

INSTRUCTIONAL LEADERSHIP IN MATHEMATICS: COMPENSATING FOR
PRINCIPALS' LACK OF MATHEMATICAL BACKGROUND

by

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**Instructional Leadership in Mathematics: Compensating for Principals' Lack of
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Acknowledgements and Dedication

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Abstract

Principals are responsible for ensuring the academic achievement of students in mathematics. Researchers have identified that principals who possess a combination of mathematical content knowledge and instructional leadership skills are most effective at increasing the academic achievement of students in mathematics. Yet, many principals do not have a background in mathematics. This capstone provides a review of literature related to the teaching and leadership practices that have been demonstrated to increase the academic achievement of students in mathematics. Additionally, recommendations are provided by which principals can increase their leadership, instructional, and content knowledge, thereby enhancing their ability to ensure the academic success of all students in mathematics.

Key words: Mathematics, principal, instructional leadership, academic success

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Instructional Leadership in Mathematics: Compensating for Principals' Lack of Mathematical Background

Chapter 1: Introduction

Mathematical knowledge and skills have a significant impact on students' future educational and career success (D. Eggen, personal communication, December 6, 2016; National Mathematics Advisory Panel, 2008; Organisation for Economic Co-operation and Development, 2016b). The increasing importance of mathematical knowledge and skills for youth is due to the diversification of Alberta's economy and related job opportunities (O'Connor, de Vries, Goldie, Beltaos, Bica, & Lagu, 2016). As a result, the Government of Alberta is focused on providing all students with access to a quality education in mathematics (Alberta Education, 2010, 2013; D. Eggen, personal communication, December 6, 2016). At the school level, however, it is principals who are mandated to ensure students are provided with this quality education (Alberta Education, 2009). Consequently, principals must be prepared with the skills and knowledge required to take necessary action to ensure the academic success of all students in mathematics (Balka, Hull, & Miles, 2010; Cummings, 2016; Katterfeld, 2013; Stein & Nelson, 2003).

Background to the Problem

“Math crisis” is the term used by Boaler and Foster (2014) to describe the state of mathematics education and achievement in North America. To further define the crisis described by Boaler and Foster (2014), poor mathematical performance is evident in the steady decline of Canadian results on international mathematical exams (Organisation for Economic Co-operation and Development, 2016a). Alberta is also viewed as a contributor to this crisis as 26.9% of participating students failed to earn an acceptable standard on Alberta Education's standardized 2015 Grade 9 Mathematics Provincial Achievement Test (PAT) (Alberta Education, 2015).

These poor results are a concern as Alberta Education is mandated to ensure every student develops the mathematical knowledge and skills needed to reach their full potential and contribute positively to society (Alberta Education, 2013). Consequently, Alberta educators must make quality mathematics instruction a priority, taking the necessary steps to ensure the academic success of all students in mathematics (Alberta Education, 2013; Stokke, 2015).

Furthermore, the school principal is responsible for ensuring all students are provided with quality educational opportunities, and the area of mathematics is no exception (Alberta Education, 2009). Accountable for the quality of mathematical instruction available to students, principals are required to provide teachers with the instructional leadership necessary to ensure students have access to appropriate programming grounded in research-based pedagogy and curriculum (Alberta Education, 2009). This intention is supported by Marzano, Water, and McNulty (2005) as they demonstrated the significant effect school leadership has on the academic achievement of students. Furthermore, they argued the academic achievement of students can be enhanced when a well-developed and research-based plan of action is carefully executed by principals (Marzano, Water, & McNulty, 2005). Despite the impact effective school leadership has on the academic achievement of students, Alberta Education does not require principals to have a background in mathematics or instructional leadership techniques (Alberta Education, 2009). Principals are, however, expected to have the knowledge and research-based skills necessary to ensure all students have access to a quality education (Alberta Education, 2009). Thus, although responsible for the quality mathematics education of students, many principals may not be prepared with the necessary knowledge and skills to carry out this directive (Balka et al., 2010; Cummings, 2016; Stein & Nelson, 2003).

Statement of Problem

Through *Ministerial Order # 001/2013*, Alberta Education (2013) mandated that educators must provide students with a quality mathematics education. Poor results on Alberta Education's standardized 2015 Grade 9 Mathematics Provincial Achievement Test (PAT) is one example that demonstrates this responsibility is not being fully met by Alberta educators (Alberta Education, 2015; McClure, 2015). Since principals are held accountable for this lack of student achievement, it is, therefore, their responsibility to ensure students have access to quality teaching and learning and are able to meet the provincial goals of education (Alberta Education, 2009). Furthermore, researchers have also demonstrated the positive effect that skilled principal leadership has on teacher efficacy and levels of learning for students (Marzano et al., 2005; Ross & Gray, 2006). The problem is that even though principals are responsible for the academic success of students, and mathematics is no exception, principals are not required to have any graduate level courses in mathematics or instructional leadership (Alberta Education 2009). This has led to the identified problem of how principals without a background in mathematics can ensure the academic success of students in mathematics.

Purpose

Guaranteeing that every student has equitable access to quality mathematics instruction and experiences academic success is a challenge (Balka et al., 2010). In my dual role as Assistant Principal and Grade 7 mathematics teacher, this capstone was intended to increase my ability to provide teachers with quality instructional leadership targeted at improving the effectiveness of mathematics instruction throughout a Grade 7 to 9 school in central Alberta. Additionally, the superintendent of this school has suggested that mathematics and numeracy will soon be a district-wide focus (Jayson Lovell, personal communication, April 18,

2017). Ultimately, the purpose of this capstone is to assist principals who lack a background in mathematics yet who are responsible for supervising mathematics instruction. Through a greater understanding of the teaching and leadership practices that have been demonstrated to increase the academic achievement of students in mathematics, principals will be better able to ensure all students have the mathematical skills and knowledge necessary for their successful futures.

