. The authors also recommended that educators should learn from their own pedagogical practices through introspection. Generally, educators devote the bulk of their time to teaching, leaving little room for reflection on their technology-informed instructional decisions. Lastly, the authors suggested that teachers should be given opportunities to learn about integrating digital technology into their teaching practices. For this, research is necessary to provide educators with guidelines on effective incorporation of digital technologies (Matos et al., 2019).

Literature Review Conclusion

In conclusion, this literature review, divided into three main sections – math curriculum, curriculum frameworks, and the future of math curriculum – offers an exhaustive analysis of diverse elements of math education. It delves into the curriculum, its historical progression, Common Core State Standards (CCSS), accountability protocols, paradigm shifts, and teaching models, thus presenting a comprehensive understanding of math standards and instructional practices. The second part highlighted the role of TRU, UbD, and UDL frameworks in the initial design of the Digital Mathematics Curriculum (DMC), demonstrating the interconnectedness of these topics and their combined influence on the development of a high-quality rigorous math curriculum.

The review also identifies the need for ongoing research to refine and evaluate the DMC using a range of revision methodologies and a strategic approach rooted in the TRU framework. Mathematical proficiency, particularly during the foundational elementary and middle school years (Grades PreK-8), is integral to academic success. However, the relentless wave of educational and mathematics reforms has led to widespread anxiety among educators and students alike across the United States (Gautreau et al., 2016).

Nonetheless, each of the frameworks – TRU, UbD, and UDL – presents its unique challenges, such as interpretation of guidelines, time constraints, resistance to change, or determining essential learning components. These complexities become further entangled as we step into the future of math education characterized by the rise of online learning and technological integration in pedagogy. These constant shifts demand ongoing commitment to refining math curricula and teaching practices, with a clear focus on improving student outcomes amidst the rapidly evolving digital curriculum.

In my Capstone project, I will rely on the insights gained from this literature review to inform my analysis and recommendations. By grounding my work in existing research, my goal is to offer an informed viewpoint on the challenges and possibilities related to designing and revising an effective digital mathematics curriculum. The literature review will act as a guidepost, assisting in situating my findings within broader trends and themes prevalent in the field of mathematics education.

Methodology

Overview of Research Design

This qualitative capstone utilized the self-study method (Samaras, 2011). The rationale for this methodology was to obtain firsthand knowledge by intensely examining the process I used as a curriculum designer at the center of the research and inquiry. The self-study method was an appropriate approach for analyzing personal experiences related to DMC design and revision. Also known as the personal experiences method (Samaras, 2011), the self-study method enabled me to reflect on my professional learning and interpret my experiences, beliefs, and practices as a math curriculum designer for the DMC.

Self-study is an effective research design for examining and understanding practices because it is a way to understand and improve a practice (Capobianco, 2007, p. 272). My personal experiences were the subject of this project. The goal of this study was to expand these experiences to a broader context of math curriculum design and revision in a large, diverse urban school district. Self-study involves connecting personal experiences to a larger context (Samaras, 2011), such as motivation or personal development related to DMC design and core values. The self-study design was appropriate to address both the understanding of how the design and revision process works and what the implications or next steps are beyond this understanding.

Purpose of the Capstone

Ideally, teachers planning their curricula could use the DMC to include culturally relevant connections and differentiated supports. By addressing the broader political climate, educators can provide a more well-rounded learning experience that not only acknowledges but also engages with fostering critical thinking and informed discussions among students. The National Council on Teacher Quality found that teachers average approximately 45 minutes of planning time daily (Jarmolowski, 2017). Students and teachers who move from school to school in a large district could struggle to adjust to newer or older math curricula. In schools with math curricula from large publishing companies, educational leaders tend to focus on major standards in the curricula to address the criteria for state and national assessments (Agodini & Harris, 2010). Therefore, continuously improving the DMC requires curriculum designers to review the design and revision processes. This capstone provided a review of the design and revision processes of a DMC developed for a large, diverse urban school district. The capstone includes recommendations for modifying the design and revision processes from my perspective as one of the designers. Currently, the DMC is undergoing revision based on teacher, administrator, and student feedback. There will be a need to evaluate the curriculum after the revisions to ensure the integrity of the initial build and alignment with best practices of the TRU, UbD, and UDL frameworks.

DMC designers consider various forms of feedback and data points to inform curricular modifications and revisions. Currently, no researcher has addressed the DMC design and revision processes. Also, no literature has included evaluations of a customized DMC for a large, diverse urban school district. Since the design and development of this curriculum are unique and unlike other curricula, it is essential to assess the DMC's impact on both students and the district. However, conducting such research falls beyond the scope of this paper. To address this need, the district plans to collaborate with universities and research partners in future investigations, leveraging their expertise to ensure a thorough and rigorous evaluation of the DMC's effectiveness and its implications for students' academic success. Instead, the project was a means of exploring my perspective as one of the DMC designers to articulate the process of creating and implementing the curriculum. The reflections conducted during this Capstone were initially broad, encompassing a range of experiences and insights gained throughout the process of designing and revising the DMC. These reflections aimed to capture the various aspects of curriculum development, including the challenges faced, successes achieved, and the lessons learned. To maintain focus on the research questions, the analysis was then narrowed down, specifically concentrating on those reflections that were directly relevant to the questions at hand. By filtering and examining the reflections through the lens of the research questions, I was able to extract meaningful insights that contributed to a deeper understanding of the curriculum design and revision processes.

There were three data reflection sources: 17 weekly self-reflection written journal entries, one self-reflective journal video, and five voice memos. These 17 weekly self-reflection written journal entries and one self-reflective journal video covered the past two years and provided insight into my experiences as a math designer and a strategic plan for evaluating and revising the DMC. Improvements to the DMC could impact the quality of instruction and learning to address the needs and feedback of teachers, students, and administrators. A strategic plan for improving the DMC in Year 3 implementation could be a way to accelerate the revision process and make larger and more meaningful changes based on feedback from teachers, students, and administrators.

Self-Reflective Journal Video		Self-Reflective Journal Entry #1	Self-Reflective Journal Entry #2	Self-Reflective Journal Entry #3
August 2020-October 2022		November 4, 2022	November 11, 2022	November 18, 2022
Self-Reflective Journal Entry #4	Self-Reflective Journal Entry #5	Self-Reflective Journal Entry #6	Self-Reflective Journal Entry #7	Self-Reflective Journal Entry #8
November 25, 2022	December 2, 2022	December 9, 2022	December 16, 2022	December 23, 2022
Self-Reflective Journal Entry #9	Self-Reflective Journal Entry #10	Self-Reflective Journal Entry #11	Self-Reflective Journal Entry #12	Self-Reflective Journal Entry #13
December 30, 2022	January 6, 2023	January 13, 2023	January 20, 2023	January 27, 2023
Self-Reflective Journal Entry #14	Self-Reflective Journal Entry #15	Self-Reflective Journal Entry #16	Self-Reflective Journal Entry #17	Voice Memos
February 3, 2023	February 10, 2023	February 17, 2023	February 24, 2023	February 20-24, 2023

Research Questions

This study focused on the development and revision of a DMC designed for a large, diverse urban school district. While the second round of revisions is underway, there is a need for educational researchers and curriculum designers to understand the DMC design and revision processes for a customized DMC to make improvements. At the large urban school, designers gather feedback from teachers to adjust and modify the DMC. The processes require evaluation to ensure the fidelity and integrity of the curriculum's initial design with the TRU, UbD, and UDL frameworks. This capstone could provide curriculum designers with the knowledge to design customized curricula for schools and districts to avoid potential pitfalls. This investigation could also provide insight into how to evaluate the current DMC design based on the TRU framework. The two guiding research questions were:

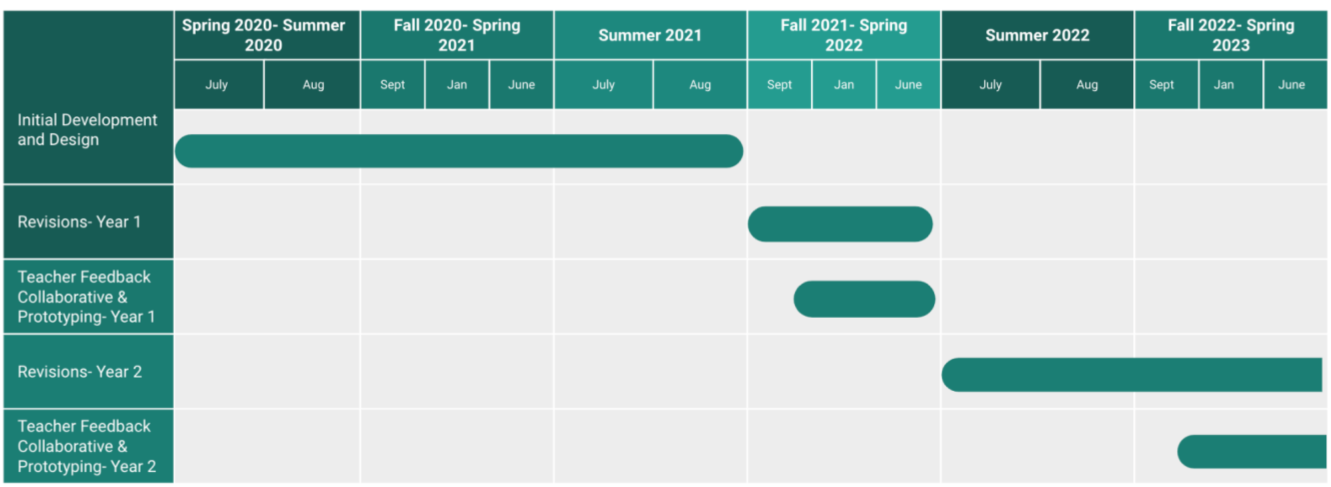
1. What did I learn as a mathematics designer about the processes of designing and revising a digital mathematics curriculum for a large, diverse urban school district?
2. What are the recommendations for enhancing the processes of designing and revising a digital mathematics curriculum for a large, diverse urban school district based on a mathematics designer's experiences?

Sources of Data

This paper included my experiences as a math curriculum designer in the DMC design and revision processes from August 2020–February 2023. The data included one self-reflective journal video that covered the past 2 years and 17 weekly self-reflection written journal entries between November 2022 and February 2023. The project provided the opportunity to explore my perspective as one of the designers and reflect on the DMC design, revision, and implementation processes. There were three data reflection sources: 17 weekly self-reflection written journal entries, one self-reflective journal video, and five voice memos recorded on a cell phone. Narratives, reflections, and interpretations of the design process related to the DMC were the primary data sources in this self-study. The self-study design provided the autonomy to identify the learning objectives specific to professional practice. The data drawn from self-study were appropriate for this capstone because, as the researcher, I sought to describe, understand, and interpret the DMC design and revision processes. As the researcher in this self-study, my role was to critically reflect on my own experiences, thoughts, and actions in the context of the DMC design and revision processes. This self-study required me to be both the subject and the investigator, examining my own practice to gain insights and understanding. Based on my understanding of the data, the study provided recommendations for a strategic plan to evaluate the current design and revision processes.

Figure 5

Years 1 and 2 Timeline



Note. This timeline captures Years 1 and 2 of the DMC design and revision processes.

Data Collection Methods

The data for this study came from 17 weekly self-reflections, voice memos, and one self-reflective journal video related to the DMC design and revision processes. Data collection occurred with individual online in-depth self-reflections via voice memos and entries via Google Docs. I conducted self-reflections weekly between November 2022 and February 2023. In one of the larger self-reflections, I focused on the process of designing and revising the DMC between August 2020 and October 2022. The larger self-reflection was a journal video and was transcribed. The self-reflective journal video addressed the first research question on understanding the DMC design and revision processes. The research questions the self-reflections provided the data used to analysis. In addition, open-ended questions showed new themes and trends. I recorded and stored all self-reflections in Google Docs.

A critical friend reviewed and validated the data and offered a different perspective to reframe some interpretations (see Samaras, 2011). The critical friend was chosen based on several factors that made them a suitable candidate to support this self-study. The critical friend was chosen partly because of our previous collaboration on a project last year. This prior experience allowed for a foundation of trust and mutual understanding, which is essential for open and honest dialogue during the self-study process. Their expertise in assessment development and curriculum design, as well as their prior experience working with me, contributed to the decision to involve them in the process. The critical friend assisted with developing the research questions and identifying the literature relevant to the DMC design and revision processes. In self-reflection journal entries and memos, I documented collaborations and critiques related to my perspectives to remain open and transparent about my perspective and interpretations of designing and revising the DMC. Open dialogue occurred to address issues I found in my reflections. Evaluating how the issues did or did not relate to the research questions supported the enrichment of identifying the indicators within my reflections.

