School Administrators Leading Teaching and Learning for Mathematical Proficiency

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Abstract

Alberta school administrators are required to provide instructional leadership (Alberta Government, 2018a). Mathematical proficiency is the goal of student learning and teacher pedagogy (Kilpatrick, Swafford & Findell, 2001). This paper examines how administrators can lead teaching and learning for mathematical proficiency through instructional leadership. Foundational knowledge for mathematics education, building personal capacity and supporting those we lead will be discussed in relation to the Alberta Government (2018a) Leadership Quality Standard (LQS). Aoki (2004) refers to the curriculum-as-planned as what is required for teachers to teach. He suggests the curriculum-as-lived attends to the reality of the classroom and the people in it. Strategies for leaders will be discussed and are intended to be an administrator's curriculum-as-planned. To complement the suggested approaches for leading mathematical proficiency, I will identify the value in administrators also being mindful of their curriculum-as-lived and adapting plans based on the realisms of the school. Attending to leadership strategies with respect to the curriculum-as-lived will be a suggestion provided for further research.

School Administrators Leading Teaching and Learning for Mathematical Proficiency

Mathematics education has been a popular topic in Alberta media for the past decade. “Just fix the bloody math curriculum”, “Parents across Canada fight for return to traditional math lessons”, and “'Shockingly low numbers': Province dropped pass score to 42% for Grade 9 math test” have been published news articles (Urback, 2017; Logan, 2014; Ferguson, 2018). Six years ago, medical Dr. Nhung Tran-Davies started a petition to pressure the Alberta Government to change the math curriculum (Change.org, n.d.). This petition has been updated based on changes in government and currently has 19135 signatures. Jason Kenney, Alberta’s current Premier, was quoted saying, “It’s a scandal that we’ve seen a precipitous decline in math competency from Alberta students in the past 10 years…” (Corbella, 2017, para. 22). Across Canada, there has been critique of mathematics teacher education and it has been suggested that teachers lack mathematical understanding (Brown, 2016; Flanagan, 2018). Mathematics education in Alberta has been referred to as a crisis (Staples, 2018). The focus of mathematics in the media and the involvement of the school community illustrate the urgency of mathematics being at the forefront of educational discussion.

Lochmiller and Cunningham (2019) have recently identified the gap in literature around leadership in mathematics education and suggest administrators are the driving forces behind high quality instruction and culture that supports mathematics education. Principals and school jurisdiction leaders are required to uphold the Alberta Government (2018a) LQS. This paper will explore what enacting the LQS looks like in relation to the underserved context of mathematics education.

LQS #3 is “Embodying Visionary Leadership” (Alberta Government, 2018a, p. 5). This LQS requires the leader to develop and enact a vision. A vision is required for a leader to identify what the school is working on, collaboratively ground focus, and celebrate successes when goals are met (Mombourquette, 2017). Mombourquette (2017) suggests that leaders having a clear vision for a school can influence student achievement. To drive mathematical success, a vision focused on mathematics can be created and enacted through instructional leadership. When crafting a vision, Engel (2018) suggests considering *who, what and how*. For a school-based leader, the *who* is the teachers, students and parents. The *what* is mathematical achievement and the how reflects the principal's responsibility of instructional leadership (Alberta Government, 2018a). A vision statement that reflects a leader focused on mathematics is *Leading teaching and learning for mathematical proficiency*[1]. Administrators can lead for mathematical proficiency by having an understanding of teaching and learning for proficiency, building personal capacity and supporting those they lead. In this paper, I will illustrate how a school leader can enact this vision statement through leadership. The ideologies will be applicable to Kindergarten to Grade 9 School Administrators in Alberta. The plan to enact the vision will be written in a linear form. However, the intention is that all aspects are addressed in a cyclical manner through weekly reflection.

Aoki (2004) discusses how educators live in the midst of the curriculum-as-lived and the curriculum-as-planed. The curriculum-as-planned represents what teachers are required to teach and the curriculum-as-lived attends to the individuals in the classroom. The strategies suggested that were synthesized from the literature are reflective of to the curriculum-as-planned as we cannot predict the curriculum-as-lived.

Foundations of Mathematics Education

[1] Bay-Williams and McGatha (2013) discuss leading for mathematical proficiency. Their work is focus around instructional coaches in contrast to administration.