Statement of Research Questions

The focus of this capstone is to address the following research questions:

1. What teaching practices have been found to improve the academic achievement of students in mathematics?
2. What instructional leadership practices have been found to improve the academic achievement of students in mathematics?

Definition of Terms

Content knowledge - Refers to the knowledge, concepts, and methodologies necessary for the effective teaching of mathematics (Alberta Education, 1997; Stein & Nelson, 2003).

Curriculum - Refers to Alberta Education's (2016) *Mathematics Kindergarten to Grade 9 Program of Studies* which includes a conceptual framework and outcomes, both general and specific. This document outlines the instruction and learning of mathematics.

Instructional leadership - Refers to the leadership skills and tasks utilized by principals to improve the academic achievement of students through ensuring access to a quality education (Balka et al., 2010).

Mathematics - Refers to both mathematics and numeracy.

Principal - Refers to the leader of a school as assigned by the school board. The principal is responsible for ensuring quality education is available to all students under their

supervision (Alberta Education, 2009). Additionally, the principal is responsible for ensuring teachers meet the requirements of Alberta Education and their specific school board (Alberta Education, 2009). As designates of the principal, assistant principals and other members of the administration team are included in this definition.

Professional Development (PD) – Refers to learning opportunities provided to teachers with the goal of improving student achievement by improving instruction (National Council of Teachers of Mathematics, 2010).

Scope of Study

This study was a consideration of mathematics instruction and, as such, did not approach mathematics and numeracy as separate components. Additionally, although stakeholders such as district office administration, parents, community members, and educational assistants (EAs) each play a vital role in a quality mathematics education (Alberta Education, 2010), their contributions were not considered as part of this capstone.

Significance of Study

Following the release of *Inspiring Education* by Alberta Education (2010) and the *Ministerial Order on Student Learning #001/2013* by the Government of Alberta (2013), one of the central Alberta school districts placed considerable resources into building teacher capacity in order to provide quality literacy development and opportunities for students (Wolf Creek Public Schools, 2015). Moving forward, the superintendent of this district has indicated that mathematics and numeracy will be implemented as a district-wide focus (Jayson Lovell, personal communication, April 18, 2017). As an Assistant Principal of a Grade 7 to 9 school, this study provided concrete steps to enhance my ability to compensate for my lack of mathematics background while increasing the academic achievement of students in mathematics. The

research study and resulting recommendations emphasized the critical role principals play in ensuring quality mathematics education is available to all students. As noted in Chapter 3, the resulting recommendations will enable principals within a central Alberta school district to prepare for a district-wide emphasis on mathematics.

Chapter Summary

Mathematical understanding has been demonstrated to be a strong predictor of the future academic success and career options of students (D. Eggen, personal communication, December 6, 2016; National Mathematics Advisory Panel, 2008; Organisation for Economic Co-operation and Development, 2016b). As a result, the Government of Alberta has focused on providing all students with access to a quality education in mathematics (Alberta Education, 2010, 2013; D. Eggen, personal communication, December 6, 2016). Yet, for many students in Alberta, success in mathematics remains a struggle (Alberta Education, 2015, McClure, 2015). As principals are mandated to ensure the academic achievement of all students, they must take the steps necessary to increase the quality of teaching and learning opportunities available to students (Alberta Education, 2009).

Principals are accountable for the quality of education provided to their students (Alberta Education, 2009). Balka et al. (2010) took this one step further, arguing that to ensure quality mathematics education is available to all students, principals must have a comprehensive understanding of the relationship between quality mathematics teaching and effective instructional leadership practices. This is complicated by the fact that although principals are responsible for supervising mathematics instruction, many lack a background in mathematics (Balka et al., 2010; Cummings, 2016; Stein & Nelson, 2003). However, Marzano et al. (2005) maintained that by applying research-based instructional leadership practices, principals can

positively impact the academic success of students. Ultimately, principals must recognize that providing a quality mathematics education to all students is an essential step in ensuring their successful futures and must not be left to chance (McAskill, Holmes, Francis-Pelton & Watt, 2004; O'Connor et al., 2016; Organisation for Economic Co-operation and Development, 2016b; Stokke, 2015).

Outline of the Remainder of the Paper

As outlined in Chapter 1, this capstone was focused on how principals without a background in mathematics can ensure the academic success of students in mathematics. Chapter 2 is a review of the relevant literature regarding teaching practices and instructional leadership practices that have been found to result in improved academic achievement of students in mathematics. Finally, Chapter 3 provides recommendations on how principals can enhance their knowledge and skills in an effort to increase the academic achievement of students in mathematics.

Chapter 2: Literature Review

Introduction

Due to the social and economic impact academic achievement in mathematics can have on students later in their lives, mathematics education is an area that must be considered by educators (McAskill et al., 2004; O'Connor et al, 2016; Organisation for Economic Co-operation and Development, 2016b; Stokke, 2015). Ensuring that students are provided with effective mathematics instruction and are prepared for future success is a fundamental purpose of the educational system (Alberta Education, 2013; National Council of Teachers of Mathematics, 2012). As a school leader, this responsibility falls on the principal (Alberta Education, 2009). Many principals, however, lack a background in mathematics yet are still held to this high standard (Balka et al., 2010; Cummings, 2016; Stein & Nelson, 2003). Through a review of the current literature, the problem addressed by this capstone is how principals who lack a background in mathematics can ensure the academic success of students in mathematics.