Self-Reflective Journal Video. As previously mentioned, this self-study included three data reflection resources. The primary data source which documented the design and revision process of the Digital Mathematics Curriculum (DMC) from August 2020 to October 2022 was a self-reflective video journal. The purpose of the video entry was to comprehensively cover the design and revision process by examining my emails and work documents, prompting the recollection of specific details to address the first research question related to understanding the process of designing and revising a culturally relevant, high-quality digital mathematics curriculum. To effectively achieve this, I identified specific timeframes in which I recorded myself discussing crucial moments during the DMC's design and revision process. These key periods included: Summer 2020; the Teacher Feedback Collaborative (TFC); Fall 2020-Winter 2020, which focused on Technical Feedback; Spring 2020-Summer 2021, emphasizing Communication; Fall 2021-Spring 2022, featuring Teacher Feedback Collaborative 2.0, Classroom Observations, and Prototyping Year 1; and finally, Summer 2022-October 2022, which covered Teacher Intern Summer Work, Cultural Relevance, Expansion of the Math Design Team, and Tools and Communication. After recording the video, I utilized the transcription feature of Google Meets Recording to identify any suggested priorities for reference.

Weekly Self-Reflection Written Journal Entries. While reflecting on the design and revision processes, I entered into Google Docs 17 weekly self-refection journal entries (recorded November 2022–February 2023) and one larger self-reflection (recorded August 2020 and October 2022). The self-reflection showed my experiences and perspectives on the design and revision processes. Although I intended to reflect on my processes three times weekly immediately after work, I instead used weekly journaling to explore my perceptions of the week's work related to the DMC design and revision processes. The purpose of the reflective journal entries was to record my thoughts, what I worked on, issues, and possible recommendations for the design and revision processes. I used two open-ended questions for self-reflection: What do you wonder about the design and revision process? and is there an issue or question about the design and revision processes? Initially, I did not plan to include citations for my emails or work trackers. However, I found it useful to review and reflect on the work trackers in the self-reflection journal entries. The work emails also provided details regarding the timelines I referenced in the larger self-reflection between August 2020–October 2022. I also referenced informal conversations with my colleagues on the design and revision processes to contribute to data reliability.

Voice Memos. I used voice memos to remind myself of significant moments that I had not documented in the written weekly self-reflection journal entries but deemed valuable. In total, I recorded five voice memos, which recounted specific information related to emails or conversations with colleagues that I wanted to utilize as data, such as increasing the number of math experts and enhancing communication. These voice memos were recorded due to a sudden thought that related to the research questions that I wished to document for this Capstone. I recorded these five voice memos during the last week of my self-reflective journal entries in February 2023.

Data Analysis Methods

In this study, data triangulation came from analyzing the three types of self-reflection sources—the 17 self-reflective journal writings, one self-reflective journal video, and five voice memos. After the self-reflections, I used open coding to categorize the data. The purpose of classifying the data was to determine the relationships between the categories to identify recommended priorities. The recommended priority grouping occurred for the self-reflection transcripts to address the research questions. I sorted terms or phrases crucial to the inquiry into coding categories, which I divided into themes for concept-mapping or detailed narratives. Pinnegar and Hamilton (2009) recommended being skeptical and reflecting on ideas by asking questions to gain confidence in the data and having a critical friend to collaborate, challenge ideas, and offer new perspectives.

Self-study also involves the constant comparative method, which entails constantly comparing the information from the data to find emerging themes or categories (Creswell, 2007). The grounded theory essentially produces an explanation of the process, shaped by the view of the participant or researcher. Therefore, I used my reflections as the data points to compare journal writings and find emerging themes or categories to highlight and generalize. Reviewing the text line by line and taking notes of my reflections enabled data saturation to create codes as necessary (see Samaras, 2011). After creating codes and identifying recommended priorities or categories, I followed Creswell's (2007) guide, moving away from specific examples in the reflections to provide a general understanding of the data. Self-study enabled me to engage in my practices as an insider in designing and revising the DMC. The data provided recommendations for evaluating the DMC based on the design and revision processes.

Theoretical Framework

Constructivist learning theory was the approach used to collect and analyze the data, as the aim of this capstone was to explain the DMC design and revision processes. Constructivist learning theory references that learning is an active process in which learners construct their own understanding and knowledge through experiences and interactions with their environment (Bruner, 1990). This theory highlights the importance of prior knowledge, personal experiences, and social interactions in shaping how people acquire new knowledge and skills (Palincsar, 1998). According to constructivist theory, learners actively engage with the material, ask questions, and make connections between new information and their existing understanding (Richardson, 2003). Therefore, in this study, I used constructivist and interpretive approaches through constructivist learning theory to emphasize feelings, assumptions, and values while designing and revising the DMC.

Limitations

The study included data limited to my experiences as a math curriculum designer. A limitation is that the data originated from the perspectives of one math curriculum designer. Consequently, the findings of this study are not generalizable to all math curriculum designers or contexts. Eliminating biases and focusing on the DMC development and design could be difficult due to personal feelings and attitudes related to some of the challenges of the process. Other limitations of this project include the lack of teachers' perspectives on DMC design and revision. This study focused on the DMC designed for a large, diverse urban school district. Although this paper does not serve as a universal guide for other large school districts, district leaders could use the processes and recommendations to initiate procedures for their districts.

Ethical Considerations

Some ethical considerations could relate to sharing thoughts and feelings and criticism and judgment from district leaders and peers. As a researcher, I consider that others could have different views or perspectives on certain experiences. I also might have interpreted certain events differently than my peers while designing and revising the DMC. To preserve confidentiality during this self-study, I implemented several measures to ensure that the sensitive information and the identity of the individuals involved were protected. Although I did not use pseudonyms in my personal reflections, when sharing or discussing the study with others, such as my critical friend or peers, I used pseudonyms to maintain the anonymity of individuals involved in the DMC design and revision processes. I kept all self-reflective journal entries related to the self-study securely stored on my personal laptop. When sharing my reflections and data with my critical friend I made sure to do so in a confidential manner. Throughout the self-study, I refrained from disclosing personal information about myself or others that could compromise confidentiality. This approach helped ensure that the focus remained on the DMC design and revision processes rather than on specific individuals.

Due to the limited time spent on each reflection, the paper did not cover certain passages. Readers of this capstone should know my positionality as a math curriculum designer reflecting on the DMC design and revision processes. When writing my reflections, I remained respectful, thoughtful, and transparent about my experiences to represent the processes and the information documented in my reflections. Lastly, I shared my reflections with a critical friend for review and offered space to respond to the reflections and offer corrections.

Findings

This capstone focused on my experiences as a math designer to provide insight into the DMC's design and revision processes. The study focused on two research questions:

RQ1: What did I learn as a mathematics designer about the processes of designing and revising a digital mathematics curriculum for a large, diverse urban school district?

RQ2: What are the recommendations for enhancing the processes of designing and revising a digital mathematics curriculum for a large, diverse urban school district based on a mathematics designer's experiences?

This section includes suggested priority areas to inform a strategic plan to improve the processes. The three narrative clusters used to address the first research question were initial development and design cycle, Year 1 revisions, and Year 2 revisions. Also, this section presents the findings from November 2022–February 2023, including recommended priority areas based on my 17 self-reflection journal entries and analysis with a critical friend. I used the November 2022–February 2023 reflections to suggest priority areas and code details to address the second research question related to recommendations.

Based on the coding, the recommended priority areas are increasing math experts, providing professional learning, analyzing feedback, and improving communication. The recommendations section addresses the second research question related to the actions for a strategic plan. To reiterate, the purpose of this study was to share and examine my curriculum design experiences from my perspective as a DMC designer involved in various design and revision processes. The significance of this capstone was that it showed the complexity and challenges of designing and revising a custom DMC based on feedback from teachers, students, and administrators. Ideally, based on my perspective, the proposed recommendations for a strategic plan could support myself and others with lessons learned over the past 2 years for future changes to the current processes.

Initial Develop and Design Cycle: Summer 2020–Summer 2021

RQ1: What did I learn as a mathematics designer about the processes of designing and revising a digital mathematics curriculum for a large, diverse urban school district?

Summer 2020

In the summer of 2020, I was hired to be the sole math curriculum designer for the DMC for Grades PreK–11 at a large, diverse urban school district. As a math curriculum designer, I have a background in first-grade, third-grade, and middle school math. With approximately eight years of teaching experience, I found my passion for teaching mathematics and designing lessons and assessments relevant to my students. For this work as a math curriculum designer, I worked with minority and women-owned publishing companies on unit and lesson design, ensuring alignment with the curriculum design book and rubrics developed in the winter of 2019 and spring of 2020. These rubrics and curriculum design book had been developed by the original design team before I joined the design team. Vendor partners received guidance and templates to begin developing the DMC, with various internal review windows established to ensure alignment with the rubrics (see Appendix A); a guidebook; and the three frameworks that include Teaching for Robust Understanding (TRU; Schoenfeld & the Teaching for Robust Understanding Project, 2016), Understanding by Design (UbD; Wiggins & McTighe, 2005), and Universal Design for Learning (UDL; CAST, 2018). The vendors developed the DMC and recruitment commenced for teachers to review the DMC based on the criteria from the rubrics; evidence guides; and TRU, UbD, and UDL frameworks. I communicated with schools to recruit teachers by grade level to review the DMC's delivery in draft form.

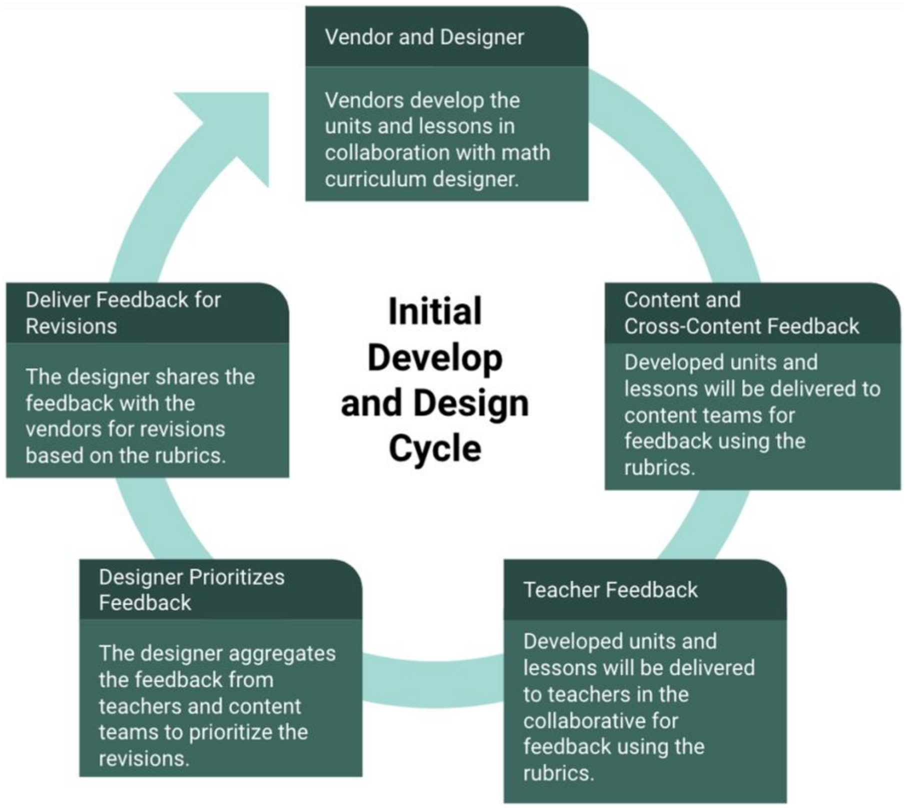
Teacher Feedback Collaborative

Recruitment occurred for approximately 50 teachers to review the DMC. A few emails were sent out to potential participants containing a Google Form to assess their qualifications for involvement in the Teacher Feedback Collaborative (TFC). Recruitment efforts were targeted at approximately 50 teachers, inviting them to review the DMC. The Google Form was designed to gather information about the teachers' background, experience, and expertise, ensuring that those selected for participation were well-suited to provide valuable feedback on the DMC design and revision processes. However, by August 2020, some had dropped out of the Teacher Feedback Collaborative (TFC) due to the challenges of teaching online during the pandemic. The TFC included approximately three to four teachers per grade band, with a total of nine to 12 teachers. In the TFC, teachers analyzed the lessons developed by the vendors and aligned with the rubrics, guidebook, and the TRU, UbD, and UDL frameworks. The teachers used the rubrics to review and quantitatively rate the lessons and units and suggest improvements.

