Journal of Educational Leadership and Policy Studies

Southern Connecticut State University

ISSN#: 2473-2826

Tensions and Alignment between Simultaneous Implementations of an Ambitious Mathematics Program and Understanding by Design

[1]Jeffrey Choppin

[2]Christine Green

Abstract

We studied a case of a school in a high need setting that undertook multiple simultaneous initiatives during a major school reorganization. We focused on the simultaneous implementations of two comprehensive initiatives, one related to ambitious mathematics teaching and one related to the Understanding by Design curriculum writing process. We explored the extent to which educators in a mathematics department saw these initiatives as aligned or in tension. The results show that simultaneous ambitious initiatives may ultimately be mutually reinforcing, especially if grounded in common principles. We also found that initial tensions existed and diminished both initiatives at the outset

Keywords: *Educational reform; Policy implementation; Understanding by Design;*

---

[1]**Jeffrey Choppin**, PhD, Professor of Mathematics Education, Warner Graduate School of Education, Teaching and Curriculum
University of Rochester, Rochester, NY, USA
Email: jchoppin@warner.rochester.edu
[2]**Christine Green**, PhD, Assistant Professor of Education, School of Education, Reading and Literacy Department
State University of New York at Geneseo, Geneseo, NY, US
Email: greench@geneseo.edu

Recommended Citation: *Choppin, J., Green, C. (2024). Tensions and Alignment between Simultaneous Implementations of an Ambitious Mathematics Program and Understanding by Design, Journal of Educational Leadership and Policy Studies, 8(2)*

Journal of Educational Leadership and Policy Studies

ISSN#: 2473-2826

Tensions and Alignment between Simultaneous Implementations of an Ambitious Mathematics Program and Understanding by Design

Educational initiatives are not implemented in isolation. Often, schools simultaneously implement multiple initiatives that involve different agendas and theories of action (Farrell et al, 2019; McLure, & Aldridge, 2022), complicating decisions for those in charge of interpreting and implementing them (Honig, 2006; Honig & Hatch, 2004). The literature on education reform recognizes the potential for teachers to feel overwhelmed by the many roles and initiatives places upon them (Lomba-Portela et al. 2022; Reeves, 2006), when initiatives are fragmented and compete for time and resources (Cohen et al., 2018; McLure, & Aldridge, 2022). This is particularly prevalent in high-poverty urban contexts, in which schools often find themselves implementing multiple and fragmented initiatives (Berends et al., 2002).

We studied a case of a school in a high need setting that undertook multiple simultaneous initiatives during a school reorganization effort that was initiated at the behest of state and local educational entities. The school had been threatened with closure due to poor performance on high stakes assessments and other metrics, leading to the formation of an Educational Partnership Organization [EPO] tasked with improving the school (Larson & Nelms, 2021). We focused on the simultaneous implementation of two comprehensive initiatives, one related to what mathematics educators call *ambitious mathematics teaching* (AMT) (cf., Lampert et al., 2010) and one related to a process of curriculum design termed *Understanding by Design* (UbD) (Wiggins & McTighe, 2005) that involves an extensive articulation of curriculum goals, assessments, and instructional plans. Both initiatives were championed by external consultants hired to support the overhaul of the school's curriculum. Though the initiatives were consistent with the overall thrust of the school reform, their simultaneous implementation had the potential to create tensions for those responsible for implementing them. This context provided an opportunity to explore how well-intentioned efforts potentially interfere with each other and to identify conditions in which they mutually reinforce each other.

The study was situated in a school that over a seven-year period devoted substantial time and resources to the implementations of both AMT and UbD. The development of the mathematics program was led by a group of mathematics educators who were given the authority to implement research-based practices and curriculum programs, while the UbD process was led by an external consultant with extensive experience implementing UbD in other local districts. We were curious about the extent to which educators at the EPO saw these initiatives as aligned or in tension with each other, which led to the following research questions:

1. What tensions did educators identify regarding the simultaneous implementations of AMT and UbD?
2. What areas of alignment did educators identify regarding the simultaneous implementations of AMT and UbD?

Below, we describe in more detail the context in which the study was situated, review the literature on AMT and UbD, and then provide an overview of the AMT and UbD implementations at the research site.

John Lewis School and the Educational Partnership Organization

The John Lewis School (a pseudonym, as are all names) was reconstituted in 2014 as part of an Educational Partnership Organization [EPO] that was formed at the request of the Fullerton City School District Board of Education and the State of New York. The State of New York, in conjunction with the Fullerton School Board, asked the University of Landover to submit a plan to become the EPO because the state was threatening to close the school due to poor performance on standardized tests and other measures. The EPO was developed as a collaborative multi-year process between the University of Landover, the Fullerton City School District Board of Education, the local community, collective bargaining units, and the State Department of Education (Larson et al., 2021). As part of the crafting of the EPO:

> [a] leadership team of university faculty and school administrators met with community agencies, [Fullerton's] mayor, parents, community members, teachers, administrators, and students. More than 2,000 stakeholders over the course of 6 months provided extensive input, including from approximately 1,200 students across Grades 7 through 12 at the school in September 2014. (Larson et al, 2021, p. 179)

The goal of the EPO was "to transform the educational infrastructure and culture of underachievement of this school with an explicit focus on equity" (Larson et al, 2021, p. 179) that resulted in multiple comprehensive reforms, including those pertaining to the mathematics program. We note that despite the wide latitude given the EPO in designing the curriculum and student experiences, the EPO was held accountable to state level examinations and other metrics as a condition of the renewal of the EPO.

Journal of Educational Leadership and Policy Studies
Southern Connecticut State University
ISSN#: 2473-2826

When the EPO began, there was pervasive academic failure and graduation rates were below 30%. Demographically, both prior to the EPO and throughout the seven years that preceded this study, over 90% of the students qualified for free-and-reduced lunch. The school served high numbers of students labeled as Limited English Proficient (15%) and Students with Disabilities (14%). Over 80% of the students identified as Black or Latinx. Furthermore, the John Lewis School is located in a city that ranks number one in child poverty and number one in concentrated poverty in the United States for similar sized cities (Doherty, 2015).

Ambitious Mathematics Teaching

Ambitious mathematics teaching is a constellation of practices whose purpose is to engage students in mathematical activities that involve core mathematical ideas and that incorporate participation structures and pedagogy that position students as important and competent intellectual contributors (Choppin et al., 2024; Lampert et al., 2010; Singer-Gabella et al., 2016). The constellation of practices includes attending and responding to student thinking, developing student autonomy, recognizing student competence, and using complex tasks.