Balka et al. (2010) argued that in order to ensure student success in mathematics, it is essential that principals understand the relationship between quality mathematics teaching and effective instructional leadership practices. This literature review, therefore, is focused on two key areas. The first of these key areas is that a clear understanding of current instructional practices has been found to help principals ensure student academic achievement (Alberta Education, 2009; Marzano et al., 2005). Thus, the first section of Chapter 2 is a review of teaching practices that have been shown to increase student achievement in mathematics. Additionally, it was found that principals must also recognize which instructional leadership practices contribute to increased student achievement (Marzano et al., 2005; Leigh Sanzo, Sherman, & Clayton, 2011; O'Donnell & White, 2005). Correspondingly, the second portion of

Chapter 2 is an examination of the instructional leadership practices of principals that have resulted in increased student achievement in mathematics.

Components of Effective Mathematics Instruction

To effectively provide students with a quality education, principals must have a comprehensive understanding of teaching and learning (Alberta Education, 2009). The components of effective mathematics instruction makes mathematics a complex subject to teach (Alberta Education, 2016; National Council of Teachers of Mathematics, 2014). Still, Alberta Education requires mathematics teachers to meet general expectations for teaching as well as teach mathematics-specific outcomes as outlined in the program of studies (Alberta Education, 1997, 2013, 2016). Although curricular documents from Alberta Education (2016) provide guidance and direction, effective teaching is required to ensure that students gain the knowledge, skills, and attitudes necessary for success in mathematics (National Council of Teachers of Mathematics, 2014). Therefore, the first section of this literature review draws attention to four areas that impact the effective teaching of mathematics: (a) teachers' knowledge of mathematics, (b) teachers' knowledge of students, (c) the learning environment, and (d) approach to instruction.

Teachers' knowledge of mathematics.

To properly supervise and support mathematics teachers, principals must recognize that the teachers' understanding of mathematical content is an essential component of quality instruction (Alberta Education, 1997, 2009). Specifically, two areas found to impact a quality mathematics education are the teachers' content knowledge and need for career-long learning. First, researchers have found that teachers' mathematical content knowledge has been demonstrated to impact student achievement (Hill, Rowan & Ball, 2005; Jacobs, Franke,

Carpenter, Levi, & Battery, 2007; McDonald, Polnick & Robles-Pina, 2013). Second, enhancement of knowledge and skills is a professional obligation requiring participation in professional development (PD) and collaborative opportunities (Alberta Education, 1997). Therefore, in an effort to ensure the academic success of all students in mathematics, principals and teachers must work to increase the content knowledge of teachers (Alberta Education, 1997, 2009).

To effectively teach mathematics, teachers are required to have a deep understanding of the concepts and skills students are expected to learn (Alberta Education, 1997; National Council of Teachers of Mathematics, 2014). Moreover, teachers' content knowledge has been demonstrated to be a significant predictor of student achievement (Hill et al., 2005; Jacobs et al., 2007; McDonald et al., 2013). For example, the Organisation for Economic Co-operation and Development (OECD) (OECD, 2016b) concluded that the teachers' content knowledge impacted their instructional strategy selection and influenced their students' approach towards mathematics. Additionally, it was found that teachers who did not have the necessary mathematical proficiency often overlooked opportunities to deepen students' learning (Nolan, Dixon, Roy & Andreasen, 2016). Extending beyond this basic understanding of the curriculum, researchers have concluded that a comprehensive grasp of mathematics provides teachers with a foundation for informed decision making and instruction (Alberta Education, 1997; McDonald et al., 2013; O'Connor et al., 2016). Furthermore, providing students with optimal learning opportunities requires teachers to continually enhance their content knowledge through the use of PD and opportunities for professional collaboration (Alberta Education, 1997).

Collaboration and other forms of professional development (PD) are essential for effective teaching (Alberta Education, 1997). Since teachers are not expected to develop this

crucial content knowledge in isolation, career-long learning and collaboration are also essential components of effective instruction (Alberta Education, 1997). Meaningful collaboration and PD have been demonstrated to increase individual and collective teacher efficacy, ultimately resulting in enhanced achievement by students (Chao, Murray & Gutierrez, 2014; National Council of Teachers of Mathematics, 2014). However, it is important to recognize that not all collaborative and PD opportunities boost student learning (Murray, Ma, & Mazur, 2009). PD which integrated content knowledge with pedagogy was shown to have a greater impact on teacher effectiveness than when content knowledge and pedagogy were considered in isolation (Boaler & Foster, 2014; Doerr, Goldsmith, & Lewis, 2010; Garet, Porter, Desimone, Birman, & Yoon, 2001; McAskill et al., 2004; OECD, 2016b). Mathematics teachers must commit to continued professional growth if they are to have the knowledge and skills required to ensure all students succeed in mathematics (National Council of Teachers of Mathematics, 2014). Ultimately, effective instruction is based on more than content knowledge; teachers must also understand the unique qualities and backgrounds of their students (Alberta Education, 1997).

Teachers' knowledge of students.

To effectively supervise and support mathematics teachers, principals must recognize that the understanding teachers have of their students is an integral component of effective instruction (Alberta Education, 1997, 2009). Researchers have found two elements of teachers' understanding of their students that impact effective instruction. The first of these two elements, the development of authentic relationships with students, allows teachers to understand the unique qualities of each student (Alberta Education, 1997). Secondly, these relationships enable teachers to understand and impact the beliefs students hold regarding mathematics (Boaler, 2016). As instructional decision-making is impacted by what teachers know about their students,

development of these authentic relationships with students is foundational to effective instruction (Alberta Education, 1997).