LQS #6, "Providing Instructional Leadership," requires leaders to have an in-depth understanding of pedagogy (Alberta Government, 2018a, p. 6). Leaders should have an understanding of teaching and learning practices in mathematics education (Greenes, 2013; Lochmiller & Cunningham, 2019). Mathematical proficiency is the ultimate goal of mathematics education (Kilpatrick et al., 2001). Students who are mathematically proficient can successfully interact with mathematics in their everyday lives. For students to obtain mathematical proficiency, they need to be educated through the five intertwined strands of mathematical proficiency (Kilpatrick et al., 2001). The strands are conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. Conceptual understanding is the ability to relate mathematical ideas to each other and apply them appropriately (Kilpatrick et al., 2001). Procedural fluency is being able to identify the right procedure to use and carry it out with accuracy and flexibility, depending on the nature of the question. Strategic competence is the ability to create, represent and solve mathematical tasks. Adaptive reasoning is being able to explain and justify mathematical ideas. Productive disposition is a view that mathematics is meaningful, purposeful and worthwhile. Focusing on one strand in silo cannot develop mathematical proficiency; educators are to attend to all aspects of proficiency to drive success (Kilpatrick et al., 2001). Kilpatrick et al. (2001) suggests that school mathematics should be focused around teaching for mathematical proficiency and it should guide teaching and learning in schools. Alberta administrators are required to be instructional leaders and make decisions that support effective teaching and learning (Alberta Government, 2018a). Leaders should have an understanding of mathematical proficiency to effectively guide their schools.

Kilpatrick et al. (2018) identifies the value of mathematical discourse and cognitively demanding tasks as pedagogical practices that promote the development of mathematical proficiency. Both of these practices are heavily grounded in literature as supporting student achievement in mathematics (Heibert & Wearne, 1993; Schleppenbach, Perry, Miller, Sims & Fang, 2007; Henningsen & Stein, 1997; Stein, Smith, Henningsen & Silver, 2000). Since discourse and cognitively demanding tasks are pedagogical practices that facilitate the development of mathematical proficiency, an overview will be provided to establish understanding for the leader.

Mathematical discourse is the representation of mathematical ideas in various forms and the related discussion that consists of reasoning, arguing, and justifying to make sense of mathematics (Herbel-Eisenmann, 2009; National Council of Teachers of Mathematics (NCTM), 1991). Mathematical discourse can promote student learning by discussing concepts, strategies, procedures and relationships (Chapin, O'Connor & Anderson, 2003). Discourse practices can lead to increased achievement because students are focusing on analyzing and reflecting on mathematical concepts instead of procedural thinking (Heibert & Wearne, 1993). Mathematical disagreements can enable deep thinking about mathematics (Barlow & McCrory, 2011). Schleppenbach et al., (2007) suggest that mathematical discourse promotes conceptual understanding concepts in mathematics. Mathematical discourse is a learning tool, but it also aids in assessment. Discourse discussions can provide teachers with valuable information about student misconceptions and areas of difficulty (Barlow & McCrory, 2011).

There are a variety of facets that enable discourse in a math classroom. Teachers create environments that promote discourse when students feel that their ideas are valued and respected (Barlow & McCrory, 2011; Chapin et al., 2003; Kilpatrick et al., 2001; NCTM, 1991; White, 2003). Teachers should develop a norm where risk-taking, discussion and debates between students are appreciated (Barlow & McCrory, 2011). Teachers can prepare students by explicitly teaching them how to engage in discourse and explain their thinking so that all students can participate (Erath, Prediger, Quasthoff & Heller, 2018; Sherin, 2002). Teachers should model thinking aloud so students know how to engage with problems (Trocki, Taylor, Starling & Heck, 2012). Language supports with sentence starters or other discourse language strategies can be provided to students to enable them to engage in discussion (Rumsey & Langrall, 2016).

To encourage discourse, teachers need to value students' understanding of mathematical concepts and not exclusively the right answer (Stein, 2007). There needs to be discussion about both correct and incorrect answers to facilitate meaningful discourse (Chapin et al., 2003; Gronewold, 2009; Kilpatrick et al., 2001). Conversation after an answer is found can lead to increased discussion about mathematical rules that can promote conceptual understanding (Schleppenbach et al., 2007). The teacher should not resolve the disagreements that occur (Barlow & McCrory, 2011). Students should be asked to justify their thinking and clarify their ideas (NCTM, 1991). Although there are a variety of strategies that teachers can use to facilitate discourse, teachers need to be flexible and use their judgment to determine how to best utilize discourse practices to include all students (Kilpatrick et al., 2001; Krusi, 2009; NCTM, 1991).