As the math curriculum designer, I facilitated four of the six TFC meetings for Grade Bands K–2, 3–5, 6–8, and high school. The TFC sessions were facilitated via Google Meets, which were approximately 1.5 hours long. There was a schedule and format for these meetings with the teachers who were reviewing the DMC. The schedule was structured to ensure that all units assigned for review were thoroughly discussed, with ample time dedicated to examining the content and equity rubrics. At the beginning of each meeting, an introduction and overview of the session's objectives were provided. This helped set the context and focus for the discussion. Teachers were given time to go over the units they were assigned to review and provide feedback. This allowed them to familiarize themselves with the content and prepare for the subsequent discussions. After reviewing the assigned units, teachers shared their ratings on the content and equity rubrics. This facilitated a collaborative discussion where teachers could compare their evaluations and provide feedback on the DMC. During the meetings, both quantitative (e.g., scores on rubrics) and qualitative (e.g., written feedback or comments) ratings were reviewed. This comprehensive approach helped identify areas of agreement and disagreement among the teachers and provided a well-rounded perspective on the DMC's strengths and weaknesses. At the end of each meeting, a summary of the main points discussed was provided, along with any agreed-upon next steps for revisions or further review. This structured schedule and format for the meetings ensured that the review process was systematic, collaborative, and effective in gathering valuable feedback on the DMC design and revision processes.

Figure 6

Initial Develop and Design Cycle



Note. This diagram shows the initial DMC design and development.

In August 2020, teachers preparing to teach remotely due to the pandemic provided insight into making the lessons user-friendly for remote learning. The unsolicited feedback, which was received without direct request, provided insights on teaching the content online and improving the user experience and interface. This feedback may have been shared spontaneously by teachers through various channels such as emails and social media. Some feedback on the DMC might have been influenced by the transition to teach remotely during the end of the 2019-2020 school year and the beginning of the 2020-2021 school year. During the pandemic, the team and vendor partners provided teachers with the curriculum in the draft version, as the teachers did not have many online resources for remote mathematics curricula instruction. The feedback indicated an apparent demand for a high-quality mathematics curriculum on a digital platform. However, there could have been confusion that the platform, units, and lessons were drafts, as evidenced by teams and teachers sharing their frustrations with the platform and misunderstanding how to use the unit and lessons. Although all schools and administrators knew that teachers and students could use the DMC, there was little professional learning and few training videos because the rollout of the DMC was scheduled for the next school year. Although the DMC was available, training and implementation for the program were not built out yet.

Fall 2020–Winter 2020

At the beginning of the school year, I collaborated with the vendor partners to implement rigorous tasks according to the TRU framework. All assessments aligned with the following TRU dimensions:

2. Cognitive demand and dimension (Schoenfeld & the Teaching for Robust Understanding Project, 2016)
5. Uses of assessment (Schoenfeld & the Teaching for Robust Understanding Project, 2016).

Dimension 2 focuses on conceptual richness and problem-solving, whereas Dimension 5 addresses students' ability to share their mathematical thinking and use the data to address misconceptions.

The UbD was the framework used to review the end-of-unit and formative assessments for the unit's enduring understanding and essential questions. According to the UbD framework, the first step is to understand the unit's or lesson's desired results (Wiggins & McTighe, 2005). The formative assessments underwent review to ensure students could share their understanding of the skills and concepts learned in the preceding lessons.

While designing and collaborating with vendor partners, I continued working with teachers on rounds of DMC review. The TFC provided insight into the student-facing and teacher-facing materials, such as student tasks, presentation slides, unit plans, lesson plans, assessments, and the platform. Some teachers from the TFC also offered insight into using the platform to teach remotely. As mentioned, the DMC rollout was scheduled for the next school year, with many units still in draft form alongside the platform. The teachers struggled to share information with students on the platform due to technical issues, such as features timing out or extended time to transition between slides.

Technical Feedback

Like the teachers, the vendor partners began to experience technical difficulties working on the platform. Although the DMC rollout was scheduled for the next school year, many teachers logged on to the platform because they needed an online curriculum due to the pandemic. However, the unforeseen number of users during the school year caused the platform to run slower than expected. The technical difficulties impacted the timely delivery of the units in development. The vendor partners faced challenges uploading and updating the curriculum to the platform because it timed out while teachers used it. Therefore, I worked with vendor partners to upload the materials when the number of teachers on the platform decreased. The uploads typically occurred in the evenings and on weekends, with technical updates to make the platform run faster.

With the UDL and TRU frameworks, I worked with vendor partners to add culturally relevant tasks related to the local city. The goal of building the curriculum was to ensure the students saw themselves and engaged in a high-quality, rigorous curriculum. With the UDL framework, the vendors and I built out UDL tables within the unit and lesson plans for the three UDL guidelines of engagement, representation, and action and representation (CAST, 2018). Each unit plan and lesson plan included actionable opportunities for incorporation within lessons to ensure inclusive learning and multiple opportunities for student comprehension (Universal Design for Learning: Center for Teaching Innovation, n.d.). The unit plans included a table that showed how to support students through the three guidelines. Each UDL chart included specific support for each lesson or multiple lessons (see Appendix B).

Spring 2021–Summer 2021

During the spring of 2021, the vendors and I finished the final units and began focusing on the user experience and user interface. Teachers reported unanticipated technical difficulties and extended wait times while transitioning between slides and navigating within the platform. Based on the feedback related to these technical aspects, the vendors and I began enhancing the platform before its official launch and the start of the school year. The challenge with the feedback was that I worked individually, supplemented by vendor comments. Therefore, I prioritized information as much as possible without a formal process. Vendor partners accepted the feedback I shared to update the curriculum, and they continued to remain timely with the curriculum's official launch. At the end of Spring 2021, the DMC consisted of nine units per grade level, for a total of 108 units and approximately 2,100 lessons. Typically, my reviews involved evaluating the materials using the equity and content rubrics and providing feedback to meet the indicators and criteria. However, as the exclusive math designer, I could not review each unit, lesson, and student-facing document.

Because I did not review much of the material, I could not state that I knew everything about the DMC. The teachers reviewed the units and lessons as an audit review, meaning they did not necessarily comb through all the deliverables developed by the vendor partners. In addition to the internal rubrics, evidence guides, and the design guidebook, the vendor partners developed the DMC with the UbD, UDL, and TRU frameworks. The units and lessons underwent review before the launch of the school year. Communication on adopting and participating in professional learning was the next big step before the launch.

Communication

"Roadshows" occurred to communicate that the DMC was in its final form. The roadshows were presentations to school leaders on the DMC's design and features. The school leaders learned they could access the curriculum for free within the district. Further, there was a suggestion that the school leaders formally adopt the DMC to order the manipulatives for the schools. The school leaders who formally adopted the curriculum registered their teachers for professional learning over the summer. The professional learning was a deep-dive into the DMC materials, lessons, and platform experience facilitated by an instructor. Teachers who participated in the summer workshops were compensated for their time.

Communication across the district was critical. The members of my department reached out to administrators and school leaders via email and newsletter to share information about DMC and roadshows. Despite the efforts to communicate the roadshows, approximately 17 roadshows were scheduled with limited or no representation across the 500 schools. Members of my department shared deadlines for formal adoption to obtain an accurate count of materials and professional learning sessions, and we extended deadlines as school leaders continued to adopt beyond the deadlines. School leaders received emails with links to further information on DMC adoption and professional learning opportunities.

Revisions – Year 1 Feedback: Ticketing, Emails, Classroom Observations, and Feedback Forms

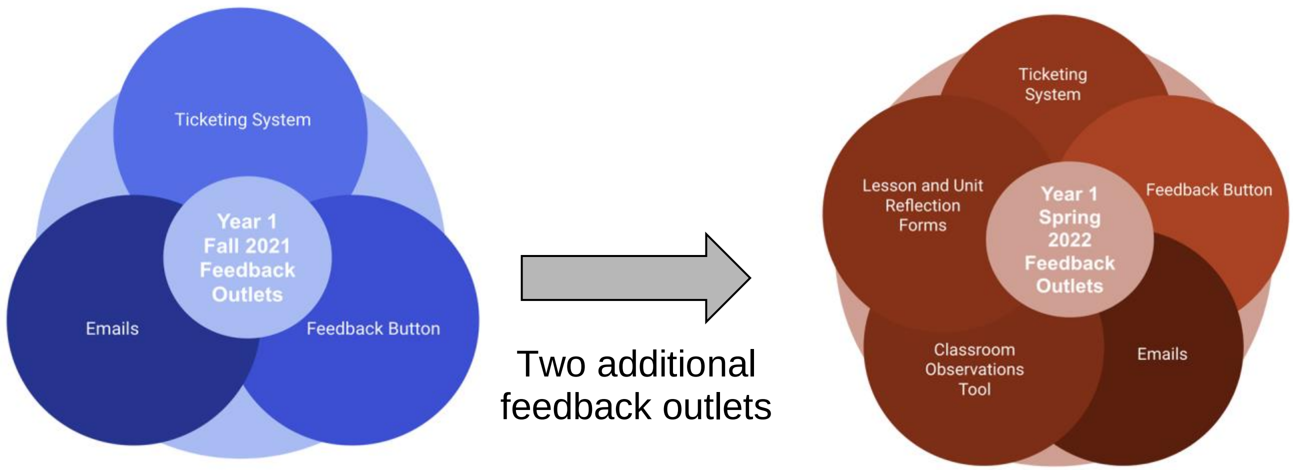
Fall 2021–Spring 2022

In the first year of DMC implementation, the leaders of the large, diverse urban school district wanted to better understand the curriculum in action from teachers' perspectives. Therefore, a feedback button added to the platform enabled teachers to share their thoughts regarding specific lessons. As a designer, I received an email notification when a teacher provided feedback on a specific lesson via Google Docs. If a teacher submitted feedback through this button, I responded to the teacher via email. However, teachers began emailing me directly about issues, and I had to determine a process to sort and organize the feedback. At the start of the school year, I received more than 10 emails weekly and rerouted some teachers to the ticketing system, another outlet teachers could use to give feedback on lessons, student-facing materials, course-level documents, assessments, the platform, and technical issues. The platform housed all the feedback, so teachers did not email or chat with me about issues. At the beginning of the school year, teachers became familiar with the ticketing system and began to submit tickets related to lessons, units, course plans, and assessments.

The first year of implementation was challenging due to online/remote teaching. As of the school year 2022-2023, approximately 432 schools adopted one subject area (Koumpilova & Karp, 2023). Some school leaders formally adopted the curriculum and had teachers attend professional learning to understand its scope and how to navigate the platform. Other school leaders used the curriculum without professional learning and tried to navigate via asynchronous learning sessions. The district did not mandate the professional learning, however, principals who have asked their teachers to adopt the curriculum encouraged or mandated their teachers to attend based on their understanding of robust lesson planning (Koumpilova & Karp, 2023). I began receiving an influx of tickets through the ticketing system, approximating more than 20 tickets weekly, because teachers did not know where to find documents or how to navigate the platform. The unintentional outcome of the lack of professional learning was that the ticketing system became an outlet for teachers to ask questions and report technical login issues rather than share feedback and report issues. There was a need to increase communication regarding professional learning sessions to resolve some reported issues.

Figure 7

Year 1 Feedback Outlets



Note. Year 1 feedback outlets Fall 2021–Spring 2022.

Teacher Feedback Collaborative 2.0

I recognized that teachers needed time to implement the curriculum, so I offered them a period to become familiar with it before asking for feedback on the design and user experience. After 5 months of DMC implementation, I formed the TFC 2.0, in which teachers volunteered to give feedback on using the curriculum. The teachers met after school monthly to provide feedback on the lessons, units, and user experiences. Ideally, the TFC 2.0 would have included teachers from all grade levels; instead, it comprised four high school, one sixth-grade, one fifth-grade, one third-grade, and one second-grade teacher and a teacher of diverse learners. All teachers welcomed me to view the lessons in action in their classrooms to determine the user experience on the platform and observe other components, such as the student-facing documents and manipulatives. The teachers offered ideas on enhancing the DMC, and the design team determined if the feedback aligned with the design guidebook and rubrics before prototyping the idea.