The first of these elements is the relationships teachers have with their students. For optimum student learning, teachers must augment content knowledge with a thorough understanding of their students (Alberta Education, 1997). Formation of these authentic relationships with students enables teachers to learn unique aspects of each child (Alberta Education, 1997). Therefore, these relationships are essential, as teachers who comprehend the needs, experiences, and backgrounds of individual students are better able to utilize appropriate instructional strategies and provide students with effective interventions (Alberta Education, 1997, 2010, 2016; Chao et al., 2014; McAskill et al., 2004). In support of these authentic relationships, researchers have also shown that all students can learn mathematics when they are provided quality instruction and support to fit their needs (Boaler, 2013; Boaler & Foster, 2014; Burris, Heubert, & Levin, 2006; Slavin & Lake, 2008). For example, teachers must take into consideration how students' culture or socioeconomic status can impact their preferred learning style or attitude towards mathematics (Alberta Education, 1997; Chao et al., 2014; McAskill et al., 2004; OECD, 2016b). In summary, one key element is that the development of authentic and supportive relationships with students provides teachers with the insight necessary to enhance both the teaching and learning of mathematics (Alberta Education, 1997; OECD, 2016b).

The second area in which teachers need to understand their students is recognizing and attending to the beliefs students hold regarding mathematics. Alberta Education (2016) has also emphasized the importance of teachers focusing on the attitudes, feelings, and emotions student have towards learning mathematics. The beliefs students hold regarding mathematics and their personal abilities have been demonstrated to affect their effort, participation, persistence, and

motivation (Alberta Education, 2016; OECD, 2016b; Pantziara & Philippou, 2015). For example, feelings of anxiety and fear regarding mathematics have been shown to reduce the working memory of students (Boaler, 2015a). These negative emotions can prevent students from demonstrating their true mathematical abilities (OECD, 2016b). A positive attitude towards mathematics, however, has been linked to students with a belief in their own mathematical abilities (Boaler, 2016; OECD, 2016b). This self-confidence results in students who are resilient, enjoy learning, and seek challenge, essential characteristics of successful mathematics students (Alberta Education, 2016; Boaler, 2013, 2016; O'Connor et al., 2016). Finally, mathematics teachers are responsible for creating a learning environment where students are encouraged to enhance their self-confidence and develop positive attitudes towards learning mathematics (Alberta Education, 2016; Boaler, 2013, 2016; National Council of Teachers of Mathematics, 2014). Consequently, the formation of a positive and disciplined learning environment is essential for quality mathematics instruction.

Learning environment.

In order to provide mathematics teachers with effective supervision and support, principals must understand the need for teachers to ensure the classroom environment supports student learning (Alberta Education, 1997, 2009). Researchers have emphasized two key areas in which the classroom environment affects the learning of mathematics. First, the disciplinary climate of the mathematics classroom has a direct impact on student learning (OECD, 2016b). Secondly, students must feel supported and secure if they are to explore and learn mathematics to a high level (National Council of Teachers of Mathematics, 2014). It is important for teachers to understand how their classroom environment impacts students' learning of mathematics.

For teachers to provide a safe and supportive learning environment, they must first maintain appropriate student behaviour in the classroom (Alberta Education, 1997). This is essential as the disciplinary climate created by the teacher has been demonstrated to impact the mathematical skill level of students (OECD, 2016b). Alberta Education (1997, 2016) and the National Council of Teachers of Mathematics (NCTM) (2014) recognized this connection and emphasized that students must feel respected and safe in their learning environment if they are to take risks and grow as mathematicians. Student involvement in the creation of classroom routines and norms is one strategy to develop a disciplined yet encouraging learning environment for students (Alberta Education, 1997; Boaler, 2016). These supportive parameters of established routines and norms at work within a disciplinary climate provide students with a safe learning environment (Alberta Education, 1997). It is important that this feeling of safety also be evident in how students learn mathematics.

Secondly, it is important teachers attend to the messages and opportunities they provide students. These messages and opportunities impact the development of a learning environment in which students feel safe and valued (Alberta Education, 2016; Boaler, 2016). For example, mathematical risk taking and growth is encouraged when teachers utilize student errors as opportunities for learning, rather than an indicator of ability (Boaler, 2013, 2016; O'Connor et al., 2016). Additionally, placement of emphasis on the mathematical process rather than the final answer allows students to explore a variety of strategies, further developing their mathematical confidence (Alberta Education, 2016; Boaler, 1998, 2016; OECD, 2016b). A student's understanding of mathematics is also enhanced through opportunities to communicate their reasoning and consider the alternative approaches of others (Alberta Education, 2016; Cirillo, 2013; McAskill et al., 2004; McDonald et al., 2013; OECD, 2016b). Therefore, in order to

ensure the mathematical success of all students, teachers need to develop classroom environments that allow students to feel safe and secure as they explore mathematics (NCTM, 2014). In addition to a supportive learning environment, effective approaches to mathematics instruction are necessary for students to learn at high levels.

Approach to instruction.

In addition to being supervised by principals, teachers are expected to monitor the effectiveness of their own teaching practices and ensure high-quality instruction by implementing changes as necessary (Alberta Education, 1997, 2009). The willingness of teachers to monitor and enhance their instruction is significant in the teaching of mathematics (NCTM, 2014; OECD, 2016b). Moreover, four key areas related to how teachers approach instruction have been found in the literature. Firstly, an understanding of how students learn mathematics provides a foundation for effective instruction (Alberta Education, 2016). Secondly, it is important students be allowed to develop a personal understanding of mathematics (Alberta Education, 2016; NCTM, 2014). The development of students' problem-solving skills is the third key area indicated by research (Alberta Education, 2010, 2013; Boaler, 2015b; OECD, 2016b). Finally, effective mathematics teachers utilize a variety of research-based instructional strategies (Alberta Education, 2016; NCTM, 2014). As the approach to instruction taken by teachers has a significant effect on student learning, it is essential teachers develop an understanding of how students learn mathematics.