Book Suggestions for Further Reading on Mathematical Discourse:

- Herbel-Eisenmann, B. A., & Cirillo, M. (Eds.). (2009). *Promoting purposeful discourse: Teacher research in mathematics classrooms*. Reston, VA: National Council of Teachers of Mathematics.
- Smith, M.S., & Stein, M.K. (2018). *Five practices for orchestrating productive mathematics discussions* (2nd ed.). Thousand Oaks, CA: Corwin Press.
- Bill, V., & Sherin, M. G. (2019). *The Five Practices in Practice [Elementary]: Successfully Orchestrating Mathematics Discussions in Your Elementary Classroom*. Corwin Press.

- Sherin, M. G. (2019). *The Five Practices in Practice [Middle School]: Successfully Orchestrating Mathematics Discussions in Your Middle School Classroom*. Corwin Press.

Kilpatrick et al. (2001) suggests that tasks provide students with the opportunity to learn mathematics and work towards becoming mathematically proficient. Stein and Lane (1996) suggest that tasks that require a high-level of cognitive demand yield higher gains in student learning and achievement in contrast to the use of tasks that require a low-level of cognitive demand. Smith and Stein (1998) suggest that there are four different levels of cognitive demands that tasks can require. There are two types of tasks with low-level cognitive demand, “memorization” and “procedures without connections” (Smith & Stein, 1998, p. 348). “Memorization” tasks require students to reproduce previously learned facts, formulas or definitions from memory (Smith & Stein, 1998, p. 348). There is one correct answer and students are not required to demonstrate understanding. “Procedures without connections” tasks elicit students to think in an algorithmic way. In this type of task, the algorithm has been previously modeled and students are required to replicate it without explanation or connection to concepts. The two high-levels of cognitive demand are “procedures with connections” and “doing mathematics”. “Procedures with connections” tasks result in students focusing on deeper levels of understanding by making connections to concepts (Smith & Stein, 1998, p. 348). In these types of tasks, there are multiple pathways to find a solution and students often have to represent their thinking in different ways. The highest level of cognitive demand is “doing mathematics” (Smith & Stein, 1998). Tasks with this level of cognitive demand result in students utilizing nonalgorithmic thinking to draw on background knowledge, reasoning and explore mathematics. In these types of tasks, there is no predictable approach and students are required to self-monitor their process.

How tasks are utilized in class can impact student learning. Henningsen and Stein (1997) suggest that a task can require a high level of cognitive demand, but a teacher can alter the level of demand required from their students based on their actions. Teachers must select a task that requires a high-level of cognitive demand and must also act in ways that support and enable a high-level of cognitive demand from their students (Henningsen & Stein, 1997). Stein, Grover and Henningsen (1996) found that a class' focus on correct answers may impede the level of thinking that a task requires. The authors noticed that when students only placed value on the accuracy and completeness of the question, cognitive demand decreased. High levels of cognitive demand are promoted when students consistently hear that their explanations and justifications are as valuable as correct answers (Stein et al., 1996). Students are motivated to engage with mathematical tasks meaningfully in teacher created environments where various strategies are valued (Lambert & Stylianou, 2013).

Warshauer (2015a) suggests that struggling is a part of mathematics and contributes to learning and understanding. Teachers can put pressure on students to generate the correct answer when they are working on a mathematical task (Stein et al., 1996). If a teacher provides students with a strategy or guides them to a path that leads to a correct answer, the teacher can make a highly demanding task routine and procedural. When teachers intervene too much they reduce the complexity of the task and consequently decrease the level of cognitive demand (Kilpatrick et al., 2001; Stein et al., 1996). Using probing questions like "Tell me what you mean" and prompts that promote students to make sense of their ideas can support students in understanding their struggle and help them make sense of their ideas (Warshauer, 2015a, p. 396). Murawska (2018), Warshauer (2015b), and Townsend, Slavit, and McDuuffie (2018) suggest that to promote productive struggle, classrooms should develop a culture where mistakes are a part of learning and problem solving. To be able to promote an appropriate amount of struggle, teachers can use questioning techniques, avoid leading students toward an answer and develop a classroom community that values productive struggle (Murawska, 2018; Stein et al., 1996; Warshauer, 2015a; Wasrhauer, 2015b).

Book Suggestions for Further Reading on Mathematical Tasks:

- Lappan, G., Smith, M., & Jones, E. (Eds.). (2012). *Rich & Engaging Mathematical Tasks: Grades 5-9*. National Council of Teachers of Mathematics.
- Small, M. (2017). *Teaching Mathematical Thinking: Tasks and Questions to Strengthen Practices and Processes*. New York, NY: Teachers College Press

Strategies to Build Personal Capacity

The National Council of Supervisors of Mathematics (NCSM) (2008) suggests that student achievement will stay the same unless leaders intentionally attend to improving practice daily. Administrators can personally build their own capacity to lead for mathematical proficiency by having a mindset focused on student learning, fostering school culture, effectively managing school operations, engaging in professional learning and utilizing best practices.