In conceptions of AMT, teachers attend and respond to student explanations to make student thinking public (Boston 2012; Franke et al., 2007). This helps teachers to understand the ways that students think about mathematics and what they find interesting about it (Anthony et al., 2015), insights that should inform subsequent instruction. An outcome of the focus on student thinking is the development of student autonomy. Providing students autonomy to approach mathematics entails recognition of their competencies, which is an *asset-based* perspective. An asset-based approach "is grounded in the belief that students', families', and communities' ways of knowing, including their language and culture, serve as intellectual resources and contribute greatly to the teaching and learning of high-quality mathematics" (NCTM Research Committee, 2018, p. 375). The use of complex tasks provides opportunities for teachers to elicit and build from student thinking. Ideally, these tasks provide opportunities for students to invent strategies and approaches that emerge from their intuitive and everyday ways of thinking and acting in the world (cf. Gravemeijer & Doorman, 1999; Moschkovich & Brenner, 2002). An integral theme of ambitious mathematics teaching is that it addresses multiple dimensions of equity (Zahner et al., 2021). The focus on equity conceptualizes teaching in terms of culturally responsive instruction, which we interpret as attending to the lived experiences of students, incorporating multiple modes of participation, and recognizing and building from students' social, linguistic, and cultural resources (cf. Moschkovich, 1999).

Understanding by Design

UbD is a three-stage process for developing curriculum units. In UbD, designers begin by focusing on the end goals and then work backward to develop instructional content (McTighe & Brown, 2020; Wiggins & McTighe, 2005). The initial focus is on identifying key understandings and essential questions, which are used to define the evidence and assessment used to evaluate the goals. These assessments then guide the creation of unit and lesson plans. Stage One focuses on identifying desired knowledge and competencies (McTighe & Brown, 2020). The primary task is to articulate the big ideas and essential questions, which are stated in terms of *transfer goals*, which articulate long term skills and knowledge (Wiggins & McTighe, 2005). The

Journal of Educational Leadership and Policy Studies
Southern Connecticut State University
ISSN#: 2473-2826

artifacts from this stage guide the development of the assessments and lesson plans in Stages Two and Three.

Stage Two focuses on generating assessments that serve as evidence of what students learn and are aligned to the transfer goals and essential questions from Stage One (McTighe & Brown, 2020). In these assessments, students are expected to demonstrate their understanding through performance and justifications (Wiggins & McTighe, 2005). The assessments inform the content of lesson plans developed in Stage Three. Stage Three focuses on designing activities, experiences, and learning tasks that align to the goals in Stage One and assessments in Stage Two (McTighe & Brown, 2020).

The literature on implementations of UbD is sparse. Much of the literature consists of descriptions of the design process (cf. McTighe & Brown, 2020; Sumrall & Sumrall, 2018; Wiggins & McTighe, 2005), the extent to which the UbD process was followed in a given context (Pradhan Joshi, 2021), or the impact of the use of UbD on student learning (Gloria et al., 2019). This literature provides little detail of how UbD was taken up or implemented; furthermore, there is scant literature on implementations of UbD using a school as the unit of analysis. A notable exception is another study that took place at the John Lewis School that focused on the literacy program (Larson et al., 2021). Larson et al. describe how the teachers at John Lewis revised all aspects of the literacy curriculum over a 5-year period following the principles of UbD. The literacy curriculum "addressed the school's mission, the UbD unit and lesson writing requirements, and students' interests and needs" (p. 189). The study showed that following the UbD planning process did not deter the teachers from adhering to the core mission established by the EPO, a phenomenon we explore below with respect to the mathematics department. Below, we describe the conceptions and initial implementations of AMT and UbD at the EPO in order to show how these initiatives emerged from the principles of the EPO.

Development of the Mathematics Program

The mathematics department, with the support of external consultants, aimed to develop equitable and rigorous learning opportunities for students. The external consultants assisted with identifying curriculum materials that differed substantially from the materials used prior to the EPO because the school had a dismal history of student achievement in mathematics and was tasked to do something different. The curriculum programs they adopted were aligned with the EPO's core principles, as described below, and supported by research. Prior to the COVID-induced disruptions, the John Lewis School had seen considerable increases on NYS assessments, including on the Algebra I Regents exam, Geometry Regents exam, and Algebra II Regents examinations. Below, we provide a brief overview of the foundations of the program and the curriculum materials adopted by the mathematics department.

Guiding Principles of the Mathematics Program and the EPO

To understand the tenets that guided the development of the mathematics program and selection of curriculum programs, we interviewed the chief academic officer, the lower and upper school administrators, teacher leaders, and the external consultants who were involved in developing and supporting the mathematics program. These personnel described the criteria used to identify curriculum materials that aligned with the principles of the EPO. Two documents were frequently mentioned as exemplifying the principles of the EPO and that influenced the selection of the curriculum materials, the *Learning Principles* and the *Curriculum Evaluation Chart*. There were nine learning principles that applied to all content areas (see Figure 1).

Figure 1

Learning Principles of the EPO

Learning Principles:

Autonomy Supportiveness:

1. Successful learning requires metacognition: learning how to reflect, self-assess, and use feedback to self adjust. These metacognitive processes can (and should) be taught explicitly.
2. Learning is most effective when differences in learners' prior knowledge, interests and strengths are accommodated.

Relatedness to Self and Others:

3. Learning is most effective when built on individual students' prior knowledge and experiences.
4. Learning is most effective when students are engaged in authentic inquiry.
5. Learning is most effective in a classroom-based community of learners.
6. Learning is most effective when instruction is linked to core concepts in order to focus on and nurture connection-making
7. Students must have regular opportunities to see the value of what they are asked to learn, how it relates to past learning and how it will relate to future learning.
8. As a model learning community, a school appropriately requires learning from every member of its community, since continual learning is vital for instructional as well as personal success.
9. Learning is social.

The Learning Principles emphasized rigor, potential for student engagement and student agency, cultural relevance, participation in a democracy, and thinking skills. These principles informed the development of the Curriculum Evaluation Form [CEF], which in turn was used to select curriculum programs. EPO personnel described the role of these documents when developing the mathematics program. Bassett, an external consultant who assisted in selecting the curriculum materials and providing professional development, stated that:

> [The Learning Principles were] very helpful … whenever we would have difficulties with conveying what we were hoping we would see in classrooms, we could return to that document [and say] 'this is what we're talking about when we're talking about instructional moves' … That document was key.