The first key area regarding teachers' approach to instruction requires an understanding of how students develop mathematical knowledge and skills. To ensure students develop high-level problem-solving and mathematical skills, instruction must reflect how students learn mathematics (Alberta Education, 2016). The OECD (2016b) stated that students who were

taught mathematics based on memorization of facts and traditional algorithms demonstrated skill in completing basic questions but did not achieve success with more complex problems (OECD, 2016b). It has also been noted by researchers that students require opportunities to develop conceptual understanding before advancing to procedural fluency (McAskill et al., 2004; NCTM, 2014). Therefore, it was found that planning instruction to guide students from conceptual to procedural understanding has been shown to improve the mathematical abilities of students (McDonald et al., 2013; NCTM, 2014). This progression of understanding requires teachers to help students navigate from simple to complex concepts using concrete, pictorial, and symbolic representations (Alberta Education, 2016; NCTM, 2014). As teachers ensure that instruction progresses from concrete to abstract representations, students are provided the opportunity to form their own understanding of mathematics (Alberta Education, 2016). The development of students' personal understanding of mathematics has therefore been found to be dependent upon teachers to understand the important role student reasoning plays in the learning of mathematics.

The second area evident in the research is the need for students to develop their own understanding of mathematics. Boaler (2016) emphasized reasoning as the core of mathematics (Boaler, 2015a). Students must, therefore, be allowed to establish their own mathematical understanding (Alberta Education, 2016; NCTM, 2014). After teachers ensure students have a conceptual understanding of a skill, instruction may progress to an exploration of procedural strategies (Alberta Education, 2016). Traditional algorithms cannot be taught in isolation or mandated as the only correct method; it is essential students have the freedom to explore a variety of procedural strategies and select a preferred strategy based on their current understanding and ability level (Alberta Education 2016; Boaler, 2015a). To ensure students can utilize mathematics in a flexible and purposeful way, teachers must encourage students to

develop personal connections to a variety of mathematical approaches and strategies (Alberta Education, 2016; Boaler, 2015a; NCTM, 2014). If students are to understand the purpose behind these approaches and strategies, however, they must be provided opportunities to solve complex problems (OECD, 2016b).

A focus on complex problem solving is the third approach to instruction made clear in the research. As teachers consider their approach to mathematics instruction, the development of students' problem-solving abilities must be a priority (Alberta Education, 2013, 2016; Boaler 2001, 2016). Ensuring students can solve complex problems is a legislated goal of the Alberta educational system and is considered to be an essential skill in the workplace (Alberta Education, 2013). Therefore, students must become experienced problem solvers, able to flexibly apply mathematics in real-world situations (Alberta Education, 2010, 2013; Boaler, 2015b; OECD, 2016b). The benefits of immersing students in problem-solving go beyond the development of problem-solving skills alone. As found in the research, students' mathematical literacy increased when they were provided opportunities to solve authentic problems requiring mathematical reasoning, communication and connections between mathematical concepts (Alberta Education, 2016; McAskill et al., 2004; NCTM, 2012; OECD, 2016b). Additionally, the OECD (2016b) indicated that increased mathematical success resulted from teaching students to examine problems, consider a variety of strategies, and utilize mistakes as learning opportunities. Along with preparing students to utilize problem-solving skills in the workplace, researchers have concluded that students with frequent exposure to real-world problems requiring the application of mathematical skills and reasoning were more positive about their mathematical abilities than students without that exposure (Boaler, 2017; OECD, 2016b). Teachers must understand that the development of students' problem-solving abilities goes far beyond meeting a goal set by

Alberta Education (2013). These problem-solving abilities enable students to think deeply and understand the real-world application of mathematical concepts (OECD, 2016b). To fully develop the problem-solving abilities of students, it is necessary for teachers to implement a diverse range of research-based instructional strategies (Alberta Education, 2016; NCTM, 2014).

Lastly, the connection between appropriate instructional strategy selection and student learning is supported by researchers. To meet Alberta Education's (2016) goals for mathematics instruction, teachers must utilize a variety of research-based instructional strategies (Alberta Education, 2016; NCTM, 2014). The selection of instructional strategies by teachers should be based on student need, concept complexity, and formative assessment (Alberta Education, 1997; NCTM, 2014; OECD, 2016b). It is important to note that gains in student academic achievement were found to be highest when teachers utilized a balance of teacher-centered and student-centered instructional strategies (MacDonald et al., 2013; OECD, 2016b). Additionally, a traditional textbook approach with a focus on memorization of rules and procedures has been demonstrated to not provide students with the understanding and skill necessary for high-level problem-solving (Boaler, 1998, 2016; OECD, 2016b). Reliance on a single instructional strategy does not provide the depth of instruction and learning required to ensure student understanding of mathematical concepts and skills; therefore, it is necessary for teachers to understand and implement a variety of research-based instructional strategies (OECD, 2016b).