Mindset

How a leader focuses their mindset can influence how they lead (Hattie, 2015; Terosky, 2016). Hattie (2015) and Terosky (2015) advocate that instructional leaders ground their focus on student learning. Terosky (2015) discusses that both the learning of students and the professional learning of teachers should be at the forefront of decisions. She identifies that instructional leaders avoid circumstances that do not promote learning for staff and students. Administrators can ground their focus on the teaching and learning of mathematics. Decisions can be made based on how the choice contributes to the development of mathematical proficiency. LQS #3, “Embodying Visionary Leadership” requires leaders to implement a vision that is student-centered and grounded in effective teaching and leadership practices (Alberta

Government, 2018b, p. 5). Having a mindset that is focused on students and instruction contributes to leading for mathematical proficiency and is an aspect of LQS #3.

Culture

Leaders have influence on school culture (MacNeil, Prater & Busch, 2009; Pounder, Ogawa and Adams, 1995). LQS #4, "Leading a Learning Community," holds leaders accountable for establishing a culture of high expectations and evidence-informed teaching (Alberta Government, 2018a, p. 4). Hitt and Tucker (2016) suggest that principals have the ability and responsibility through instructional leadership to create an environment that fosters student achievement. It is the role of the leader to build a culture that is rooted in exceptional mathematics pedagogy (Lochmiller & Cunningham, 2019; NCSM, 2008). Fullan (2006) advocates for developing school cultures where teachers are always learners. To drive success in mathematics, there needs to be a culture of teamwork in the school (NCSM, 2008). A school culture that supports mathematics education is grounded in school personnel utilizing best practices, lifelong learning and teamwork.

Turan and Bektas (2013) identify leaders as role models for school culture. Leader visibility is identified as a key component of school culture (Fiore, 2000). Instructional leaders make it visible that teaching and learning is their first priority (Terosky, 2016). Terosky (2016) notes how it is easy for administrators to focus on emails and other administrative tasks that do not relate to instruction. However, she discusses how leaders can schedule time in their days to attend to instructional leadership. Terosky (2016) shared a story of a leader who reserved the school day for attending to instruction by being a part of classrooms, facilitating professional learning, meeting with educators about instruction and attending to the managerial aspects of her job after school hours. Terosky's (2016) story illustrates how administrators can also be role models by informally attending time when teachers are in learning communities. The NCSM (2008) suggests that leaders model teamwork by being a part of teams. Teachers should also see leaders reading about mathematics education and engaging in other forms of professional learning like workshops (Strangwood, 2009). Leaders can foster a positive school culture by attending to it every day (Casas, 2017; Saphier and King, 1985). Leaders can model what they want to see by displaying a commitment to mathematics education, and can develop a culture centered on mathematics education by frequently being visible. Visibility shows a commitment to learning and supporting teaching.

School Operations

LQS #8, “Managing School Operations and Resources,” identifies administrators as responsible for budget and staffing (Alberta Government, 2018a, p. 7). Instructional leaders recognize the value in having the “right team” when striving for academic achievement (Terosky, 2016, p. 320). Terosky (2016) discusses leaders identifying their ambitions to promote student achievement in their recruitment and selection processes when staffing. Some administrators attended workshops aligned with school goals to meet potential candidates and developed relationships with universities to find teachers who would contribute to their school’s success. Strangway (2009) suggests that leaders consider hiring teachers who have a mathematics specialty to enhance mathematics education in schools to support mathematical proficiency. Terosky (2016) discusses the value in leaders becoming creative when prioritizing instruction in their schools. Principals may be required to decrease funding for assistant principals and other staffing positions to allocate resources for instructional coaches. Instructional leaders can also prioritize teaching and learning by utilizing administrative assistants to alleviate the workload of managerial tasks (Terosky, 2016). Leaders should consider the goal of striving for mathematical proficiency when making decisions about budget and staffing.

Professional Learning

Leaders can support their professional learning toward leading for mathematical proficiency individually and collaboratively with teachers. Greenes (2013), Terosky (2016) and Strangway (2009) advocate for administrators to be involved in professional learning alongside teachers. LQS #2 requires leaders to “Model a Commitment to Professional Learning” (Alberta Government, 2018a, p. 4). Participating in professional learning would build the capacity of the leader by supporting their personal learning. Greenes (2013) continues that this learning will be necessary when observing and evaluating teachers so that administrators have specific criteria to look for. LQS #6, “Providing Instructional Leadership”, identifies the school leader as responsible for the supervision and evaluation of teachers. Learning “shoulder-to-shoulder” with teachers would provide administrators with specific outcomes to observe when evaluating teachers. Greenes (2013) also suggests that when leaders have participated with teachers in professional learning, they are able to speak knowledgeably with parents about the pedagogy happening in classrooms.