Deprez, an external consultant who supported the Upper School teachers, stated that "I would say all of those learning principles pretty strongly support [the materials selected for the EPO], there's direct alignment." Marshall, who was on the committees charged with selecting curriculum materials and hiring mathematics teachers, stated, "we grounded all of our hiring documents and curriculum review documents on those learning principles … which are grounded in research." She described how they used the learning principles "to create the curriculum review document [CEF], to see which aspects of the learning principles were held up by different curricular materials." In terms of which programs aligned with the principles, Marshall stated "once you laid the curriculum next to the learning principles it was relatively obvious which curricular materials matched. Connected Math turned out to be the most aligned to the learning principles [at the Lower School], then Meaningful Math at the Upper School." Friske, an external consultant who was on the committee that selected the mathematics curriculum programs, described the programs the EPO selected as "research based and [supported] student engagement, student processing, student discussion and interaction with other people."

Lester, the external consultant in charge of implementing UbD, explained the broad attributes the EPO was looking for in curriculum programs, stating that the selected programs had "an inquiry-based approach to doing math and getting students to be the ones who are doing the thinking and making the connections." She further explained the curricular philosophy at the EPO:

> [It's] connected to equity issues, issues of equity and access. The more we limit mathematics to one way of doing something and that you're not necessarily thinking about it but you're expected to regurgitate things, mathematics as we know is used as a gatekeeper. As opposed to supporting kids in robust thinking, bringing in their experiences and opinions and ways of thinking and ways of doing, again, to support equity issues, access issues.

These quotes demonstrate that key personnel attended to the Learning Principles and CEF when developing the mathematics program, including hiring teachers, selecting curriculum materials, and supporting teachers to implement the program.

Curriculum Materials Adopted by the EPO

The Lower School adopted Connected Mathematics Program 3 (CMP3) (Lappan et al., 2014) and the Upper School initially adopted Meaningful Math (Fendel et al., 2014) and then CORE Plus (Hirsch et at., 2015). Prior analyses of these materials show that they present tasks that elicit students' thinking around an idea and do not initially model an approach to solve the task (Choppin et al., 2022); these characteristics provide opportunities for productive struggle.

Furthermore, the materials emphasize connections between topics and between multiple representations in ways that conventional materials do not (Author & Colleagues, 2022). These characteristics provide opportunities for students to develop autonomy and demonstrate a range of competencies rather than more narrow forms of competencies favored in more conventional curriculum programs. The teacher resources in both programs emphasize the need to have students collaborate on problems and publicly share their thinking.

Alignment to AMT

The mathematics department drew from documents that expressed perspectives aligned with AMT, such as emphasizing student engagement, student agency, and cultural relevance. The participants also expressed that the mathematics programs explicitly focused on issues of equity and access, most prominently through broadened forms of participation.

The UbD Process in the Mathematics Department

The EPO relied on the UbD framework to provide a common process for developing curriculum across content areas and grade levels at the John Lewis School. There were two key differences with how the UbD process was carried out in the mathematics department relative to other content areas. First, there was support from a group of external consultants who assisted the mathematics department. Second, the mathematics department, in conjunction with the external consultants, adopted existing curriculum materials to implement at John Lewis. The curriculum materials provided an established scope and sequence of content, with accompanying student materials and teacher resources. This was not the case in other content areas and contrasted with the backwards design process associated with UbD.

We identified four phases in the UbD implementation in the mathematics department, which we corroborated via member checking. These phases were relatively consistent across different planning teams in the mathematics department. Furthermore, these phases were partly a function of adapting the curriculum design process to the contingencies of COVID.

Phase One: 2015-2019

Phase One of the UbD process at the John Lewis school focused on the development of the transfer goals and essential questions as part of the first stage of UbD. Furthermore, these transfer goals and essential questions needed to be aligned with the principles of the EPO. To ensure this alignment and to support the UbD process, the EPO provided professional development on the UbD process during this phase. Phase One was primarily carried out by the Professional Learning Committee, whose charge was to develop a “viable curriculum” (PLC Agenda, 9/21/2015); this committee was supported by several external consultants from the University of Landover, who provided professional development during the summers and throughout the school year. Other members of the committee included administrators and teachers. Deprez, a consultant from the University of Landover, described the importance of the transfer goals created during this phase, seen in Figure 2:

> This is what we felt like was most important for teachers … this idea that we're working towards scholars having the ability to provide specific mathematical evidence, explain

their thinking and writing at the appropriate level. That's something that we're trying to get teachers to consider. Everything you're doing, how is it attending toward that goal? These are the transfer goals in the Stage One of the UBD; this is why we're engaging in the mathematics, to be able to do these things.

Figure 2

The Mathematics Department's Strategic and Transfer Goals

Department Strategic Goal:
Scholars will demonstrate the ability to provide specific mathematical evidence and explain their thinking, in writing, on tasks that assess grade level standards with appropriate sophistication for the grade and content level.

Transfer Goals:
1. Think purposefully using mathematical reasoning to analyze and model new problem situations.
2. Make sense of and be tenacious in solving real world problems, seeking out and using appropriate tools and resources.
3. Communicate mathematical ideas clearly by constructing viable arguments, critiquing the reasoning of others, and using precise mathematical language.

The transfer goals were then incorporated into the Understanding by Design template used for the development of unit plans and lesson plans for the mathematics department.

Phase Two: 2019-2020

In Phase Two, the responsibility for writing the UbD units shifted from the external consultants to teachers and teacher leaders in the mathematics departments, though the external consultants continued to provide support. During the summer of 2019, the mathematics department engaged in curriculum writing sessions that focused on writing assessments and lesson plans, Stages Two and Three of the UbD process. Stage Two work in this phase included developing performance assessments that were characterized as "complex tasks requiring higher level thinking demands that are part of transfer and meaning making" expressed in Stage One (EPO Curriculum Unit Checklist). An example of higher level thinking demands includes the need for students to explain and justify thinking verbally and in writing, practices that were listed in the unit plans developed in this phase. For example, the evaluative criteria for a unit in Algebra included *making a claim and supporting it with appropriate justification and details*.

The Stage Three work in this phase focused on developing a plan for each unit that integrated the criteria from the Lesson Plan Quality Checklist and the Learning Target Checklist. In the Unit Planning Template, the document included a prompt for writers to consider "Does the learning plan reflect [John Lewis's] vision for learning?" The inclusion of these prompts and references to documents supported teachers with aligning the curriculum writing to the mission and vision of the school.