In conclusion, the current research and literature provided evidence that teachers must attend to multiple areas to provide students with a quality mathematics education. A solid understanding of the mathematical content allows teachers to make informed instructional decisions (Alberta Education, 1997; McDonald et al., 2013; O'Connor et al., 2016). Additionally, the development of authentic relationships with students has been shown to

provide teachers with the ability to meet students' individual needs and to ensure academic achievement (Alberta Education, 1997, 2010, 2016; Chao et al., 2014; McAskill et al., 2004). A learning environment of respect and safety was found to be essential if students are to take risks and develop their mathematical abilities (Alberta Education, 1997, 2016; NCTM, 2014). Once these three items are in place, teachers can turn their attention to their instructional approach. Students require the opportunity to develop concrete understandings before being required to develop procedural fluency (McAskill et al., 2004; NCTM, 2014). Similarly, problem-solving must be a foundational approach to mathematics learning for students, enabling them to flexibly apply mathematics in real-world situations (Alberta Education, 2010, 2013; Boaler, 2015b; OECD, 2016b). Ultimately, teachers should base their instructional strategy selection on an understanding of concept complexity, student needs, and the ongoing use of formative assessment (Alberta Education, 1997; NCTM, 2014; OECD, 2016b). As teaching mathematics is a complicated task that requires teachers to have the knowledge and skills necessary to ensure academic achievement for all students, principals must understand the components of quality mathematics instruction to assist all teachers in achieving this high standard (NCTM, 2014).

Leadership Practices Which Improve the Mathematics Achievement of Students

The primary responsibility of principals is to increase the academic achievement of students; this is achieved by ensuring students are provided quality instruction and learning opportunities (Alberta Education, 2009; O'Donnell & White, 2005). Researchers have determined that effective leadership by principals has been shown to have a significant effect on the achievement of students (DuFour & Marzano, 2011; Marzano et al., 2005; Ross & Gray, 2006). In exploring the connection between leadership and student achievement, researchers

have also demonstrated that although principals had little direct impact on student learning, they indirectly increased student achievement through positively impacting the efficacy and commitment of teachers (DuFour & Marzano, 2011; Marzano et al., 2005; Ross & Gray, 2006). The resulting correlation between leadership, teacher efficacy, and student achievement holds true in the teaching and learning of mathematics (Dumay, Boonen, & Damme, 2013). Therefore, it is important that principals understand how they can positively impact the academic achievement of students (Alberta Education, 2009).

Part Two of this literature review draws attention to three areas that impact the ability of principals to improve the mathematics achievement of students: content and leadership knowledge, the purposeful creation of a mathematics learning environment, and methods to increase teacher efficacy. Although effective leadership comes in different forms, principals who want to increase the academic achievement of students must consistently cultivate a school culture and instructional program focused on student learning and teacher growth (Shannon & Bylsma, 2007). These efforts, however, are significantly impacted by the content and leadership knowledge of principals (Balka et al., 2010; Katterfeld, 2013; Marzano et al., 2005).

The knowledge of principals.

The ability of principals to be effective instructional leaders is impacted by their knowledge and skills (Alberta Education, 2009; Marzano et al., 2005). More specifically, in the role of instructional leader, principals are required to understand curriculum as well as current pedagogy (Alberta Education, 2009). Yet, many principals lack knowledge or expertise in mathematical content (Balka et al., 2010; Cummings, 2016; Stein & Nelson, 2003). As this content knowledge has been demonstrated to impact the leadership actions principals take regarding mathematics teaching and learning in their schools, its importance cannot be

overlooked (Stein & Nelson, 2003). When considering the impact of the content knowledge of principals, Marzano et al. (2005), however, provided evidence that a solid understanding of best practices regarding instruction and assessment had a greater impact on the academic achievement of students than content knowledge alone. Katterfeld (2013) reinforced this concept by also connecting increased student learning in mathematics with the instructional leadership knowledge and skills of principals. Therefore, although a lack of content knowledge does not preclude principals from positively impacting student achievement, principals who wish to be more effective should work to increase their instructional leadership skills and knowledge of mathematics content (Stein & Nelson, 2003; Cummings, 2016; Katterfeld, 2013). The combination of mathematical knowledge and instructional leadership skills enables principals to become informed visionaries, prepared to develop and implement a plan for increasing student academic achievement in mathematics (Balka et al., 2010).

Development of the learning environment.

Through quality leadership, principals are also expected to support and sustain a learning environment focused on the academic achievement of students (Alberta Education, 2009). Researchers have emphasized three key areas in which principals are able to significantly impact the mathematics learning environment. First, student achievement has been shown to increase when principals work to develop a personal vision of mathematics education followed by the collaborative development of a vision shared amongst staff (Katterfeld, 2013). Second, the development of a school culture based on high expectations of staff and students has a positive impact on learning and teaching (National Council of Teachers of Mathematics, 2014). Thirdly, relationships built on trust must be developed between principals and teachers (Crum & Sherman, 2008). All three of these areas are significant as the collective vision and culture of a

school must be the foundation upon which principals develop plans, make decisions, and take action to improve the learning of students (Alberta Education, 2009). It is the role of the principal, however, to work collaboratively with staff to create a shared vision for increasing student academic achievement (Leigh Sanzo et al., 2011).

A vision for mathematics learning is the first area of consideration in the development of the learning environment which is centered on the academic achievement of students. The formation of a personal vision for mathematics learning and teaching provides principals with a necessary foundation on which to base related decisions and actions (Balca et al., 2010). As these decisions and actions directly impact the instruction and learning of mathematics, Katterfeld (2013) argued this vision must be detailed and based on a solid understanding of instructional practices. Once this personal vision has been established, principals of effective schools can work collaboratively with staff to create a shared vision (Leigh Sanzo et al., 2011; Shannon & Bylsma, 2007). When this shared vision is understood by all staff and is evident in the decisions and actions taken by principals, there was found to be a greater impact on student learning (NCTM, 2014). Furthermore, it is this principal leadership, focused on the formation and communication of a shared vision of mathematics education, which is key to the development of a culture focused on teaching and learning (Dumay et al., 2013).