Fullan (2006) advocates for individual learning as well. Instructional leaders also dedicate time to promote their own learning of instructional concepts independently (Terosky, 2016). Strangway (2009) suggests that the principal must remain up-to-date in mathematics education literature to support teachers. Administrators dedicated to improving instruction take time to read educational journals and reflect on their practice (Terosky, 2016).

Scholarly Journal Suggestions:

- Teaching Children Mathematics

- Mathematics Teaching in the Middle School
- Delta-K (Mathematics Council of the Alberta Teachers' Association)
- Educational Studies in Mathematics
- Journal of Mathematics Teacher Education
- Journal for Research in Mathematics Education

Terosky (2016) discusses how some instructional leaders also enroll in formal course work and teach courses in their schools to make instruction their focus. Strangway (2009) suggests that administrators also seek and attend professional learning opportunities designed for administrators in mathematics education.

Modeling

Posamentier (2013) suggests that it is the role of the mathematics education leader to popularize best practices and motivate teachers. Teachers suggest that effective principals demonstrate practices they wish to see in classrooms (Blase & Blase, 1999). Hitt and Tucker (2016) suggest there is benefit in administrators modeling changes in their practice (Hitt & Tucker, 2016; Leithwood & Sun, 2012). Strangway (2009) advocates that leaders should work shoulder-to-shoulder with mathematics teachers to support achievement in their schools. Mathematics education leaders need to be in classrooms modeling engaging lessons that promote student understanding (NCSM, 2008). Leaders modeling can result in an increase of teacher motivation and encourage reflection (Blase & Blase, 1999). Administrators could demonstrate facilitating mathematical discourse and utilizing cognitively demanding tasks in classrooms as a means to display practices that they expect to see.

Strategies to Support Those We Lead

Blase and Blase (1999) share an example of the benefits that resulted from an administrator supporting staff. Blase and Blase (1999) quoted a teacher stating, "I don't really mind taking chances because of our support base" (p. 136). Leaders can support teachers by facilitating professional learning, coaching, providing resources, utilizing shared leadership, assessment, parent involvement and celebration.

Facilitating Professional Learning

Teachers often teach mathematics in the way they were taught (Strangway, 2009). To promote student achievement in mathematics, administrators should facilitate professional development around high quality mathematics education. LQS #4, "Leading a Learning Community", identifies the leader as responsible for providing staff with collaborative learning opportunities (Alberta Government, 2018a, p. 5). Effective mathematics education requires teachers to have an understanding of content, pedagogy, connections between mathematical ideas, student learning and school context (NCSM, 2008). Guskey (2014) advocates that professional learning be planned using backward design. He suggests that the desired outcomes be developed and subsequent decisions about professional learning should be made based on whether it contributes to the desired outcome or not. The goal of the leader is to create learning conditions that foster pedagogical and student proficiency. Thus, these cornerstones of mathematics education can be utilized as professional learning topics to meet the goal. As discussed in the foundations of mathematics education, discourse and cognitively demanding tasks are pedagogical practices that foster mathematical proficiency (Kilpatrick et al., 2001). These two topics could serve as catalysts to kick start professional learning in the school. To promote teacher learning, Smith and Stein (1998) suggests that teachers sort tasks based on levels of cognitive demand. After providing an overview of cognitively demanding tasks, the administrator could facilitate professional learning through task sorting to support the use of cognitively demanding tasks in classrooms.

Small and Duff (2018) identify that there is value in whole school teams participating in professional learning. They suggest it is unlikely that all teachers have the same level of understanding and teachers who have a higher level of knowledge can use professional learning time to share their experiences. Althauser (2015) suggests that professional learning be job-embedded and sustained over a long period of time, so it can improve student's mathematics achievement. Greenes (2013) suggests that leaders in mathematics are to sustain professional learning. She continues that effective professional learning is two to four hours, bi-monthly and over several years. Instead of covering logistics that can be shared in emails or bulletins, leaders can use staff meeting time to attend to teachers' professional learning (Bedard & Mombourquette, 2015; Terosky, 2016). Whole staffs should engage in sustained professional learning to support the vision of fostering mathematical proficiency.