Classroom Observations

I performed one observation of the TFC 2.0 during the spring of 2022 with an observation protocol. The observation protocol (see Appendix C) included a checklist and quantitative sections for notes on the digital components used within the lesson, manipulatives, student-facing materials, and teaching practices related to the LED model. The observation protocol allowed me to capture trends or development gaps I could act upon as a math curriculum designer. One trend I captured was that not all students had access to technology. The teachers had a limited number of personal devices for students. Additionally, projectors or smartboards occasionally caused problems for teachers. I documented and reported these technical issues to my department so they could understand and address the issues.

Another trend I noticed was the teachers' unfamiliarity with using the Launch, Explore and Discuss (LED) model to teach mathematics. Many teachers spent an extended time with the Launch stage of the lesson because they did not consider their students ready to move on to the explore state. The significant number of teachers off-pace with the launch and explore sections showed the need for teachers to attend professional learning and become familiar with the TRU framework and the cognitive demand and equitable access to mathematics principles (Schoenfeld & the Teaching for Robust Understanding Project, 2016). Teachers should be comfortable allowing students to struggle productively and persevere through sense-making. The importance of perseverance and sense-making aligned with the DMC's design and the equity and content rubrics.

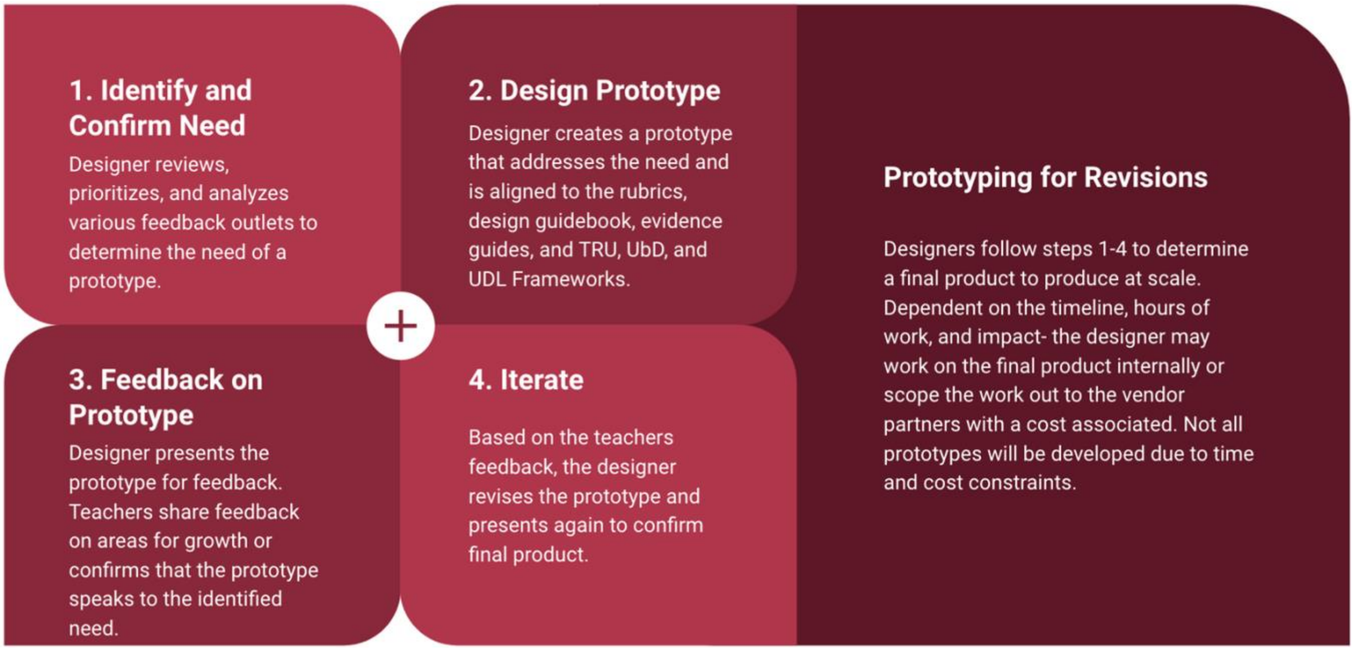
Finally, I noticed the consolidation of all the student-facing materials by units into workbooks. The document consolidation was an interesting observation because we did not have this available, and the teachers shared the need for students to have a workbook to reference when taking notes and reviewing for assessments. I developed prototypes to present to teachers based on my observations and the ticketing system and feedback button feedback (see Appendix D).

Prototyping Year 1

One of the biggest challenges I encountered when developing the prototypes was considering all forms of feedback. I found it challenging to organize and analyze the feedback from the ticketing system, feedback button, observation protocol, and unit and lesson reflection forms. After determining what to prioritize, I shared the prototypes with the TFC 2.0 for feedback. Prototyping was a new concept for me as a designer, although I had heard and read about different variations of the process. The curriculum design team approached prototyping as designing a product based on a need identified from the feedback. The team shared the product with TFC 2.0 for their feedback, iterated the product's design to meet teachers' needs, and finalized the product to move forward for production. At the end of the school year, I solidified five prototypes based on teacher feedback and needs; later, I identified the process of developing these prototypes as final products within the DMC.

Figure 8

Prototyping Steps



Note. Prototyping steps the designer followed to inform the revisions made to the DMC.

Summary of Year 1

There were some limitations in the first year of feedback and implementation. The first limitation is that I was the only math designer on the team. I had to understand the intricacies of all the DMC grade-level courses, with nine units per grade equaling 108 units with approximately 2,100 total lessons. Also, it was my responsibility to understand or find a way to understand and respond to the feedback. Although I had experience teaching mathematics for the first, third, and sixth grades, I did not have experience with high school courses. Therefore, I needed to understand how to attend to high school teachers' needs as they used the courses. In Year 1, I identified a few limitations in the feedback and implementation process.

The second limitation relates to the number of teachers providing feedback. The teachers appeared to have limited knowledge of submitting feedback through the platform and ticketing system. The third limitation is the need to prioritize feedback based on capacity, budget, and platform limitations. I found it challenging to prioritize the feedback based on the various quantitative and qualitative feedback outlets. At times, I coded the qualitative feedback to determine connections or themes, finding that many teachers misunderstood how to use and navigate the platform to find specific materials. Therefore, the feedback regarding navigation showed the educators would have benefited more from professional learning and not a different prototype or product.

Revisions – Year 2: Summer 2022–October 2022

In reviewing the data sources from year one, two areas requiring attention began to emerge. It became clear that the team needed expansion and more mechanisms for communication were necessary. In order to facilitate this, I began by recruiting teachers from the TFC who were familiar with the DMC to support the development of the three prototypes that were to be embedded at scale across grades K-12. The prototypes that were going to enhance the DMC were presented to the TFC for feedback and received overall positive reviews.

Teacher Intern Summer Work

As the school year ended, I formed three groups of teacher interns to work on the prototypes confirmed by the TFC. Over the summer, approximately 130 teachers received training in the three prototypes on which the TFC provided feedback. Teachers were compensated for their time. The teachers redesigned the lesson and unit format and consolidated all the student-facing documents per unit into an e-workbook. I reviewed the work for quality assurance while completing my responsibilities as a math curriculum designer. Between July 2022 and August 2022, the teachers reformatted approximately 2,100 lesson plans and 108 unit plans and developed 90 e-workbooks based on my guidance and training.

I could not review every lesson and unit plan due to the tight time frame, so I audited and edited at least three units or lessons per teacher. Some teachers dropped out of the summer work project due to vacations and other obligations; therefore, I assigned the work to teachers who had completed their work ahead of schedule. Fortunately, the three projects (unit plans, lesson plans, and e-books) took place by the deadline due to the teachers who took on extra paid workloads. By completing these three projects with the teachers, I learned how to proceed with teacher intern work for future projects. Another lesson learned from this project was to provide a longer time frame to ensure flexibility with schedules. I learned I needed to create a teacher quality assurance committee to review the work. In the beginning, only I reviewed the projects for quality assurance and editing; later, I could not review the projects because of the short time frame and the time it took to review them.

High Quality, Cultural Relevant Curriculum

The goal of the DMC was to create a rigorous, high-quality, culturally relevant mathematics curriculum. The ideal culturally relevant curriculum should resonate with all students, allowing them to see themselves represented within its content. This means that students should be able to recognize various neighborhoods, cultures, names, events, and more. To assess the quality of the culturally relevant components of the Digital Mathematics Curriculum (DMC), it will need to be thoroughly examined and evaluated. In the coming year, the CHRE framework and equity rubric will serve as the primary evaluation to determine the quality of the DMC's culturally relevant aspects.

At the beginning of development, I worked closely with the vendor partners to design culturally relevant lessons that provided content that was not merely superficial. The vendor partners worked in alignment with the design guidebook and core values related to cultural relevance. In the initial stages, the vendor partners and I used community cultural connections that extended to various parts of the city. The initial cultural relevance build focused on enabling students to identify with the examples at a personal or community level. During the Year 2 development, the designers attended professional development training in the Culturally and Historically Responsive Education (CHRE) framework to enhance their capacity to implement meaningfully culturally responsive lessons. Dr. Gholdy Muhammad (2021) led a few of the professional development sessions that focused on the CHRE equity framework. The following is an excerpt of my notes on the initial lesson design:

> In the launch component of this lesson, students watch a video about the Ricky Byrdsong Memorial Race Against Hate, which began in 2000 to bring attention to the need to combat hate and racism. Thousands of runners from across the U.S. participate in the race each year, and the money earned from the event goes towards the YWCA Evanston and North Shore’s work to prevent violence and promote racial justice. An excerpt from the lesson: Ask students if they have ever heard of the phrase: “Before you judge a person, walk a mile in their shoes.” Ask students what they think the phrase means. Gather multiple students’ responses. Explain to students this phrase is a reminder to practice empathy. Ask students if they know what empathy means. Gather multiple students’ responses. Explain to students empathy is the ability to recognize and understand the thoughts and feelings of other people.

This lesson was a significant component of the design, as it showed students and teachers how to use social-emotional learning and culturally relevant components to combat hate and racism. The educators learned to ask the students if they would rather wear shoes that were half an inch too small or 5" too big. This mathematical connection could enable students to consider the perspective of what they were wearing and empathize with individuals who might not have the opportunity to wear well-fitting shoes. After making the connections related to the race and "would you rather" scenarios, the students would proceed with measuring to the nearest half-inch and inch mark.

Figure 7 is an example from *Cultivating Genius: An Equity Framework for Culturally and Historically Responsive Literacy* (Muhammad, 2021) that shows how lessons can include identity, intellect, and criticality that align with the CHRE framework. Designers who proceed with revisions could use the CHRE framework to design a high-quality, culturally relevant DMC. The following lesson sample allows students to identify with a preferred roller coaster and graph a proportional relationship by referencing the history of the first roller coaster and the segregation of amusement parks.

Figure 9

Culturally and Historically Responsive Education–Aligned Lesson Sample

Lesson Sample

Identity: Students will consider their own preference for roller coasters and amusement parks. (*risk or thrill identity*)

Skills:

- **English Language Arts:** Students will determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.
- **Math:** Students will graph proportional relationships, interpreting the unit rate as the slope of the graph, and compare different proportional relationships represented in different ways.
- **Science:** Students will learn about the kinetic energy of roller coasters.
- **Social Studies:** Students will learn the history and context of amusement parks.

Intellect: Students will learn about the history of the first roller coaster and the timeline of its evolution.

Criticality: Students will learn about the segregation of amusement parks and other recreational facilities.

Note. From *Cultivating Genius: An Equity Framework for Culturally and Historically Responsive Literacy*, by G. Muhammad, 2021 (p. 132). Copyright 2021 by Scholastic.

The CHRE professional learning sessions enabled the math design team to reflect on the DMC and seek ways to enhance its cultural relevance. The math design team began actively working toward creating an inclusive and equitable DMC by auditing lessons and aligning them with the equity rubric indicators and the CHRE framework. In Years 2 and 3, the math design team will consider the following strategies to enhance the DMC's culturally relevant aspects:

1. Incorporate diverse perspectives: Ensure the lessons include examples, problems, and contexts that reflect the diverse backgrounds and experiences of the students in the class. Such lessons could enable students to connect with the content and feel their culture and experiences are valued.
2. Promote critical consciousness: Encourage students to think critically about math and consider how math relates to their lives and the larger society. Lessons could address historical and current issues so students can explore how to use math as a tool for understanding and addressing current social issues.
3. Build on students' strengths: Design lessons to draw on the cultural assets and knowledge students bring to the classroom. DMC lessons could include elements of students' home languages, cultural practices, and family knowledge.
4. Provide ongoing support and feedback: Continuously evaluate the revised lessons' effectiveness in supporting cultural relevance and adjust based on feedback from students, teachers, and other stakeholders.