Secondly, the development of a culture of high expectations must be considered by principals looking to increase student learning. Marzano et al. (2005) emphasized that effective principals can build a school culture that has a positive influence on staff who then positively impact students. Moreover, principals are ultimately responsible for fostering and maintaining a culture of high expectations for both students and staff (Alberta Education, 2009; NCTM, 2014). Clark (2013) pointed out that when teachers are held to high standards, they can be held

accountable for instructional improvement and student achievement. However, for a culture of high expectations to result in student achievement, it must be accompanied by a supportive learning environment for staff and students alike (Shannon & Bylsma, 2007). Effective principals are able to encourage and support the professional growth of teachers by creating an environment of trust and caring (O'Donnell & White, 2005).

Thirdly, although principals are to be focused on increasing the academic achievement of students, this cannot be done without the development of trusting relationships with staff (Alberta Education, 2009; Balka et al., 2010; Clark, 2013; Crum & Sherman, 2008). Through connecting with individual teachers on a personal and professional level, principals can foster and sustain essential relationships with teachers (Clark, 2013; Marzano et al., 2005). Additionally, principals can earn the trust of staff by being honest and open (Alberta Education, 2009; Balka et al., 2010; Hoerr, 2005; Leigh Sanzo et al., 2011). Thus, principals who wish their teachers to be comfortable in taking risks and growing professionally must first take the time and effort required to develop trusting relationships (Leigh Sanzo et al., 2011; O'Donnell & White, 2005). Once these trusting relationships are in place, principals can begin to implement instructional leadership practices designed to increase teacher efficacy (Crum & Sherman, 2008).

Supporting and sustaining a learning environment focused on the academic achievement of students is the responsibility of principals (Alberta Education, 2009). Through a review of current literature, the three key areas that were emphasized all reinforced the concept that principals are able to significantly impact the mathematics learning environment. First, the personal vision of mathematics education held by principals has been shown to increase student achievement in mathematics when it is transformed into a vision shared by school staff

(Katterfeld, 2013). Second, the teaching and learning of mathematics are positively impacted by the development of a school culture based on high expectations of staff and students (NCTM, 2014). Lastly, through the development of trusting relationships with teachers, principals are able to encourage and empower staff (Crum & Sherman, 2008). A common vision, culture of high expectations, and formation of trusting relationships provide a solid foundation upon which principals can increase teacher efficacy and ensure the mathematics achievement of all students (Balka et al., 2010).

Practices to increase teacher efficacy.

As teaching quality significantly impacts student learning, principals must understand and utilize practices designed to increase teacher efficacy (DuFour & Marzano, 2011). Principals are required to take the necessary actions in order to ensure students consistently receive quality instruction (Alberta Education, 2009; DuFour & Marzano, 2011). Four instructional leadership practices that enhance teacher efficacy have been found in a review of the relevant literature: (a) data analysis to inform instruction, (b) classroom walkthroughs and feedback, (c) professional development, and (d) teacher collaboration. Each practice enables principals to support teachers as they address instructional issues, increase their knowledge of content and pedagogy, and ultimately enhance their efficacy (Balka et al., 2010). By starting with an examination of student assessment data, principals and teachers are able to identify areas of instruction which require attention (Clark, 2013).

The analysis of student assessment data is the first strategy for increasing teacher efficacy covered in this section of the literature review. To assess progress towards goals such as increasing student academic achievement and enhancing teacher efficacy, principals are expected to analyze data from a variety of sources (Alberta Education, 2009). In the research on effective

schools, the practice of analyzing data by principals and teachers has been noted to inform instruction and thereby increase student learning (Clark, 2013; Masumoto & Brown-Welty, 2009; Shannon & Bylsma, 2007). Student assessments, assignments, and performances can be scrutinized in order to better understand the academic progress of students (Shannon & Bylsma, 2007). For example, through Alberta's standardized Provincial Achievement Tests (PAT), teachers, principals, and school districts are provided valuable data regarding student achievement which can be used to inform instruction and increase student learning (Alberta Education, n.d. a). In mathematics specifically, this wealth of data can be used by teachers and principals to monitor student learning and identify effective instructional practices (Balka et al., 2010; Clark, 2013). Furthermore, Clark (2013) noted that changes to instructional practices resulted from teachers taking the time to analyze assessment data. Therefore, principals can positively impact student learning and reinforce high expectations of staff by requiring teachers to utilize available data to inform their instructional practices (Balka et al., 2010; Clark, 2013; Williams, 2013). This data, however, is not the only source of information that can impact teacher efficacy. Principals must also consider information gathered through personal observations of teachers and students engaged in mathematics (Williams, 2013).

Secondly, a legislated requirement of principals is to provide teachers with continual supervision, support, and guidance (Alberta Education, n.d. b, 2009). Frequent classroom visits enable principals to effectively monitor teaching and learning throughout the school and provide teachers with essential feedback (Balka et al., 2010; Shannon & Bylsma, 2007). This practice makes it possible for principals to communicate high expectations and provide the support necessary for teacher growth (Balka et al., 2010; Shannon & Bylsma, 2007). Researchers have also demonstrated that principals with high achieving students in mathematics regularly observed

mathematics classes and provided teachers with feedback targeted at improving instruction and increasing student achievement (Cobb & Jackson, 2011; Williams, 2013). It is important, however, that principals understand what constitutes quality mathematics instruction and focus on areas such as students' mathematical reasoning rather than emphasizing student behaviour (NCTM, n.d.). Ultimately, by engaging in classroom visits, principals are able to determine specific instructional growth areas for teachers and increase teacher efficacy by providing targeted PD opportunities (Ross & Gray, 2006).