Collaboration should be an aspect of teacher professional learning (Alberta Government, 2018a; Blase & Blase, 1999; Hattie, 2015; Greenes, 2013; NCSM, 2008; Pfeil & Hirsch, 2013; Reeves, 2009; Small & Duff, 2018). Blase and Blase (1999) discuss the many benefits that result from teacher collaboration. These benefits include increased motivation, efficacy, reflection, innovation and creativity. Althauser (2015) suggests that a transformation to research-based pedagogy can occur when teachers have collegial support. She suggests that teachers collaboratively plan, analyze and reflect on their teaching practice to promote and sustain improvements in their practice. Administrators can support collaboration by timetabling uninterrupted periods for teachers to work together (Greenes, 2013; Pfeil & Hirsch, 2013; Strangway, 2009; Terosky, 2016). They can also provide substitutes or administrators can cover classes to support teachers in their collaborative work (Greenes, 2013; Pfeil & Hirsch, 2013; Terosky, 2016). Leaders can also find creative ways to make time. Pfeil and Hirsch (2013) discuss how an assistant principal took various classes to the cafeteria to teach them a lesson on study skills while the teachers had collaboration time. Terosky (2016) shared how a principal utilized the community to final local talents to host assemblies where students came to learn about art, music or other topics. The principal, with the help of support staff, supervised the assembly while the teachers benefited from time working together. During collaboration time, teachers can plan lessons based on the goals of the school (Hattie, 2015). A key aspect of successful professional collaboration is communication (Pfeil & Hirsch, 2013). Pfeil and Hirsch (2013) identify the value in professional discussion, timely responses and the use of communication tools. To support the use of communication, the leader could formulate a standard method of communication for collaborative teams. An example could be the use of Google Docs to identify what was discussed during the meeting time, actions to be taken before the next meeting and next steps. The document can be shared with administration and all members of the team to enable communication.

Professional learning can also be facilitated outside of the school. Fullan (2005) suggests that collaborative professional learning can occur with teachers across different schools. Leaders can enable professional learning by creating conditions where teachers can observe other teachers in their own school and other schools to learn from other professionals (Blase & Blase, 1999; Strangway, 2009).

Strangway (2009) suggests that leaders can also use Book Studies to promote professional learning around mathematical proficiency. Book Study encourages teachers to dive into content that they can apply in their classrooms. Discussions that arise from groups of people reading the same book can yield further understanding of concepts. Strangway (2009) recommends that groups be between 5 and 15 members and find a consensus about meeting times. Meetings should be sixty to ninety minutes and occur four to eight times over the course of the school year (Strangway, 2009). Administrators can provide time for teachers to engage in Book Study discussions. Strangway (2009) advises that participants determine how they will read the book. She also continues that readers are to read with a lens of the goals of the teacher and the school. Using a lens of the school goals can prompt discussion and reflection about teaching practices.

Book Suggestions

- Boaler, J. (2015). Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching. John Wiley & Sons.
- Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: helping children learn mathematics.* Washington, DC: National Academy Press.
- National Council of Teachers of Mathematics. (2014). Principles to actions: Ensuring mathematical success for all. Reston, VA: Author
- Small, M. (2009). Making math meaningful to Canadian students, K–8. Toronto, ON: Nelson Education, Ltd

Fullan (2006) advocates for a combination between individual and collaborative learning. Strangway (2009) suggests that leaders encourage teachers to attend professional learning related to mathematics education outside of the professional learning occurring at the school to further support their growth. Leaders can also promote professional learning by encouraging teachers to participate in action research (Blase & Blase, 1999). All Alberta teachers are required to create and implement a Professional Growth Plan to improve their practice through lifelong learning (Alberta Teachers' Association, n.d.). Leaders in mathematics can support teachers with the development and enactment of their Professional Growth Plans by facilitating individual and collaborative learning (NCSM, 2008; Fullan, 2006).

Coaching

LQS #6, “Providing Instructional Leadership,” requires administrators to build teacher capacity for high quality teaching and learning. Strangway (2009) suggests that leaders should be in classrooms coaching teachers with the goal of students developing mathematical proficiency. Hattie (2015) identifies value in observing teachers based on teacher impact on student learning. Terosky (2016) discuss how instructional leaders use instructional goals when observing teachers. McGatha and Bay-Williams (2013) advocates that the most effective mathematics leaders support teachers in shifting their practices to ensure that they support the development of mathematical proficiency. Once staff has received professional learning on mathematical discourse and cognitively demanding tasks, the leader could tailor their observations and coaching around these two practices.