Interviews with students and teachers at the end of the school year could provide valuable insight into the effectiveness of the revisions and future improvements. With a commitment to equity and cultural relevance, the math design team could contribute to a more inclusive, engaging, and meaningful learning experience for all students.

Expanding the Math Design Team

There was an apparent need for additional math curriculum designers. In August 2022, the leaders of the district hired a new math curriculum designer to expand to a three-person math design team. Determining how to onboard the designer was challenging. Many processes had changed since I joined the district in August 2020. The new math designer received an onboarding document, training, and an explanation of the design and revision processes. The second math designer assisted with prototype development, revisions, work with vendors, classroom observations, and the analysis and sorting of various feedback points.

Protocols and Communication

The teachers using the DMC had various ways to provide feedback on the curriculum. The teachers could submit a ticket through the ticketing system or a feedback form through the feedback button. They could also reach out to me directly via email; however, as the emails increased, I began to refer teachers to the ticketing system and feedback form to capture data. The teachers provided an abundance of data on the protocols and structures that indicated the need for a redesign. Many content designers had trackers or processes for sorting and analyzing data to inform a revision. Before moving into the third TFC round, we conferred with an outside consulting company for insight into how to approach and streamline some processes. The consulting professionals reviewed and consolidated the trackers and protocols to produce a workbook for designers. We customized the workbook to fit our needs and began developing the TFC 3.0 and the second round of prototyping and classroom visits.

Revisions – Year 2: November 2022–February 2023

Teacher Feedback Collaborative 3.0

The TFC was essential in the initial design and revision process in the first year of implementation. This year, we reached out to the entire district for nominations for the TFC 3.0. The TFC 3.0 teachers provided insight into lessons and units, opportunities for designers to observe their classrooms, and opportunities for the designers to facilitate student focus groups. The administrators nominated many candidates, and my team member and I screened the applicants using an extant checklist to determine the best-fit candidates. The TFC 3.0 required two candidates per grade level for PreK–12, for a total of 26 teachers. After screening the candidates, the administrators confirmed their nominations. The potential teachers received invitations to participate in the collaborative. The teachers in the TFC 3.0 would receive a stipend for participating in the after-school meetings once a month and completing two reflection forms once a month, one classroom observation, and one student focus group facilitation. The TFC 3.0 setup occurred in a more organized manner than the TFC 2.0. Following is an entry from my reflection journal from November 2022:

> This week, we screened the applicants for the TFC 3.0. I'm really glad we had a rubric to determine who was a qualified candidate. I recall last year, some of the teachers in the TFC 2.0 did not use the DMC with fidelity, and it was challenging for them to provide quality feedback. I do wonder how we will accomplish 26 school visits and 26 teacher focus groups by June 2023. I'm really excited that we also have representation across all grade levels (minus PreK, unfortunately). Luckily, I have my tracker from last year and email templates to begin my communications and scheduling. My plan is definitely to start reviewing data as it comes in and try to code the qualitative data as it is submitted to better inform our prototypes for this year. I'm super curious about how teachers feel about the DMC, considering this could be Year 2 of implementation for many. Have teachers become comfortable with the LED model yet? Do teachers find the platform easier to navigate, considering we've updated some features? Will the feedback this year be substantial enough to move forward with prototyping immediately? I'm really interested in what the DMC looks like in classrooms with Year 2 implementation.

The TFC provided designers with invaluable feedback on their firsthand experiences using the DMC. The teachers provided the designers with insight into what worked and what needed improvement in alignment with the rubrics, evidence guides, design guidebook, and the TRU, UbD, and UDL frameworks. The student focus groups in Year 2 were the first to provide data from the students' perspectives for future revisions and designs.

Classroom Observations

The designers scheduled classroom visits as the teachers provided feedback through the lesson and unit reflection forms. During the TFC meetings, the designers explained the classroom visits to teachers, with the nonevaluative visits means to capture data on the DMC. The teachers welcomed the designers into their classrooms and had prior knowledge of what to prepare for the visits. The designers' expectation of the classroom visits was to observe the DMC in action with the teacher and students. I have experience teaching the third, sixth, and eighth grades. Although I did not have high school experience, I designed and redesigned the DMC in collaboration with high school teachers. I made an entry about a revision related to developing a high school glossary. The definition of a function was not established in the classroom or the student-facing documents. In a December 2022 journal reflection, I wrote,

> I observed a classroom using the DMC and noticed students were using the internet and books unrelated to the DMC to find the definition of the term. During our last collaborative meeting, I asked teachers how they approached introducing vocabulary. The conversation around the need for glossaries became the topic of the meeting. As I began to develop the glossary in collaboration with the teachers in real-time, they requested that the glossaries are in student-friendly language and include a visual or example of the term. I asked teachers to fill out a Jamboard that included all of their requests and ideas, and I would present the polished prototype of the glossary during the next session. I wonder how the glossary would inform future designs and what the revision process would look like. Do teachers find themselves wanting a digital and printable format for the glossaries? Will the glossaries be developed in-house if the prototype is approved, or would we hand this off to our

> vendor partners to develop? I am super curious about what teachers really want out of a glossary specific to the DMC.

This reflection showed how I collected and acted on feedback. Based on my classroom observation, I asked other teachers if they encountered the same issue regarding vocabulary. Because many teachers in the collaborative confirmed the need for a glossary, I created one.

I also observed a classroom where the educator implemented technology and a discussion with students for Black History Month. In a journal entry, I wrote,

> One of the teachers who was newer to the implementation of the DMC presented a lesson with students that offered a conversation about Harold Washington. Students viewed an image of Harold Washington side by side with a prominent library. The teacher also shared a brief video about Harold Washington and made connections to how his leadership supported the city. I enjoyed watching students engage in conversation related to whether they did or did not know him, alongside lesson engaged students in various conversations related to the math lesson and the history of Harold Washington. Students were able to connect to this lesson by engaging in contextual word problems that relate to addition and subtraction up to 1,000. The library was a means to connect students to the understanding of a primarily known library and its community connection to Chicago.

This reflection provided insight into using technology in the math lesson while inviting students to learn about Harold Washington, the first Black mayor of Chicago. The students at second-grade level learned about Washington in connection with a math and digital component that included images and a video. The math connection in this lesson was addition and subtraction problems within 1,000 with physical models and drawings specific to the Harold Washington Library. Typically, math curricula include direct addition and subtraction problems without context; however, the DMC enabled students to learn about Washington and the Harold Washington Library before completing contextual math problems.

Ticketing System for Feedback

A significant increase in tickets within the ticketing system could have resulted from a few intentional changes in Year 2. First, there was a need to increase communication about the ticketing system compared to the prior year. Before the professional learning sessions, many teachers did not know they could provide feedback or report issues through the ticketing system. Making the ticketing system visible on the platform's dashboard was another change contributing to the increased number of tickets. The ticketing system icon was one of the first things teachers saw upon entering the platform. In a journal reflection from November 2022, I wrote,

> It seems like professional learning was this week. We received tickets back-to-back this week related to specific units. As we combed through the tickets, we noticed some of the tickets related to formatting errors found in the lesson plans and unit plans. Having teachers work on the lesson plans and unit plans over the summer was a great idea, although we are finding formatting issues that need to be addressed. The initial design of the unit plans and lesson plans all went through a quality assurance process. Because I was the only math designer over the summer, it was impossible for me to review for quality assurance over 2,100 lesson plans and 108 unit plans. I do think we will need to address this by hiring a quality assurance team to resolve this matter. The formatting issues are to the extent that the color formatting is off in lesson plans, and the charts are not all aligned in the unit plans. For the time being, I will resolve these tickets by fixing all the identified submissions and developing a plan of action to address future issues. Do I have the vendor partners fix the issues, or could I identify the teachers over the summer who formatted them correctly and hire them to fix these issues? I'm sure one option is more costly; however, it is also more timely. Could these errors eat into our budget? Do I have the capacity to fix them all on my own? After adjusting one of the lesson plans, I decided to time myself and determined that it would take approximately 10 mins to format appropriately.

In this reflection, I addressed an issue in the ticketing system I had found while teachers went through the lesson and unit plans in depth through professional learning. Fortunately, there was a way for teachers to communicate their needs. After calculating the number of hours needed to address the formatting concerns, I determined I did not have the capacity for them. Therefore, I elevated this issue to my fellow math designer to devise a plan to identify the teachers who excelled at the project over the summer. The school district hired five teachers hired as temporary quality assurance reviewers to address the formatting issues in the lesson and unit plans. Hiring these teachers required developing a project plan, identifying the need, creating a training video and reference documents, and developing a timesheet process for teachers to receive payment. Overall, the ticketing system showed a need, and professional learning sessions provided insight into heightening the feedback.

Expanding the Math Curriculum Design Team

As indicated, there was a need to continue to expand the math design team. During Year 2, there were two math designers with K–8 math experience; however, the district needed a designer with high school expertise. In January 2023, the district added a math designer with high school math expertise. Next, district leaders needed to determine how to onboard the new designer within a year and identify the roles in the math design team. After the second math curriculum designer came on board, I assumed the position of the manager of the digital curriculum. As I began navigating and balancing my new role while onboarding a new math curriculum designer, I began to realize the importance of collaboration. In a journal reflection from January 2023, I wrote,

> I am really happy we now have a team member who has high school experience. What am I wondering is how appropriate were my design and revision practices related to high school? Were there any issues I was not able to address because of my lack of knowledge in high school? What are some high school-specific elements I would like to leverage for our new team member? There are so many priorities and pieces of feedback. How do I ensure our new math designer feels equipped to address these concerns?

This reflection showed the need to document processes and structures to facilitate onboarding new designers. I developed many processes for the math design work on my own or in collaboration with other team members. Therefore, I needed to clearly communicate the steps with the math designers and provide time for them to become familiar with the processes and products.

Prototyping – Year 2

The second year of prototyping involved two math designers. In Year 1, recognizing and confirming the need based on teacher feedback was challenging. The identification of feedback trends across different platforms was demanding because it involved analyzing the data in a short time. In Year 2, two math designers could jointly process the data to develop prototypes to address the need for revisions. However, maintaining and protecting the design of the DMC is critical. Revisions should occur with a protocol for identifying if they align with the rubrics, evidence guides, design guidebook, and TRU, UbD, and UDL frameworks. This year, two prototypes received positive feedback with room for growth and revisions. In a journal reflection from February 2023, I wrote,

> This evening was the first presentation of the prototypes that I was an observer. Both math designers collaborated and finalized the prototypes that speak to our initial design guidelines. I am extremely happy to hear that teachers feel like they are being heard. Many teachers shared that this is what they have been looking for and that they have been spending hours working on similar work to ensure that their students have what they need to be successful. One of the prototypes was addressed to make the activities within the lesson accessible to diverse learners. We'll need to consult with an external team that specializes in designing lessons that are accessible to all learners. How can we determine that this revision speaks to many of our students? I am wondering if we need to have teachers test this revision out first in their classrooms and provide us with feedback on what works

and what doesn't. Designing supports specific to the UDL framework will involve specificity among the units and lessons. I am wondering where the product will live on the platform and how it will be received by other teachers within the district. We may want to consider a fifth step in our prototype process that involves testing the prototype before moving it forward to the final design.

Summary of Year 2

There were two goals in the second year of DMC implementation. The first was conducting professional learning for the district on how to provide feedback via the platform and ticketing system. The second goal was to recruit more teachers to give feedback by asking administrators to nominate educators who use the DMC. In the second year of implementation, the leaders of the large, diverse urban school district initiated a formal process for collecting teacher feedback through interviews, lesson reflection forms, unit reflection forms, and focus groups. The design team overcame the limitation of the first year's response to teacher feedback by proactively recruiting teachers across grade levels with varied experience and geographical locations through administrator nominations. Additionally, the math design team grew from one to two members to improve connections with teachers by visiting their classrooms multiple times and reviewing unit and lesson reflection forms in greater detail. The final first-year goal was to show teachers how to share feedback via the platform and in-house ticketing system. Through professional learning, the teachers learned how to use feedback channels, resulting in an influx of feedback for the math design team.