Phase Three: 2020-2021

Given the move to remote instruction in March 2020, the focus of unit writing in spring and fall of 2020 shifted to the development of digitally enriched units. The EPO provided teachers additional time for professional development and curriculum writing. The outcomes of this phase were more instructional units that incorporated activities and assessments designed for online learning environments. A result from Phase Three was the completion of more detailed unit plans and the addition of digitally enriched activities.

Journal of Educational Leadership and Policy Studies

ISSN#: 2473-2826

Phase Four: 2022 - current

In the fall of 2021, the John Lewis School returned to fully in-person instruction. This phase has been characterized by increased teacher participation in the UbD process and increased detail in the unit and lesson plans. Much of the writing occurred in the summer of 2022, supported by external consultants and teacher leaders, and continued into the 2022-2023 school year. In this phase, the teachers were primarily responsible for updating and revising the curriculum, with ongoing support from the teacher leaders and external consultants. Deprez explained how the work after the COVID disruptions has built from the lesson designed during remote instruction, saying "the [teachers] are at a point now where they're trying to figure out what was really powerful that we want to keep." Since the return to in-person instruction, Deprez explained that teachers "have been continually updating and revising it each year with a new lens…. During COVID it was… culturally responsive pedagogy, and this year [it's] complexity and authenticity of tasks."

Tensions and Alignment Related to Simultaneous Implementations

Our framework focuses on the ways in which educators respond to the demands of implementing multiple simultaneous initiatives. We characterize their responses in terms of *tensions* and *alignment*. We see tensions in terms of the extent to which internal and external demands compete for time, attention, and resources. By contrast, we see alignment as the extent to which multiple initiatives involve overlapping or synergistic practices and perspectives. These are explained in more detail below.

Tensions

Tensions arise when the demands of one initiative require commitments of time, attention, and resources in ways that are *in competition with* the demands of other initiatives. Tensions at various organizational levels impact the ways in which resources are identified, allocated, and ultimately taken up in classrooms. A consequence of the potential conflicts between initiatives is that stakeholders at different levels of school organizations may have different perceptions and commitments related to any single initiative. Balancing multiple initiatives can reduce the attention to and effectiveness of any one initiative (Fullan & Quinn, 2015) and can lead to *initiative fatigue* (Reeves, 2006); each new initiative begins with a high level of energy but as initiatives are added, sustained focus on any one is limited. The limited commitment to any specific initiative reduces the efficacy of its implementation (Nolan, 2018).

Alignment

Alignment refers to the extent to which two initiatives involve similar sets of perspectives and practices. If the practices and perspectives are complementary, then work on one initiative reinforces or supports the work on the other initiative. Perspectives include the ways in which initiatives are communicated within an organization. Coburn and Russell (2008) discuss the notion of *congruence* with respect to the ways that internal communication supports alignment between initiatives. They note that incongruent messages - which reflect competing initiatives or policies - may position initiatives as competing efforts. Conversely, they point out that *congruent* messages support alignment by articulating commonalities between goals. Thus, alignment of organizational perspectives supports successful implementations of ambitious initiatives.

Methods

Below, we explain how our data collection and analysis explored the UbD process. We then provide a list of participants and their roles.

Data Collection

We conducted 35 interviews with a total of 22 teachers, teacher leaders, administrators, and external consultants. The interviews were focused on how the mathematics program was developed, what principles informed its development, how the program was implemented in its first five years, and the resources that had been allocated to support the mathematics program. The interview protocols did not explicitly reference UbD; therefore, all mentions of UbD occurred organically through the data collection process and emerged as a focus after the completion of the interviews. The exception was the interview with Lester, who was the external consultant in charge of the implementation of UbD. We note that most of the interviews focused on retrospective accounts of the development and nature of the mathematics program because the interviews occurred after the onset of the COVID pandemic, which led to an abrupt shift to remote instruction that lasted from March 2020 to March 2021. The school did not return to fully online instruction until September 2021.

Data Analysis

The project research team used a data reduction process following Saldaña's (2016) theming method to develop memos, collective memos, and themes. The first author divided the transcripts into over 1000 passages whose lengths varied from 50 to 250 words, and then placed each passage into categories (e.g., implementation, instructional philosophy). To reduce the data, three researchers created one or more memo(s) for each passage, which were reconciled into collective memos. The memos were intended to be low-inference and parsimonious paraphrases of the original passages. These memos were then queried using the keywords UbD and Understanding by Design. We then expanded the search to more broadly encompass mentions of curriculum writing in the memos, regardless of whether UbD was explicitly mentioned. We then returned to the original interviews to gain a broader understanding of the context in which UbD was mentioned. The interviews focused on the initial years of the EPO, which correspond to Phase One of the UbD process described above.

In addition to the original interviews, we conducted three member-checking interviews in 2023 as we retrospectively reconstructed the UbD process. The interviews, which involved Franklin, Owens, Matthews, focused on all phases of the UbD process, and thus added extra insights into how UbD developed over seven years rather than just the first couple of years when both UbD and AMT were being established.

To operationalize tensions evident in the quotes, we searched for instances when participants described when: UbD efforts were parallel to the development of the mathematics program; UbD efforts detracted from goals of the mathematics program; and UbD duplicated other curriculum development efforts in the mathematics department. To operationalize alignment in the quotes, we searched for instances when participants mentioned the benefits of engaging in the UbD process and connections between the UbD process and the guiding principles of the mathematics program.

Journal of Educational Leadership and Policy Studies
ISSN#: 2473-2826

Participants

There were 12 participants who discussed the UbD process in their interviews. In Table 1, we provide the pseudonyms of each participant and their roles related to AMT and UbD.

Table 1

Participants and their Roles

Pseudonym	Role
Alder	Teacher leader at the Upper School during the first years of the EPO
Deprez	External consultant who supported the Upper School mathematics department
Farrell	Upper School principal
Franklin	Teacher leader at the Lower School
Fuller	External consultant who supported the Lower School mathematics department
Lester	External consultant in charge of the UbD implementation

Journal of Educational Leadership and Policy Studies
ISSN#: 2473-2826

Matthews	Teacher leader at the Upper School who succeeded Alder; previously a mathematics teacher at the Upper School
Milbourne	Chief Academic Officer who started five years after the EPO began
Marshall	External consultant who supported Deprez and Fuller and who was responsible for guiding the curriculum selection process
Owens	Teacher leader at the Upper School who succeeded Matthews; previously a mathematics teacher at the Upper School
Ransom	Lower School principal
Tewilliger	Upper School mathematics teacher

Results

We organize the results by tensions and alignment between the initiatives, as embodied in our research questions: What tensions did educators identify regarding the simultaneous implementations of AMT and UbD? What areas of alignment did educators identify regarding the simultaneous implementations of AMT and UbD?