McGatha and Bay-Williams (2013) suggest that leaders use “coaching questions” to support teachers in making pedagogical shifts (p. 166). The coaching questions described by McGatha and Bay-Williams (2013) encourage teachers to reflect on their practices and identify ways they can improve them. Blase and Blase (1999) suggest talking with teachers to promote reflection can be a strategy utilized to improve instruction. Some talking strategies can include providing suggestions, giving feedback and prompting inquiry (Blase & Blase, 1999). Teachers can benefit from leaders coaching by listening, discussing their experiences and encouraging teachers to try new practices.

Resources

Blase and Blase (1999) suggest leaders provide resources to support teachers in improving their practice. LQS #6, Providing Instructional Leadership” also requires leaders to ensure teachers have access to resources that promote student learning. Lochmiller and Cunningham (2019) suggest that leaders play a key role in the attainment and utilization of mathematics resources. Small and Duff (2018) suggest that leaders can share resources they have found to create a culture of learning. Strangway (2009) recommends that leaders create a lending library of resources that include a wide variety of scholarly journals and instructional books. Blase and Blase (1999) shared an example where teachers filled out a form that indicated that resources they wanted, a council would meet to discuss rationale for resources and when the resource was determined to be required, it was purchased for the school. Leaders can establish a method of resource obtainment and sharing that suits the needs of their schools to support the improvement of mathematics education at their sites (Blase & Blase, 1999; Strangeway, 2009).

Shared Leadership

Lochmiller and Cunningham (2019) note that administrators are to work in consultation with staff members to foster high quality mathematics education. Leaders can develop a supportive school environment by sharing leadership with classroom teachers (Lochmiller & Cunningham, 2019). Lochmiller and Cunningham's (2019) suggestion attends to LQS #8, "Developing Leadership Capacity" (Alberta Government, 2018a, p. 7). LQS #8 necessitates administrators to empower teachers by providing teacher-leadership roles and engage in collaborative decision-making.

Terosky (2016) suggests that instructional leaders value shared decision-making and found creative ways to empower teacher leadership. She shares a story of a principal who removed funding for an assistant principal to hire two lead teachers. The principal suggested that teachers who are enacting pedagogy act as excellent leaders for guiding planning and programming. Although Terosky (2016) shares a story related to the value of teacher-leadership, she also notes that teachers need support and resources to be successful in their positions. Blase and Blase

(1999) suggest that teachers can benefit from leaders facilitating peer coaching. Peer coaching can result in increased efficacy and learning around pedagogy.

Administrators can also utilize instructional coaches, consultants and department chairs to strive toward the vision of mathematical proficiency (Lochmiller & Cunningham, 2019; Terosky, 2016). Small and Duff (2018) identify value in calling on experts. They note that the principal remains the leading agent of change in the school and other educators cannot replace the role of the administrator. Leaders can use shared leadership to foster mathematical proficiency in schools, however, leaders must continue to have a key role in the process of improvement.

Assessment

Quality assessments of student learning are aligned to the curriculum and are used for formative and summative data (NCSM, 2008). The Alberta Government (2018b) Teacher Quality Standards require Alberta teachers to use formative and summative assessments that are based on the learning outcomes and enable students to demonstrate their learning in a variety of ways. Teachers should use formative assessments to inform their teaching practices and use summative assessment to evaluate the effectiveness of their program (NCSM, 2008). The role of the mathematics education leader is to support teachers in aligning pedagogy with assessment practices, using many types of assessments to gather formative evidence, collaborating to create summative assessments and analyzing data to make decisions about future practices (NCSM, 2008). Greenes (2013) advocates for the use of interviews, group observations and think-aloud to be incorporated into teachers' assessment practices. The NCSM (2008) recommends that leaders share non-traditional examples of assessment such as performance tasks, interviews, or projects. LQS #6, "Providing Instructional Leadership" identifies administrators as responsible for ensuring effective assessment practices are being utilized (Alberta Government, 2018a, p. 6).

Leaders can support the development of mathematical proficiency by facilitating professional learning around best practices (NCSM, 2008).

The NSCM (2008) advocates that teachers receive time to develop assessments collaboratively in grade groups. Strangway (2009) suggests that teachers also receive time to mark together. By marking together with predetermined criteria, teachers are able to have professional conversations and develop shared understanding of expectations. Small and Duff (2018) advise administrators be a part of assessment practices as well. Greenes (2013) suggests it is the role of the mathematics education supervisor to appraise the quality of the assessment tools in place and participate in the development of new assessments. Leaders can facilitate time to develop and mark assessments to promote effective assessment practices.