Teacher Feedback and Prototyping Year 2: November 2022-February 2023

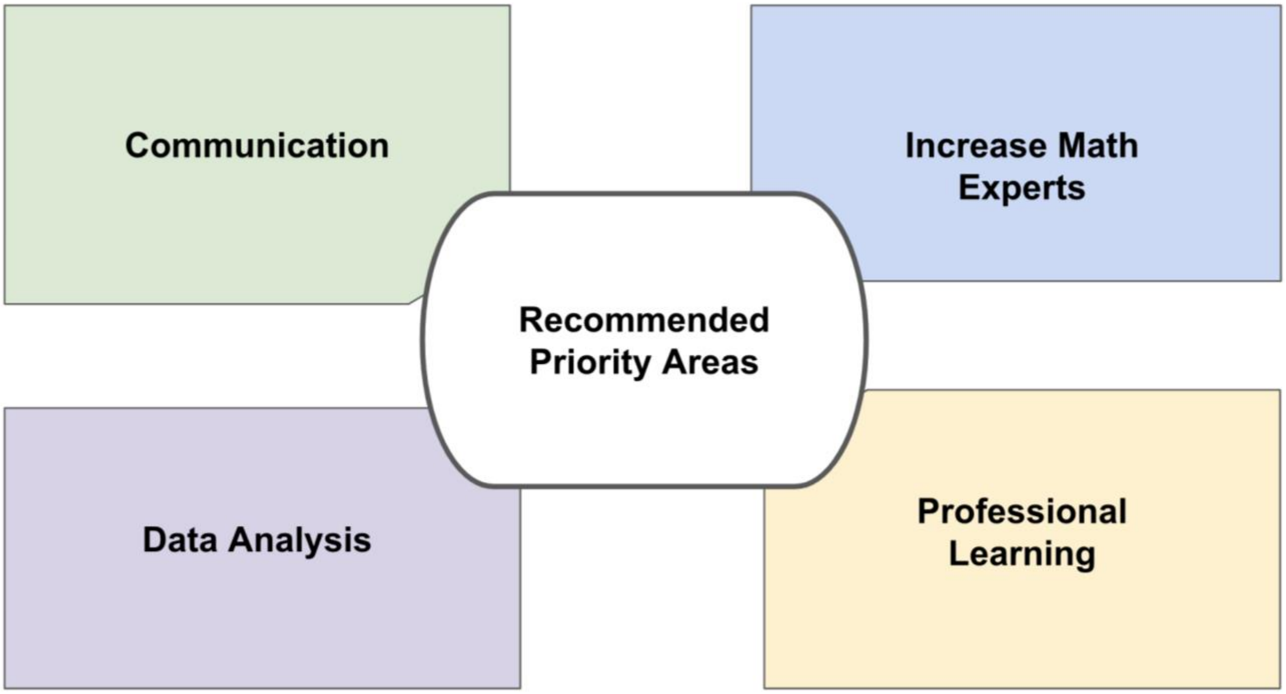
Diving into the second research question necessitates an in-depth analysis of the data gathered from the reflective journal entries. This question asks, "What are the recommendations for enhancing the processes of designing and revising a digital mathematics curriculum for a large, diverse urban school district based on a mathematics designer's experiences?" Recommendations linked to this question underscore the need for designers to optimize their processes and provide insights for district and school leaders about crafting and refining a culturally relevant, high-quality digital mathematics curriculum (DMC). The analysis of the 17 journal entries highlighted four key areas of focus that I, in my capacity as a DMC designer, grappled with throughout the two-year design and revision journey. The first priority of focus centers around the role of math experts in the teaching and learning of mathematics. As a DMC designer, I was consistently introspective about how to improve the DMC from a teaching perspective. I frequently referred to the TRU, UbD, and UDL frameworks to ensure that the DMC design and its revisions were executed with the utmost quality and rigor.

The second recommended priority area is for professional learning in implementing the DMC. This priority area emerged from the teachers' understanding and feedback on using the DMC. The third recommended priority area involves organizing, prioritizing, and understanding feedback. In the second year of DMC implementation, there was an overabundance of feedback via the feedback button and the ticketing system. Addressing this priority area involved the challenges of sorting through and making sense of the data and ensuring actionable and evidence-based feedback.

Finally, the fourth recommended priority area is to focus on communication. Teachers, administrators, and content teams did not have substantial communication related to the DMC. My reflections showed that teachers did not know they could access the DMC for free. Additionally, the teachers were unaware of the various opportunities to provide feedback to inform revisions.

Figure 10

Recommended Priority Areas



Note. Four recommended priority areas from self-reflection journal entries.

Priority Area 1: Increase Math Experts

After reviewing, coding, and analyzing the 17 journal reflections, I found the need to increase the number of math experts on the team. Twelve of the 17 journal reflections referred to my limited capacity to work on projects because I was the exclusive math curriculum designer. Currently, the team has two math designers, and we are looking to expand to a three-person team; even so, we are all accountable for Grades PreK–11. My first recommendation is to hire math curriculum designers based on their expertise in specific grade bands. In a journal entry from November 2022, I wrote,

> There are a few tickets that relate to advanced algebra problems that I am not too familiar with. I am going to need support on how to address these issues; however, I don't want to seem like I don't know exactly what issue is addressed. I'm not looking forward to presenting these issues to our vendor partners because I don't have confidence in how to present and understand the problems at hand. Can't wait for tomorrow! I really wished we had someone with a high school math lens.

This entry showed I did not feel confident addressing high school content issues, yet I was responsible for resolving them. Table 1 presents the indicators from coding my journal reflections. These indicators show the priority area for increasing the number of math experts for Grade Bands K–2, 3–5, 6–8, and 9–11. As mentioned, many journal entries indicated the need for a larger team because of the number of materials that required attention.

Table 1

Priority Area 1: Increase Math Experts Indicators

Priority Area 1: Increase math expert indicators		Journal reflection reference
High school lesson	Advanced Algebra	November 4
No time	High school Unit 0	November 11
Time	Tired	November 18
Algebra	Deadline	November 25
Capacity	Overwhelmed	December 2
Way too much	No experience	December 9
Bigger team	Frustration	December 16
Exhausted	Reference	December 23
Choice of projects	Collaboration	December 30
Expert in grades	High school need	January 6
Misunderstood feedback	Observation	January 13
Need support	High school expert	January 20
Don't know what I'm doing	Wished we had someone	

Note. Table 1 is a list of indicators in my self-reflection journal entries that supported the priority area identified.

Priority Area 2: Professional Learning

School readiness and professional learning appeared in nine of the 12 journal reflections due to the number of tickets and feedback button submissions. Although teachers could attend professional learning sessions, time constraints and schedule conflicts often left them trying to learn the platform and DMC without implementation guidance. As a result, teachers submitted tickets to find student-facing materials or assessments on the platform. In a journal reflection from November 2022, I wrote,

> I want to say that the platform is pretty intuitive. After professional learning sessions, teachers should have the capacity to locate materials to use within the lessons. Yet, I do receive tickets regarding where to find the assessments and how to access the student-facing materials. At first, I wondered if it was because of the platform. However, I am now wondering if it is due to the lack of professional learning.

When teachers reach out for help with the platform, it is my responsibility to ensure they receive the support needed to teach successfully with the DMC. However, providing support can be challenging if teachers who do not receive basic training attempt to navigate the system independently. Table 2 shows the indicators identified by coding the journal reflections that support the recommended priority area of increasing participation in professional learning and better preparing teachers to use the DMC. As mentioned, many entries suggest the need for teachers to understand the DMC's platform and design for better-quality feedback and revisions. Frequently, the feedback button and ticketing system elicit feedback related to teachers lacking knowledge of the materials' location or how to use them. Therefore, the goal was to streamline the feedback outlets to enhance the DMC based on teachers' and students' needs.

Table 2

Priority Area 2: Professional Learning Indicators

Priority Area 2: School readiness and professional learning indicators		Journal reflection reference
Logging in issue	Don't understand	November 4
Materials	School	November 11
Where do I find	Class	November 18
How do I	Lesson plans	December 2
Launch	Assessments	December 16
Pacing is off	Ticket	January 6
Help me find	Submissions	January 13
Help	Professional learning	January 20
Sessions	Feedback	January 27
Attendance	Record	
Principal	Video	
Ordering materials	Facilitation	
Professional learning	Not available	
Feedback button	Training	

Note. Table 2 is a list of indicators in my self-reflection journal entries that supported the priority area identified.

Priority Area 3: Feedback Analysis

Teachers have multiple outlets for sharing feedback on the DMC. Feedback remains abundant despite a larger math design team. A challenge I have faced over the past 2 years is sorting, analyzing, and prioritizing the feedback. Some feedback does not appear actionable or evidence-based. Currently, there is a process for rating the feedback according to priority, urgency, and impact and classifying it as high, medium, or low. I logged all the feedback and its ratings. However, the process sometimes felt subjective due to the priorities that could have impacted the ratings. In a journal reflection from December 2022, I wrote,

> The process of logging the feedback is clear to me. After responding to feedback for over 2 years, the step within the process that still troubles me is rating the feedback. I do not understand how to rate the feedback high, medium, and low based on priority, urgency, and impact. We all know that the district tends to make many changes at a fast pace, and sometimes it feels like it is impossible to catch up. When logging and rating the feedback, I try to keep into account what the district's priorities are and what impact they may have. I don't know if one perspective or two perspectives helps when rating the feedback, though. I wonder if I had a team if they could help me think about the criteria when rating.

This entry showed my discomfort with the feedback analysis. Nevertheless, one of my responsibilities was to log, analyze, and prioritize the feedback to inform DMC revisions. Table 3 presents the indicators found after coding my journal reflections that support the recommended priority area of addressing the process for analyzing and rating feedback.

Table 3

Priority Area 3: Feedback Analysis Indicators

Priority Area 3: Feedback analysis indicators		Journal reflection references
Overload	Fast	November 4
Opinion	Resolve	November 11
Rating	Rate	November 18
Logging	Evaluate	November 25
Frustration	Feedback	December 2
Questions	Analyze	December 9
Wonderings	Prioritize	December 16
Criteria	Sort	December 23
Perspective	What do I do next	December 30
Catch up	Trends	January 6
Impossible	High	January 13
Resolution	Medium	January 20
High Impact	Low	January 27
Medium Impact	Urgent	February 3
Low Impact	Data Analysis	February 10
Urgency	Coding	February 17
Where do I log this	Quantitative feedback	February 24
Actionable feedback	Qualitative feedback	
Evidence-based	What does the research say?	
Best practice	Do I address this?	
How do I address this?	What does the data say?	
Trainings	Process	

Note. Table 3 is a list of indicators in my self-reflection journal entries that supported the priority area identified.

Priority Area 4: Communication

Communication with more than 500 schools is challenging. Schools have access what has been designed to be a high quality, culturally relevant DMC. The DMC design occurred with the equity rubric, content rubric, evidence guides, design guidebook, and the TRU, UbD, and UDL frameworks. However, despite communicating about the DMC for over two years, some school leaders and teachers do not know they can access the DMC. Communication issues could impede the DMC design and revision progress in a few ways. When school leaders are unfamiliar with the DMC, fewer users can provide the math design team with feedback. Another implication of poor communication is the spread of misinformation. Teachers share information through various social media platforms, and it is challenging to change their perspectives regarding misinformation. In a journal reflection from November 2022, I wrote,

> I decided to look up what people are talking about within the district on Twitter. I noticed that a teacher Tweeted about the DMC, and a thread of teachers began to comment. Quickly, I realized that people on social media were resharing the amount of money spent on the DMC. I didn't know how to tell them that the information (from wherever they got it) was totally inaccurate. Sadly, when news spreads, it spreads fast on social media. Do I talk to my director about this to put a comment out there to share the correct information, or do we leave this alone? I wonder if we

could engage more with social media and users to capture feedback to inform revisions on the DMC. Could they Tweet us with positives and negatives? Do we want the feedback to be public? Should we leverage all social media outlets to share that the DMC is available to all schools within the district?

This entry showed that social media could cause damage; however, it could also be a means for communication across the district. I wondered how the department could leverage all social media outlets to gain the attention of teachers and administrators within the district. Table 4 shows the indicators from coding my journal reflections that support the recommended priority area of communication. The table also presents the implications of communication for the DMC design and revision processes.