Tensions between Implementations of AMT and UbD

Journal of Educational Leadership and Policy Studies
Southern Connecticut State University
ISSN#: 2473-2826

The data indicated four areas of tension. These tensions included: the UbD process competed with efforts to support teachers to understand the adopted curriculum materials; there were redundant efforts between the two initiatives around curriculum building; UbD and AMT involved competing articulations of content; and other initiatives strained attention and resources already stressed by the simultaneous implementations of UbD and AMT.

The UbD Process Competed with Efforts to Support Teachers to Understand the Adopted Curriculum Materials

The tension between the UbD process and supporting the development of teachers' understanding of the adopted curriculum materials was expressed by two different groups of external consultants who advocated for different priorities. Lester, the external consultant charged with implementing UbD, explained that:

> The [other external consultants] were focused on teaching the teachers the pedagogical practices and the theory behind … the inquiry-based math program. [So] that when [the teachers] interacted with their curriculum, they would have an understanding of what actually was behind it.

Marshall, an external consultant from the University of Landover overseeing the implementation of the adopted curriculum materials, explained how the focus on UbD detracted from helping teachers understand how students would engage with the mathematics represented in the curriculum materials:

> One of the things that we have believed from the beginning is that … while we had curriculum materials that were supportive of [the EPO] learning principles, we felt that the focus from administration … was on the teaching and not on the learning. We have always felt like there was a missed opportunity at the launch of John Lewis School to spend the first year not talking about teaching, not talking about necessarily even [UbD].

Deprez, an external consultant charged with supporting teachers to understand the curriculum materials, explained that teachers needed to first understand the adopted curriculum materials before engaging in an intensive curriculum writing process. She stated that "there was a feeling… that teachers hadn't really internalized and made sense of the curriculum in a deep enough way to be able to identify big understandings and essential questions."

Though the tension at the beginning of the EPO between simultaneous implementations of UbD and AMT did not go away, there were compromises that eased the pressure on teachers. One of the compromises was to have external consultants, including Deprez, initially take charge of the UbD process so that the teachers could focus on understanding the adopted curriculum materials. Alder, a teacher leader at the Upper School, explained the additional support from the external consultants to manage the tension between UbD and AMT:

> We definitely needed more support in terms of external support from the consultants, coaching, planning, and all those things because we were writing the curriculum at that time, writing UbDs, but we're also implementing the curriculum at the same time.

Journal of Educational Leadership and Policy Studies
Southern Connecticut State University
ISSN#: 2473-2826

The tension between UdB and AMT were most prevalent in the first few years of the EPO, as expressed in the quotes above. The tension was expressed primarily in terms of what needed to be prioritized at the outset of the EPO.

There were Redundant Efforts between the Two Initiatives around Curriculum Building

A second related tension was that the UbD process was seen as redundant given that the adopted materials were already structured into units and lessons, artifacts that overlapped with the intended outcomes of the UbD process. Consequently, mathematics educators were being tasked with taking existing versions of lessons and units and translating them into the UbD templates required by the school for unit and lesson planning. Franklin, a teacher leader, stated "it has really come to taking the curriculum that we chose and fitting it into [the UbD model] that the rest of John Lewis School is working with." Ransom, the Lower School principal, explained the translation process, saying that the teachers "are rewriting or adapting the units in the UbD model…they've got the teachers guides out, they've got the online format of that, so they have them right next to as they're writing."

Deprez explained that having teachers engaged in the UbD process was not productive because teachers had not yet developed a deep understanding of the design of the adopted materials, stating that asking teachers to articulate essential understandings would be equivalent to having them engage in "a guessing game." She explained:

> I think some people are in a place where they're filling in boxes. They've been told they have to write this curriculum to share across John Lewis School, and so they fill in the

> boxes...I think part of it is the rush to create it makes people feel like they don't have time to really be thoughtful and to internalize all of that.

A result of this critique was that consultants from the University of Landover were charged with completing the early UbD stages. Deprez described the process as unpacking the adopted materials, stating “we weren't writing the curriculum, we were unpacking the curriculum and talking about it and writing about it using the principles of UbD**.”** A teacher at the Upper School, Terwilliger similarly described the process, “they really just took the understandings and the standards from Core-Plus and put it in there.”

Owens described how having existing materials constrained the intended purpose of the UbD process, stating:

> The principles behind the backward design idea is that you start with what you want students to be able to accomplish at the end. … starting with your end goal and then deciding how you want to assess it and then coming up with the learning experiences that will get you there. [That] wasn't really the way it ended up working because we had curricular resources that were already given to us in the start.

The redundancy articulated by the participants had two effects. First, the initial efforts at writing curriculum using UbD formats resembled acts of compliance rather than learning. Second, it subverted the UbD process since lessons and units already existed in the adopted materials.

UbD and AMT involved Competing Articulations of Content

Journal of Educational Leadership and Policy Studies
Southern Connecticut State University
ISSN#: 2473-2826

A third tension was expressed in terms of competing articulations of mathematical content, as described by Lester. The UbD process was largely driven by the content of the state mathematics curriculum framework. Lester explained that the UbD performance assessments were intended to be aligned with the state assessments, stating:

> I think the focus of the work in the UBD process became more about the content and skills that were the prioritized content and skills aligned to those tests. A lot of work was done to ensure that the alignment within the unit of study was on the content and skills and that the learning that was done, and the assessments that were included in the learning sequence were focused on those contents and skills that were heavily tested on the Regents test.

Lester stated that this alignment was necessary because the mandated mathematics curriculum "is so packed with content and skills that need to be taught according to the New York State Standards." Lester noted a tension between covering this packed curriculum and the inquiry based approach in the materials, asking if it was "worth the time that it takes [to teach topics]" using an inquiry approach. Lester noted that this tension was ongoing, stating that:

> I think there was [initial] resistance maybe to using the outside consultants, to support the work because clearly the outside consultants were all about inquiry. I think that, that point in time there was some negotiation between, yes, we are looking at the content and skills necessary for the Regents, but we also are interested in the inquiry-based piece of this because we know that it supports deeper learning.