Assessment is a vital part of monitoring the impact of pedagogy on student learning (Greenes, 2013). Hattie (2015) suggests that instructional leaders view assessment as feedback on the impact teachers and leaders are making. Effective practices will show an increase in student understanding of content (Hattie, 2015). Leaders can be a part of assessment practices to facilitate mathematical proficiency and evaluate effectiveness of practices that guide future decisions.

Parent Involvement

Hattie (2015) suggests that leaders, teachers, parents and students are all part of the learning for improving outcomes. LQS #1 is “Fostering Effective Relationships” (Alberta Government, 2018a, p. 4). This LQS holds leaders responsible for “creating opportunities for parents/guardians, as partners in education, to take an active role in their children’s education (Alberta Government, 2018a, p. 4). Small and Duff (2018) suggest that leaders need to do more than just have parents attend events at a school. They suggest that parents need to also have a high expectation for mathematics education achievement and support their children in a way that is congruent to the school. Principals should share math education goals and the data behind decisions made with parents (Small & Duff, 2018). They can also commit to share results with parent council over the course of the year and encourage teachers to communicate with parents as well. NCSM (2008) advocates that leaders share the ongoing assessment results with parents to demonstrate the effectiveness of initiatives. Terosky (2016) discusses the use of staff meeting time to attend to professional learning instead of logistics. She also notes how instructional leaders can use the same principle to involve parents. Instead of parents coming to visit classrooms, leaders can facilitate evenings where parents learn about how to support their children.

Celebration

Praise can improve teacher motivation and serve to reinforce teaching practices (Blase & Blase, 1999). Greenes (2013) suggests that the mathematics leader is responsible for facilitating celebration of mathematics achievements for students and teachers to show growth. The school can host Open Houses where students can show off progress and learning to parents (Greenes, 2013). Pfeil and Hirsch (2013) suggest teachers need to be motivated to engage in professional collaboration. The authors suggest that leaders can extrinsically motivate teachers by recognizing their work. The administrator can showcase teacher work by nominating teachers for awards, encouraging presentations at conventions and commending achievements through newsletters and social media (Greenes, 2013).

Implications

The literature discussed foundational knowledge of mathematics education, a variety of ways that administrators can build their personal capacities and support those they lead to enact student and pedagogical mathematical proficiency. Leaders can utilize the literature and the curriculum-as-planned, to foster mathematical proficiency in their schools; however, administrators also need to attend to the individuals and unique circumstances of their schools (curriculum-as-lived) (Aoki, 2004). Aoki (2004) discusses the tension between the curriculum-as-lived and the curriculum-as-planned. He notes that it can feel uncomfortable to be torn by the two. However, Aoki (2004) suggests not viewing the world in binary, for example: leader/follower. He advocates for flexibility in thinking and incorporating "both this and that and more" (Aoki, 2004, p. 294). Looking through an Aokian lens, the administrator can utilize the strategies from the literature (the curriculum-as-lived) but also should be attentive to the reality of the people in their building. The leader can lead for mathematical proficiency and stand on a foundation of literature, but also should adapt and adjust based on the needs of their staff. Creating an environment where members of the school community feel cared about is an aspect of LQS #1, "Fostering Effective Relationships" (Alberta Government, 2018a, p.4).

Alberta Government (2018a) LQS #2, "Modeling Commitment to Professional Learning" requires leaders to engage in self-reflection to improve practice. Dewey (1938) discusses the value of self-refection as it acts as a catalyst to develop understanding of experiences and make meaning of them. Below are self-reflection prompts that were developed to consider the literature (curriculum-as-planned) but also attend to the unique members of the school community (curriculum-as-lived):

- What am I doing that supports my continued growth to teach and lead for mathematically proficiency?
- How am I supporting teachers to foster mathematical proficient pedagogy?
- What are students experiencing that promotes mathematical proficiency?

- What are parents experiencing that promotes mathematical proficiency?
- How am I attending to the unique context of my school when leading for mathematical proficiency?

These prompts can be used regularly throughout the course of the year to attend to the cyclical nature of enacting the vision of *Leading teaching and learning for mathematical proficiency.*

Further Research

The literature advocates for administrators who are instructional leaders and are involved in classrooms. Further research is needed to examine the impact of leaders being included in this intensive level. Examining the experience of the teachers would provide insight into how it feels to have an administrator with that level of involvement in instruction. This would focus more on the curriculum-as-lived in contrast to the curriculum-as-planned that was derived from the literature (Aoki, 2004). Increased research could provide more understanding on how administrators can support teachers while still making space for professional autonomy.

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