Table 4

Priority Area 4: Communication Indicators

Theme 4: Communication indicators		Journal reflection references
Social media	Networking events	November 4
Twitter	Miscommunication	November 11
TikTok	Just the way that it is	November 18
Other departments	Misunderstanding	December 2
Chatting	Did not receive	December 9
Unaware of the initial design	Not true	December 16
Heard from a colleague	Threads	January 6
Instagram	Did not know	February 3
Rush	Connections	
Too many schools	Perception	
Lack of communication	Unaware	
Facebook	Launch	
Misinformation	BBQ	
New teachers	Principals	
No background information	Leaders	
Emails	When was it sent out?	
Newsletters	Communication	
Mail	New leaders	
Time-sensitive	Buy-in	
Teachers did not know	Trust	
Who was it sent to?		

Note. Table 4 is a list of indicators within my self-reflection journal entries that supported the priority area identified.

The analysis revealed four key areas for prioritization: strengthening the presence of math experts, facilitating professional development, interpreting feedback, and enhancing communication. These recommendations directly respond to the second research question, which pertains to formulating recommendations for enhancing the processes of designing and revising a digital mathematics curriculum. To re-emphasize, this study's aim was to examine and narrate my experiences as a DMC designer, intricately involved in multiple design and revision procedures. The value of this capstone project lies in its vivid demonstration of the intricacies and challenges encountered while designing and revising a customized DMC, based on inputs from teachers, students, and administrators. The ultimate hope is that, informed by my experiences, the proposed recommendations will offer valuable insights from the lessons learned over the past two years, assisting both me and others in making future enhancements to the existing processes.

Recommendations

The comprehensive design and revision processes for the digital mathematics curriculum (DMC) presents a multitude of challenges and opportunities for learning. It is through addressing these challenges that I have identified four priority areas for improvement. The first priority area is the need to increase the number of Math Experts. To ensure an in-depth understanding and handling of the DMC across all grade levels, it is suggested that math curriculum designers be hired for specific grade bands, thereby improving the quality of the DMC through their specialized knowledge. The second priority area is the provision of Professional Learning. By making basic training mandatory before educators gain access to the DMC, we can ensure the confident delivery of a culturally relevant, high-quality DMC. It is not about completing all learning sessions, but about providing educators with the necessary tools to navigate and understand the DMC independently. The third area of focus lies in Data Analysis. Recommendations around this concern the training of math designers in best data analysis practices, developing feedback analysis skills, and setting specific time frames for feedback analysis, which would inform revision priorities and identify trends. The fourth and final priority area is Communication. The aim is to increase the visibility and understanding of the DMC by utilizing social media platforms and sharing quick tutorial videos based on feedback. By doing so, we can reach a wider audience, thereby facilitating the receipt of higher-quality feedback to further inform the DMC's design and revisions. This approach to improving the DMC presents a holistic view of the areas of concern and the potential for future improvement.

Priority Area 1: Increase Math Experts

To address the first recommended priority area, I suggest recruiting math curriculum designers who possess expertise in distinct grade bands. This approach would ease the burden of mastering the complexities across the entire PreK–11. By focusing on specific bands like K–2, 3–5, 6–8, and 9–11, these specialized designers could bring their insights to bear on enhancing the DMC. This strategy would effectively create a team of four math curriculum designers, each concentrating on three grade levels within their area of expertise. These grade band-specific designers could play a key role in facilitating Teacher Feedback Cycles (TFCs) and familiarizing themselves with the data and feedback pertinent to their respective grade bands. Consistent with the principles of the Teaching for Robust Understanding (TRU) framework, this specialization enables designers to develop a math curriculum that enriches student comprehension, fosters logical thinking, and stimulates engagement appropriate for each developmental level (Schoenfeld, 2014). Hiring experts tailored to specific grade bands thus emerges as a highly efficient approach to analyzing, revising, and enhancing the components of the DMC.

To further support this priority area, it is recommended that the team of math experts participate in annual math training. This would ensure they stay up-to-date of the latest teaching strategies and allow them to network with other math educators, sharing the latest insights from math research. Another supportive step would be to facilitate the attendance of designers at relevant conferences. This would provide an opportunity for them to expand their professional networks and gain exposure to the latest developments in math standards, teaching methodologies, and research associated with designing a digital math curriculum. Lastly, there's an essential need for regular internal calibration among designers. Considering they often juggle multiple projects and revisions simultaneously, it's critical they align with each other in terms of best practices, recent research, and the internal rubrics that guided the initial design of the DMC. As technology develops, the manner in which information is utilized also advances, which has repercussions on both the employment of technology and the curriculum.

Building on the ideas presented in the literature review, Matos et al. (2019) emphasized the importance of advancing teacher competencies, suggesting this can be achieved through the enhancement of teacher education programs that focus on technology and 21st-century skills. Similarly, Mayer (2019) stressed the significance of instructional design, highlighting the necessity for developing principles associated with games, simulations, and various forms of media (Mayer, 2019, p. 157). Mayer's research argues in favor of an in-depth understanding of the intricacies of online learning, suggesting that this knowledge should inform the way educators approach online instruction. This points towards a crucial implication for math specialists; to optimize the design of their content, they will need to continuously deepen their expertise in their subject area.

Priority Area 2: Professional Learning

In the domain of professional learning, I suggest initiating mandatory basic training before granting access to the DMC. This stipulation aims to ensure that teachers are equipped to deliver a high-quality DMC with confidence. While it's not necessary for teachers to complete all learning sessions to access the DMC, I advocate for basic training that enables teachers to navigate and learn the DMC independently. The successful, continuous implementation of the DMC is possible when teachers receive adequate training, allowing them to provide valuable feedback for enhancing the curriculum. This feedback should focus on curriculum improvement, rather than navigation difficulties stemming from misunderstandings of the DMC. Furthermore, the professional learning should instruct teachers on how, when, and why to utilize the various feedback outlets. This would provide a framework for processing feedback, potentially leading to more actionable, evidence-based suggestions. In line with the Teaching for Robust Understanding (TRU) framework, this approach ensures teachers' deep content knowledge, thus fostering effective instruction (Schoenfeld, 2014). To further support this priority area, I recommend scheduling quarterly sessions for teachers. Teachers often face an overwhelming number of professional learning trainings at the start of the school year. By offering DMC and best practice training every quarter, teachers may feel more competent and less overwhelmed in their use of the DMC. Lastly, providing both synchronous and asynchronous options for training sessions could accommodate the varying needs and schedules of teachers. Given the demanding nature of their roles, offering flexible options could empower teachers to learn how to use the DMC at their own pace and in their own time.

Expanding upon the concepts discussed in the literature review, Lachheb et al. (2021) highlighted the importance of dedicating time to the ideation and iterative refinement of supports within the UDL Guidelines. Additionally, Wiggins & McTighe (2005) pointed out several challenges when designing a curriculum using the Understanding by Design (UbD) Framework. Primarily, a shift in teachers' focus from teaching activities to the anticipated learning results is crucial. This leads to an important implication for math designers and teachers; to enhance the quality and effectiveness of their instructional content, they must persistently deepen their understanding and proficiency in their subject area.

Priority Area 3: Data Analysis

When reflecting on the priority area for feedback, I developed a few recommendations for the design and revision processes. My first recommendation for feedback analysis is to train math designers on the best data analysis practices to build their capacity. The district hired math designers to design and revise the DMC; however, there was an assumption that all math designers know how to analyze and prioritize feedback to positively impacts the DMC’s revision process. I suggest training math designers in feedback analysis. Math designers could successfully and continuously revise the DMC with the necessary training. This recommendation involves sharing how, when, and why to analyze all feedback outlets. Another recommendation for feedback analysis concerns the time frame.

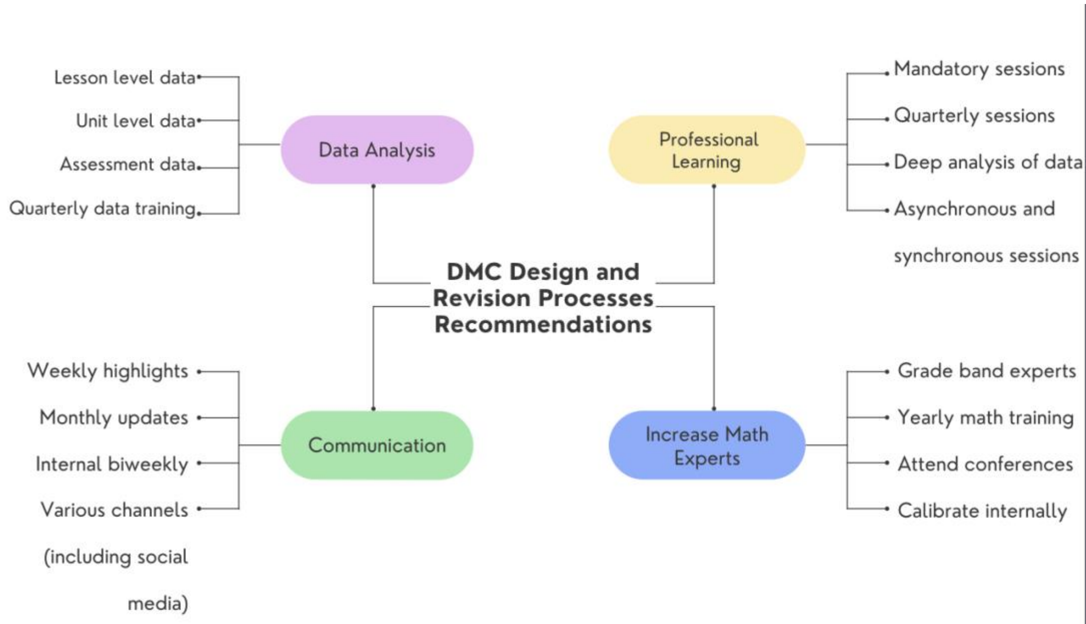
Currently, math designers review the feedback on an ongoing basis and make modifications based on the prioritized revisions of the DMC. My recommendation is to specify time frames for when and how to analyze feedback and develop an action plan. Math designers could review the feedback at the end of each month to inform revision priorities and identify trends specific to the units and lessons. Data can be analyzed at various levels, including lessons, units, and assessments, while aligning with quarterly data training that focuses on specific methods for analyzing both qualitative and quantitative data. My last recommendation is to close revision windows. When there is an influx of feedback, there is a need to reference the feedback to inform current revisions. However, reviewing the feedback concurrently with active revisions can impact the priority of certain revisions. Feedback analysis that occurs at the same time as active revisions may not adequately focus on the revisions and impact the ways in which feedback is prioritized. Incorporating the principles of Universal Design for Learning (UDL) and Understanding by Design (UbD) frameworks in the data training process for math designers will further enhance their ability to create inclusive and effective learning experiences. By prioritizing UDL's focus on accessibility and UbD's emphasis on clear learning objectives, math designers can better analyze feedback and align revisions with these frameworks to maximize student engagement and achievement.

Priority Area 4: Communication

I recommend enhancing communication by increasing the presence of the DMC on social media platforms. Currently, administrators and teachers rely on email, newsletters, and website postings as the primary means of communication. Since numerous individuals utilize social media, information spreads rapidly across various platforms. Additionally, I propose sharing brief videos district-wide based on feedback received. These videos could serve as quick tutorials or provide background information related to the DMC, thereby making the curriculum more visible. By increasing the number of users who are familiar with and understand the DMC, the math design team can obtain higher-quality feedback to inform the design and revisions of the DMC. Another step to enhance communication involves sharing internal weekly updates. This practice would benefit many teams by providing valuable information for their revisions, designs, or presentations to the district. I recommend that all teams contribute to these weekly updates to support robust internal communication across teams. Furthermore, I suggest implementing monthly updates and communication with other departments. These updates would serve to inform them about upcoming revisions and provide guidance for professional learning. Since certain departments may not participate in cross-content meetings, a monthly update would ensure they stay informed about any changes or additions to the DMC. Finally, I recommend maintaining an internal communication document that is updated biweekly for reference purposes. This document would serve as a valuable resource for teams seeking logistical information related to the revisions. By keeping it regularly updated, effective communication within the department can be facilitated.

Figure 11

Overall Recommendations



Note. Figure 11 shows the specific recommendations related to the four priority areas.

Significance and Rationale

Future scholars could extend this study as part of an internal evaluation of a school district's DMC. The intent was to provide insight into a math curriculum designer's experiences designing and revising the DMC based on the best teaching practices, the district's needs, and teacher feedback. Curriculum designers could use the study's recommendations to modify the DMC design and revision processes. Scholars could expand this study to support districts and advise decision-makers on solving issues in the design and revision processes. This research could be a way to strengthen the initial program and avoid problems and pitfalls. The purpose of this study was to share and examine the curriculum design experiences from my perspective, as I was a DMC designer involved with the varied design and revision processes. The significance of this capstone included understanding the complexity of designing and revising a custom DMC based on teacher, student, and administrator feedback. Ideally, based on my perspective, the proposed strategic plan could support myself and others with useful information from the past 2 years to change current processes. The study is significant because it could provide information useful to other U.S. school districts on how to design and revise a curriculum for teachers and students. This project could also be a guide for continuous improvement efforts and determining which feedback is actionable and evidence-based.