Other Initiatives Strained Limited Attention and Resources

The tensions between UbD and AMT were exacerbated by the presence of other initiatives that required attention. Ransom, the lower school principal, described a long list of initiatives that took place over the first five years of the EPO:

> We've provided training on [UbD], which is the way we write curriculum. We've provided training on Managing the Active Classroom. It's kind of crazy, the amount of things we've done. Deliberate Practice, which is the way we teach the lessons. We did a whole year on Learning Targets, and then we did a whole year on Feedback. Let's see, and this year specifically we've done professional learning on Digital Instruction. We've done professional learning specific to the math program, Launch-Explore-Summary; Desmos, which is the tech program that my teachers are using to deliver. Oh, trauma-informed instruction. The [mathematics department] is doing a book circle right now on Mathematics and your Identity.

The presence of multiple initiatives detracted from focusing on core aspects of instruction. Marshall, an external consultant, stated:

> I mean there was so much going on. We often talk about how there was too much emphasis on what to do as opposed to how does learning take place. That if that had grounded teachers' experiences at the beginning of the John Lewis School partnership, it would've made the then shift to instructional practices much more smoothly. We would've gotten a lot more bang for our buck. We almost felt like there were too many

> initiatives too early focused on the not necessarily the right thing. We've paid the price of that ongoing.

Marshall reiterated "I'm not convinced that [having so many initiatives] was the right place to start, which, again, I think has implications all the way down." Fuller, the external consultant in charge of supporting the Lower School mathematics department, discussed the tension that implementing multiple initiatives caused:

> These are all things we've been trying to work on, which has a tension between sometimes there's been a lot of initiatives school-wide that have been trying to be pushed in as well. It's trying to find ways that either—how this math program connects to some of those school initiatives or is it worth adding one more thing on?

Fuller also noted that the mathematics department was buffered from some of these initiatives:

> We have been given a lot of grace in the last six years to say, "You know what? You have a really strong curriculum, and right now, the math department's going to work on that curriculum," versus this [other] initiative. I would say that's been a real positive that the administrators at John Lewis have seen that as a priority and allowed us that grace to say, "Okay. Yep. You need to focus on this curriculum and implementing this curriculum with integrity," versus reading strategies in math class or whatever it might be.

In sum, the presence of other initiatives diminished the focus on core instructional processes, which exacerbated the existing tensions resulting from trying to implement UdB while simultaneously helping teachers to understand the features of the adopted curriculum materials.

Summary of Tensions between UdD and the Mathematics Program

The external consultants in charge of supporting the mathematics program explained that the UbD process detracted from their efforts to support teachers to understand the curriculum materials and that it was not productive to ask teachers to write curriculum units before they understand the materials. The participants expressed that writing curriculum units was redundant because there was already an existing scope and sequence expressed in the adopted materials. Exacerbating the limitations on resources and attention was the presence of other school wide initiatives, though there was some buffering with respect to the mathematics department. Though tensions existed between the dual efforts of UdB and implementing the adopted materials, there were ways in which the UbD process complemented the efforts to support teachers to understand the curriculum, as explored below.

Alignment

Alignment refers to the ways in which the UbD process complemented the efforts to develop teachers' understanding of the adopted curriculum materials. We noted two ways in which participants described this alignment. First, they described how the UbD process supported the development of a collaborative culture in the mathematics department. Second, they described how the UbD process supported the development of teachers' mathematical and pedagogical knowledge.

The UbD Process Supported Collaboration in the Mathematics Department

Several participants explained how the UbD process increased collaboration in the mathematics department because the department members were required to collectively design the curriculum. Alder, an Upper School teacher leader, noted the collaborative nature of the curriculum writing sessions, saying "as we started drafting [the UbD units of study] …. it was a collaborative effort, I feel like everybody was joining in to draft things, what the curriculum would look like, what the learning experiences would look like." Matthews, a teacher leader, similarly described the collaborative work that took place during the year as the teachers mapped the learning goals to their lessons:

> We're lucky enough at John Lewis to have collaborative planning time built into our schedule. I think that's absolutely essential in this kind of—with this kind of curriculum, that you need to have other people that you can think through the problems with and think through the learning goals with and think about the questions you're going to ask and think about the places kids are going to struggle.

Lester described the UbD process as a "bonding experience," resonating with Alder's explanation of how UbD helped to reduce the typically isolated nature of teaching:

> It was a big shift coming from other schools in the district into John Lewis School with a new curriculum, new expectations, and then drafting these documents together. A lot of times, we work in silos. Now, for all the silos to come together and come together and write their own narrative, their own story together [involved] … different identities, different individualities, different experiences.

Journal of Educational Leadership and Policy Studies
Southern Connecticut State University
ISSN#: 2473-2826

Deprez explained how curriculum writing forced people together who may not have shared similar perspectives:

> In some ways it has almost forced, in some ways authentic and in some cases very surface level, shared vision and shared goals in the department. There are some teachers who maybe don't believe in it, but they know they have to believe in it to be at the John Lewis School and so they are at the very least willing to go through the motions.

In sum, the participants described the ways in which the UbD process provided an opportunity for the mathematics department to focus collectively on a common process, which they indicated contributed to a collaborative culture.

The UbD Process Supported the Development of Teachers' Mathematical and Pedagogical Knowledge

Several participants described how the UbD process developed teachers' understanding of mathematics, of pedagogy, and of the instructional vision for the program due to the rigor and comprehensiveness of the process. Deprez and Lester described how the UbD process helped teachers to internalize the mathematics curriculum. Lester said "using a backwards design process as a lens to unpack a unit of study … or to write a unit of study would be beneficial to the teachers who were interacting with that particular unit of study." She added that the UbD process has "been really beneficial in bolstering teachers' conceptual understanding of math" because the UBD process involves "talking about the relationship between … content and the bigger concepts, and creating that hierarchy." Deprez similarly explained that teachers who engaged with the UbD process developed a deep understanding of the curriculum:

> There are some people who have really internalized the principles behind it, that the idea is that we need to have a vision of where we're going with kids and what that learning looks like, and then we can create experience to get us there.

Matthews saw UbD as a way to focus on preparing for questioning and supportive engagement with students to foster inquiry and reach unit goals. He stated:

> Our curriculum work with Understanding by Design, in terms of developing the dispositions and thinking about focusing on the goals of the lesson first and being very clear about your purpose. That way, every time you're trying to think of what questions you're going to ask kids or what responses you're looking for from kids, if you're not clear about where you want kids to wind up from the get-go, you're going to really struggle to figure out which of those responses are valuable and which questions you want to ask that work with backwards design.

Summary of Alignment

Participants explained how the UbD process supported the work of the mathematics department in several ways. They noted that the UbD process required that teachers collaborate in ways that otherwise would not have happened; this led to increased cohesiveness in the shared vision of the program. Several participants also explained how the UbD process supported the growth of teachers' content knowledge and their knowledge of the mathematics program. By focusing teachers on the purposes of the curriculum and associated instructional practices, the UbD process helped teachers to see important connections between their daily plans and the program's overarching goals.

Discussion

We set out to understand how the implementation of two simultaneous and comprehensive initiatives created tensions for the educators involved in both. Our study diverged from other examples in the literature in that both initiatives were borne from the same set of overarching principles that were bound to a broader school transformation effort, one that has been nationally recognized in its scope and depth (Friedman, 2019; Larson & Nelms, 2021). A second divergence was the longitudinal nature of the UbD process, which allowed us to explore how the two initiatives meshed over time. Participants largely described the initial phases of implementation in terms of tensions, while their reflections in reference to the latter stages were largely in terms of alignment. A third way our study departs from the literature is the extensive description of the UbD implementation. Though the mathematics department adopted a set of curriculum materials that contained an existing scope and sequence as well as a defined instructional approach, the department ultimately persisted through the three UdD stages, producing an extensive set of transfer goals, assessments, unit plans, and almost 1000 lesson plans. Our findings provide insights for others who wish to embark on multiple simultaneous ambitious reforms, especially in conjunction with UbD.

The guiding principles of the EPO as evident in foundational documents emphasized rigor, potential for student engagement and student agency, cultural relevance, participation in a democracy, and thinking skills. These principles informed the adoption of the mathematics curriculum programs as well as the UbD process. Lester, the external consultant in charge of implementing UbD, described the curriculum goals of the EPO in ways that resonated with AMT, stating the goals are “connected to equity issues, issues of equity and access” by “supporting kids in robust thinking, bringing in their experiences and opinions and ways of thinking and ways of doing, again, to support equity issues, access issues.” The transfer goals developed in the UbD process were similarly aligned with the guiding principles of the EPO. Similarly, educators and external consultants described how the mathematics program derived from the guiding principles of the EPO. Thus, we see these two initiatives as emerging from the same set of guiding principles, principles that were aligned with our conceptualizations of AMT.

The literature on implementations of UbD has not documented cases in which the UbD process spanned multiple years. At our site, the UbD process began at the outset of the EPO in 2015 and was still the guiding framework for curriculum writing when our study began in 2020. We documented four temporal phases of the UbD process, with the last two orienting around the time frame associated with the disruptions from COVID. Our member-checking interviews provided insight into how the switch to remote instruction spurred an intensive process of generating or revising lesson plans using the UbD template.

Similarly, the literature on UbD has not included cases in which a school or district has produced an extensive set of curriculum artifacts using the UbD process. Though this study did not analyze these artifacts, the larger project in which this study is situated has collected a large set of lesson plans (almost 1000) as well as unit plans, assessments, and transfer goals associated with the UbD process. These artifacts provide validation of the thoroughness of the UbD process described by our participants, which has contributed in positive ways to the mathematics department, as we noted in the findings section. The participants described ways in which the UbD process contributed to the development of the mathematics department, stating that the UbD process increased collaboration and supported the development of teachers' mathematical and pedagogical knowledge.

Though the UbD process endured throughout the life of the EPO, we noted tensions involved when trying to implement it simultaneously with AMT. The mathematics educators reported three ways that the two initiatives were in tension with each other, two of which resulted from their simultaneous implementations that coincided with a broader reform effort. The external consultants charged with supporting the implementation of the adopted curriculum materials described how their efforts to help teachers develop a deep understanding of the materials competed with efforts to get the students to engage in Stage One of the UbD process. These consultants explained that the teachers did not initially possess enough familiarity with the materials to write the transfer goals required in Stage One and that doing so sidetracked their efforts to help the teachers understand curriculum materials that represented a substantive departure from what they had previously used at the school. Consequently, one of the external consultants stated that trying to implement both initiatives simultaneously represented a lost opportunity to focus the teachers on how students would learn from the curriculum materials.

Teachers and external consultants described the simultaneous initiatives as redundant, resulting in perceptions of UbD-related as compliance-oriented, in which they were merely checking boxes rather than meaningfully engaging in the work of curriculum writing. They explained that the curriculum materials already had a scope and sequence, and they did not agree with the need to produce a parallel set of artifacts. Adding to the sense of having too many demands at the outset of the EPO, the participants described how their work was further strained by a plethora of other initiatives that were taking place schoolwide.

Furthermore, the external consultant in charge of the UbD implementation explained that the adopted curriculum materials were at odds with the content assessed on the state test. She stated that an inquiry-based approach took a lot of instructional time, which would mean leaving out content that was going to be assessed on the state test. She explained that the UbD process was explicitly aligned with the state test content, whereas the inquiry based program was not.

Final Thoughts

The results of this study show that simultaneous ambitious initiatives may ultimately be mutually reinforcing, but perhaps should not be launched at the same time. The initial tensions felt by educators charged with implementing both initiatives show that there were costs to both initiatives at the outset. The external consultants noted that implementing UbD in the first years represented a missed opportunity in supporting teachers to understand how the materials could best be used to help students learn mathematics. Simultaneously, the external consultants also noted that teachers lacked the requisite understanding of the mathematics program to write the Stage One transfer goals. Over time, these tensions eased because the teachers had time to better understand the nature of the curriculum materials and how to use them to productively engage learners.

A second big take-away is that if two initiatives have a common grounding, they may ultimately be mutually reinforcing. Both initiatives were based on the same underlying principles; furthermore, these principles were strongly held by the educators at the John Lewis School, guiding all aspects of the transformation. Having a set of commonly held principles sets this context apart from those who experience more fragmented sets of initiatives and offers an important lesson for others attempting to transform schools.

In terms of implications for educational leadership, the study shows the importance of aligning different initiatives to ensure that efforts related to one initiative have payoffs for other initiatives. This is particularly the case when initiatives require sustained and intensive efforts and affect core instructional practices, as was the case with both AMT and UbD in this study. Another implication is the necessity to continue to provide resources and administrative support to sustain intensive reform initiatives. The mutual benefits of the AMT and UbD initiatives became evident only after many years of co-existing. The stability of these initiatives was essential to their success.

References

Anthony, G., Hunter, J., & Hunter, R. (2015). Supporting prospective teachers to notice students' mathematical thinking through rehearsal activities. *Mathematics Teacher Education and Development*, 17(2), 17-24.