Limitations

Although these recommendations have potential, they are not without limitations. A limitation of the first recommendation to hire an additional person and assign grade bands is budget implications. Ideally, additional funds to hire more math designers could increase the amount of focus on feedback with prompt resolutions. The second recommendation for professional learning could have limitations regarding mandating training before a teacher can use the DMC. Mandatory training might cause teachers and school leaders to avoid using the DMC, or they might prefer learning at their own pace. Related to feedback analysis, the third recommendation could have limitations related to changing feedback outlets in the future. Some changes might include removing one or more of the outlets or changing the location of feedback outlets on the DMC's platform. The last recommendation for communication has the limitation of trying to communicate with more than 500 schools in the large, diverse urban school district. Many district departments have shown frustration with communicating with all schools in the district. Often, teachers and administrators do not read or pay attention to mass emails from outside their schools.

This capstone included data limited to my experiences as a math curriculum designer. The limitations of the data are that they originated from my perspective as one math curriculum designer. Therefore, eliminating biases and focusing on the DMC development and design could be challenging due to my feelings and attitudes. Other limitations of this research include lacking teachers' voices on the DMC design and revisions. This study focused on a DMC designed for a large, diverse urban school district. Therefore, the findings might not be a universal guide for other large school districts. Instead, district leaders could use the processes and recommendations to initiate their own processes.

Conclusion

This capstone focused on my experiences as a math designer to provide insight into the DMC's design and revision processes. The study had two research questions:

RQ1: What did I learn as a mathematics designer about the processes of designing and revising a digital mathematics curriculum for a large, diverse urban school district?

RQ2: What are the recommendations for enhancing the processes of designing and revising a digital mathematics curriculum for a large, diverse urban school district based on a mathematics designer's experiences?

Through the three data reflection sources: 17 weekly self-reflection written journal entries, one self-reflective journal video, and voice memos this capstone provided inspiration and recommendations for districts and curriculum designers pursuing a customized DMC. The findings showed the process of designing and revising a culturally relevant, high-quality DMC for a large, diverse urban school district, providing a strategic plan for future revisions.

Future researchers could find that improved communication and increased expertise in the design process would result in more satisfaction among schools, teachers, and students using the DMC. As a next step, I would like to explore the relationship between student achievement scores on the DMC's summative assessments and the quality and alignment of those assessments with the standards. That study could contribute to the development of effective professional learning sessions and future DMC revisions. Future scholars could evaluate the DMC's culturally relevant aspects, specifically from students' perspectives. Based on my observations, students who see their identities and communities within the curriculum could engage with the lessons presented. As previously mentioned, the DMC was designed to be unique by aiming for cultural relevance to all students within the district from the start of its development. To assess the quality of these culturally relevant components in the Digital Mathematics Curriculum (DMC), a comprehensive evaluation and analysis will be required. In the upcoming year, the CHRE framework and equity rubric will be used as the primary instruments for measuring the quality of the culturally relevant aspects of the DMC.

This study found four priority areas for informing a strategic plan to design and revise the DMC. This capstone contributed to the knowledge base on designing and revising a culturally relevant, high-quality DMC from the perspective of one of the creators. The broader implications relate to continuously improving the quality of the DMC over time. It is possible to implement a culturally relevant, high-quality DMC in classrooms, schools, and districts. The main challenge to rigorous mathematics education is the intertwining of current practices and trade-offs. A challenge in the district was the availability of technology and stable internet. School district leaders made enormous efforts to provide educators with personal devices at all schools where educators implemented the DMC. The DMC was a means of eliminating economic obstacles and implementing a high-quality mathematics curriculum. Future scholars could identify the factors that impede access to rigorous mathematics education, producing findings that could have significant implications for the rigor, accountability, and equitable access to mathematical knowledge students need to succeed.

Gaps in the Literature

The DMC has a unique development and design. No school district leaders have attempted to design a culturally relevant DMC based on the TRU, UbD, and UDL frameworks. This capstone focused on the process of designing the DMC and my reflections as a math curriculum designer. Future designers and school district leaders could use the findings to learn the strengths of the process and receive recommendations based on one math curriculum designer's perspective. There is abundant literature on self-efficacy and math anxiety; however, limited research has shown how to implement a new DMC and approach teacher professional development. Thus, there is a gap in the literature on what an ideal mathematics program looks like and how to design and revise such a program.

Based on the study's findings on mathematics education, there is a need to determine how math curriculum designers design and implement feedback to revise a newly adopted mathematics curriculum. There is also a need to act to ensure the successful implementation of a new DMC. Math curriculum designers could consider reflection as a part of their practice in their design and revision processes.

Future Research

Further research could address why teachers have certain attitudes toward and perceptions of mathematics and the DMC. Studies could also indicate how teacher professional development opportunities align with best practices and instructional strategies. Such research could show why teachers might not feel confident with new reforms in mathematics and how professional development could address these reforms. Negative attitudes toward math in society have persisted, and it is time for them to stop (Looney et al., 2017). The successful implementation of a mathematics curriculum could be a way to foster positive attitudes toward the content area.

Researchers could also address how to evaluate the DMC with custom evaluation protocols that align with best practices. Achieve the Core is a nonprofit organization with a Student Achievement Partners team that designs protocols, resources, and professional development for teachers to ensure equity and quality across curriculum content areas. In July 2021, Achieve the Core provided an updated evaluation protocol aligned with the CCSS shifts. The Instructional Materials Evaluation Tool is a means of evaluating coherence, rigor, and focus on mathematics (Achieve the Core, 2021). Teachers could use the protocol to evaluate the purchase of a new curriculum or the development of their curriculum and programs. EdReports, another nonprofit organization that enables teachers to review materials, produced K–8 math rubrics to assess focus and coherence, rigor and mathematical practice, and instructional support (EdReports, n.d.). These protocols could be part of an internal evaluation of the DMC and show the effectiveness of the design and revisions made based on teacher feedback.

The cultural relevance element of the DMC emerged as a meaningful component and enhancement to the curriculum. While there is a need to investigate the cultural relevance aspect of the DMC, my research questions for this capstone did not allow for an in-depth exploration of this topic. One of the primary challenges I faced while designing and revising the DMC was that the vendors involved were not all local, which constrained their understanding of the city's distinctive nuances and requirements. To address this issue, I would recommend prioritizing cultural relevance in future research, as it is a crucial aspect to consider. This study emphasizes the necessity for further examination of the challenges associated with integrating cultural relevance, particularly when collaborating with non-local vendors.

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Appendix A

Math Rubric Reference Example

The following is an example of one indicator and guidance on how to evaluate the lesson based on the criterion below.

<table>
<tr><th colspan="6">Criterion Two- Aspects of Rigor

The instructional materials reflect the balances in the Standards and help students meet the Standards' rigorous expectations, by giving appropriate attention to developing students' conceptual understanding, procedural skill and fluency, and engaging applications.</th></tr>
<tr><td rowspan="2">Indicators</td><td>Evidence that indicator is not met</td><td>Evidence that indicator is partially met

Include specific relevant locations that partially meet this indicator</td><td>Evidence that indicator is met

Include specific relevant locations that fully meet this indicator</td><td rowspan="2">Provide suggestions on how to meet this indicator (optional)

Include specific relevant locations of any suggested additions or changes</td><td rowspan="2">Rating

1 = does not meet indicator
2 =partially meets indicator
3 = meets indicator</td></tr>
<tr><td colspan="3">At least one box per indicator (row) must contain evidence.</td></tr>
<tr><td>2a

More details
The three aspects of rigor are not always treated together, and are not always treated separately. There is a balance of the three aspects of rigor within the grade.

Assessment Characteristic: Alignment
Return to Assessment Characteristics
Questions and tasks reflect the appropriate balance of conceptual understanding, procedural skills and application within and across assessments within a unit.</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Appendix B

UDL Implementation Example

Below is an example of one of the three UDL Guidelines found in the Unit Plan.

UNIVERSAL DESIGN FOR LEARNERS

UDL: Multiple means of action and expression/modes of communication

4: Provide options for physical action

4.1 Vary the methods for response and navigation

- Students use physical paper shapes to sort, respond verbally, and write (Lessons 1, 4, 5)
- Students use rulers, respond verbally, and write (Lesson 3)
- Students draw, respond verbally, and respond to drawn shapes (Lesson 7)
- Students respond verbally and write (Lessons 8, 9, 10)

5: Provide options for expression and communication

5.2 Use multiple tools for construction, and composition

- Students choose how to sort shapes (Lessons 1, 4)
- Students use rulers to measure drawn shapes. Students choose strategies to find perimeter (Lesson 3)
- Students use physical paper shapes to sort, respond verbally, and draw (Lesson 5)
- Students choose how to partition shapes (Lesson 7)
- Students draw, respond verbally, and write (Lesson 10)

5.3 Build fluencies with graduated levels of support for patience and performance

- The students describe attributes in their own language, and the teacher provides the appropriate vocabulary words that correspond with their language. (Lesson 2)

Below is an example of one of the three UDL Guidelines found in the Lesson Plan.

UNIVERSAL DESIGN FOR LEARNERS

UDL: Multiple means of action and expression/modes of communication:

4: Provide options for physical action

4.1 Vary the methods for response and navigation

- Students use physical paper shapes to sort, respond verbally, and draw

5: Provide options for expression and communication

5.2 Use multiple tools for construction and composition

- Students use physical paper shapes to sort, respond verbally, and draw

6: Provide options for executive functions

6.2 Support planning and strategy development

- Students select and execute strategies of choice

6.3 Facilitate managing information and resources

- Students are sorting mats to sort shapes and graphics organizers to draw shapes

Appendix C

Observational Protocol

Below is an example of one section of the observation protocol used on classroom observations.

Math		
Indicator	**Observable**	**Notes**
Launch: The teacher poses the warm-up problem and facilitates questions. There is no direct teaching here. (2) Students are reflecting and working on the proposed problem with a partner, group, or individually where applicable and are invited to share their strategies. (2) *Rationale: This informs how teachers and students engage in the lesson to inform PL about LED. This will also inform how to support teachers with the Launch by revising the lesson plan and/or the slide decks.*	☐ (4) All observed ☐ (3) Some observed ☐ (2) Few observed ☐ (1) One observed ☐ (N/A) Did not see this part of the lesson	
Explore: The teacher is facilitating the Explore section by asking questions and monitoring progress and not directly modeling the problems. (2) Students persevere in solving problems in the face of difficulty by working with partners or groups. (1) Use of materials is present (student tasks docs, playlists, and manipulatives).(1)	☐ (4) All observed ☐ (3) Some observed ☐ (2) Few observed ☐ (1) One observed ☐ (N/A) Did not see this part of the lesson	

Appendix D

Prototyping Example

Below is an example of a section of the Unit Plan I designed to present to teachers for feedback. This prototype was in response to having the standards of the lesson alongside with the assessment opportunities.

Check for Understandings/Exit Tickets	Include language about lesson level formative exit tickets.
Cluster Level Assessments	OA Cluster Level Assessment NBT Cluster Level Assessment NF Cluster Level Assessment
End of - Course Assessment	Include language about what is included in the ECA (# of questions and how much time should e allotted to administering it).

Pre- Course Assessment			
Playlist	**Content Standards**	**Vocabulary**	**Assessment**
Lesson 1	CC.3.OA.1 CC.3.OA.2 CC.3.OA.3	Equal Groups	**Formative Assessments:** • **Launch**: Check for student understanding of the context and the expectations for the task. • **Explore**: Check for students' understanding to select and apply strategies to create equal groups. Monitoring Chart • **Discuss:** Check for students' understanding to make connections between and among strategies and solutions. Exit Ticket
Lesson 2	CC.3.OA.1 CC.3.OA.2 CC.3.OA.3	Equal Groups	**Formative Assessments:** • **Launch**: Check for student understanding of the context and the expectations for the task. • **Explore**: Check for students' understanding to select and apply strategies to create equal groups. Monitoring Chart • **Discuss:** Check for students' understanding to make connections between and among strategies and solutions. Exit Ticket
Lesson 3	CC.3.OA.1	Equal Groups	**Formative Assessments:**