Berends, M., Chun, J., Schuyler, G., Stockly, S., & Briggs, R. J. (2002). *Challenges of conflicting school reforms: Effects of New American Schools in a high-poverty district.*

Boston, M. (2012). Assessing instructional quality in mathematics. *Elementary School Journal*, 113, 76-104.

Boston, M. D., & Candela, A. G. (2018). The instructional quality assessment as a tool for reflecting on instructional practice. *ZDM: The International Journal on Mathematics Education*, 50(3), 427-444. https://doi.org/http://dx.doi.org/10.1007/s11858-018-0916-6

Choppin, J., Roth McDuffie, A., Drake, C., & Davis, J. (2022). The role of instructional materials in the relationship between the official curriculum and the enacted curriculum. *Mathematical Thinking and Learning*, *24*(2), 123-148. https://doi.org/10.1080/10986065.2020.1855376

Choppin, J., Green, C., & Zahner, W. (2024). Demands, tensions, and resources when implementing ambitious mathematics. *Education Policy Analysis Archives*, *32*(17). https://doi.org/10.14507/epaa.32.8098

Coburn, C. E., & Russell, J. L. (2008). District policy and teachers' social networks. *Educational Evaluation and Policy Analysis*, 30(3), 203-235.

Cohen, D. K., Spillane, J. P., & Peurach, D. J. (2018). The dilemmas of educational reform. *Educational Researcher, 47*(3), 204-212. https://doi.org/10.3102/0013189X17743488

Doherty, E. (2015). *Benchmarking Rochester's poverty*.

Farrell, C., Coburn, C. E., & Chong, S. (2019). Under what conditions do school districts learn From external partners? The role of absorptive capacity. *American Educational Research Journal*, *56*(3), 955-994. https://doi.org/10.3102/0002831218808219

Franke, M. L., Kazemi, E., & Battey, D. (2007). Mathematics teaching and classroom practice. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 225-256). Information Age.

Fullan, M., & Quinn, J. (2015). *Coherence: The right drivers in action for schools, districts, and systems*. Thousand Oaks.

Gloria, R. Y., Sudarmin, W., & Indriyanti, D. R. (2019). Applying formative assessment through understanding by design (UbD) in the lecture of plant physiology to improve the prospective teacher education students' understanding. *Journal of Turkish Science Education*, 16(3), 350-363.

Gravemeijer, K., & Doorman, M. (1999). Context problems in realistic mathematics education: A calculus course as an example. *Educational Studies in Mathematics*, 39, 111-129. https://doi.org/10.1023/a:1003749919816

Hirsch, C. R., Fey, J. T., Hart, E. W., Schoen, H. L., & Watkins, A. E. (2015). C*ore-Plus Mathematics: Contemporary Mathematics in Context*. McGraw Hill.

Honig, M., & Hatch, T. C. (2004). Crafting coherence: How schools strategically manage multiple, external demands. *Educational Researcher*, 33(8), 16-30. https://doi.org/10.3102/0013189X033008016

Honig, M. I. (2006). Complexity and policy implementation: Challenges and opportunities for the field. In M. I. Honig (Ed.), *New directions in education policy implementation: Confronting complexity* (pp. 1-24). State University of New York Press

Lampert, M., Beasley, H., Ghousseini, H., Kazemi, E., & Franke, M. (2010). Using designed instructional activities to enable novices to manage ambitious mathematics teaching. In M. K. Stein & L. Kucan (Eds.), *Instructional explanations in the disciplines* (pp. 129-141). Springer.

Lappan, G., Phillips, E. D., Fey, J. T., & Friel, S. N. (2014). *Connected Mathematics 3.* Prentice Hall.

Larson, J., Duret, E., Rees, J., & Anderson, J. (2021). Challenging the autonomous wall: Literacy work in an urban high school. *Journal of Literacy Research*, 53(2), 174-195. https://doi.org/10.1177/1086296X211009279

Larson, J., & Nelms, S. (2021). Collaborating for equity in urban education: Comprehensive reform in an innovative university/school partnership. *Urban Education*, 1-32. https://doi.org/10.1177/00420859211017976

Lomba-Portela, L., Domínguez-Lloria, S., & Pino-Juste, M. R. (2022). Resistances to educational change: Teachers’ perceptions. *Education Sciences*, *12*(359), 12. https://doi.org/10.3390/educsci12050359

McLure, F. I., & Aldridge, J. M. (2022). A systematic literature review of barriers and supports: initiating educational change at the system level. *School Leadership & Management*, *42*(4), 402-431. https://doi.org/10.1080/13632434.2022.2113050

McTighe, J., & Brown, P. (2020). Standards are not curriculum: Using understanding by design to make the standards come alive. *Science and Children*, 58(1), 76-81.

Moschkovich, J. (1999). Supporting the participation of English language learners in mathematical discussions. *For the Learning of Mathematics*, 19(1), 11-19.

Moschkovich, J., & Brenner, M. E. (2002). Preface. In M. E. Brenner & J. Moschkovich (Eds.), E*veryday and academic mathematics in the classroom* (pp. v-x). NCTM.

NCTM Research Committee. (2018). Asset-Based Approaches to Equitable Mathematics Education Research and Practice. *Journal for Research in Mathematics Education*, 49(4), 373-389. https://doi.org/10.5951/jresematheduc.49.4.0373

Nolan, K. (2018). The lived experience of market-based school reform: An ethnographic portrait of teachers' policy enactments in an urban school. *Educational Policy*, 32(6), 797–822. https://doi.org/10.1177/0895904816673742

Pradhan Joshi, S. (2021). *Evaluation of the implementation of understanding by design processes in select Minnesota public schools.* St. Cloud State. https://repository.stcloudstate.edu/edad_etds/82

ISSN#: 2473-2826

Reeves, D. (2006). Pull the weeds before you plant the flowers. *Educational Leadership*, 64, 89–90.

Singer-Gabella, M., Stengel, B., Shahan, E., & Kim, M.-J. (2016). Learning to leverage student thinking: What novice approximations teach us about ambitious practice. *The Elementary School Journal*, 116(3), 411-436.

Sumrall, W., & Sumrall, K. (2018). Understanding by design. *Science & Children*, 56(1), 48-54. https://doi.org/10.2505/4/sc18_056_01_48

Wiggins, G., & McTighe, J. (2005). *Understanding by design*. Association for Supervision and Curriculum Development.

Zahner, W., Green, C., Tenney, K., Pelaez, K., Choppin, J., & Al, S. (2021). What is ambitious mathematics teaching? A literature synthesis. Forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education Philadelphia, PA.