Thirdly, focused professional development is another practice principals can use to increase the effectiveness of teachers and ensure student achievement (Balka et al., 2010). Through research conducted on successful schools, principals of these schools were noted to consistently facilitate PD as a method of increasing teacher capacity, improving student learning, and reinforcing school and district priorities (Leigh Sanzo et al., 2011; Shannon & Bylsma, 2007). Ultimately, the goal of mathematics PD should be to ensure all teachers have high levels of content and pedagogical knowledge with which to impact student achievement (Balka et al., 2010; Kanold, 2010). Additionally, it is important for principals to understand that connecting teaching practices to current research requires long-term PD, not a single and isolated session (Kanold, 2010; NCTM, n.d.). To ensure that knowledge gained from PD is transferred into the teaching of mathematics, principals need to follow through and support teachers in their endeavours (Cobb & Jackson, 2011; Kanold, 2010). The integration of collaborative structures enables principals to further support teachers as colleagues are provided opportunities to collaboratively apply new skills and increase their personal and collective teaching efficacy (Balka et al., 2010; DuFour & Marzano, 2011; NCTM, 2014).

Finally, moving away from professional isolation, teacher collaboration has been shown to have a significant impact on the professional growth of teachers and the academic achievement of students (Dumay et al., 2013; Masumoto & Brown-Welty, 2009; NCTM, 2014). Additionally, teacher collaboration helps to develop a sense of community among mathematics teachers and an atmosphere of positive influence as all team members work towards continued growth (Balka et al., 2010). A collaborative culture, however, requires effective leadership on the part of the principal (DuFour & Marzano, 2011; Murray et al., 2009). The principal must set aside time for teachers to engage in peer observations, common planning, and peer coaching (Balka et al., 2010; NCTM, n.d., 2014). Collaborative structures, such as a professional learning community, provide teachers with opportunities to support colleagues and increase the collective teaching efficacy through leveraging the experiences, skills, and understandings of each participant (Balka et al., 2011; Hoerr, 2005). Ultimately, teacher collaboration provides principals with the opportunity to increase the consistency of mathematics teaching throughout the school; ensuring all students are provided with a quality education and held to the same high standards (Clark, 2013).

In conclusion, the ultimate goal of principals is to increase the academic achievement of students by ensuring they are provided quality instruction and learning opportunities (Alberta Education, 2009; O'Donnell & White, 2005). Through instructional leadership practices proven to enhance the learning environment and increase teacher efficacy, principals can have a significant impact on the teaching and learning of mathematics (Balka et al., 2010). Although content knowledge is beneficial, it is the leadership knowledge and skills of the principal that have the most significant impact (Balka et al., 2010). Principals must, however, take the time to develop a personal and collective vision of mathematics education as it has been demonstrated to

support a culture of high expectations for students and staff (Katterfeld, 2013). This culture is further reinforced as principals work to increase teacher efficacy through examination of data, classroom observations and feedback, PD opportunities, and the inclusion of collaborative structures for teachers (Balka et al., 2010). With the ultimate responsibility for student learning, principals must focus their time and energy on instructional leadership practices proven to positively impact teacher efficacy and correspondingly, the academic achievement of students in mathematics (Balka et al., 2010).

Summary

In summary, a review of research has demonstrated that as principals are mandated to ensure the success of all students, it is essential they understand the relationship between quality mathematics teaching and effective instructional leadership practices (Balka et al., 2010). Thus, the first part of the literature review was an examination of teaching practices that have been demonstrated to improve the mathematics achievement of students. As the teaching of mathematics is a complex task, teachers are required to have essential knowledge and skills to ensure the academic achievement of students (NCTM, 2014). Mathematical content knowledge provides teachers with the foundation to make informed instructional decisions (Alberta Education, 1997; McDonald et al., 2013; O'Connor et al., 2016). Yet, when content knowledge is combined with information gathered through the formation of authentic relationships with students, teachers are able to meet the individual needs of students and help to ensure their academic achievement (Alberta Education, 1997, 2010, 2016; Chao et al., 2014; McAskill et al., 2004). Additionally, teachers must create learning environments where students feel secure and safe in taking the risks necessary to learn mathematics (Alberta Education, 1997, 2016; NCTM, 2014). In conjunction with those areas, the effective teaching of mathematics is centered around

research-based instructional strategies selected based on an understanding of content complexity, student needs, and ongoing formative assessment (Alberta Education, 1997; NCTM, 2014; OECD, 2016b). Based on an understanding of these effective teaching practices, principals can implement instructional leadership practices which have also been shown to positively impact student achievement.

As many principals do not have a background in mathematics, it is important to note that although content knowledge is beneficial, it is the leadership knowledge and skills of the principal that have the most significant impact on student achievement (Balka et al., 2010). As such, researchers have demonstrated that principals are advised to begin by developing a personal vision of mathematics education on which to foster a collective vision shared by staff and a culture of high expectations for staff and students (Balka et al., 2010; Katterfeld, 2013). Principals are then able to reinforce this culture and increase teacher efficacy through analyzing data, completing classroom observations and providing feedback, arranging targeted PD for teachers, and ensuring teachers have access to collaborative opportunities (Balka et al., 2010). With the ultimate responsibility for student learning resting on them, principals must focus their time and energy on instructional leadership practices proven to positively impact teacher efficacy and, correspondingly, the academic achievement of students in mathematics (Balka et al., 2010).

Outline of the Remainder of the Paper

Chapter 2 was a review of the literature on the practices of teachers and principals that have been demonstrated to increase student academic achievement. The conclusion, reached through a review of the literature, is that by understanding the practices of effective mathematics instruction, development of a personal vision of mathematics education, and implementation of

instructional leadership practices proven to increase teacher efficacy, principals without a background in mathematics education are able to increase the academic achievement of mathematics students. Chapter 3 is a review of the conclusions reached in Chapter 2 and contains recommendations designed to assist principals without a background in mathematics to develop the knowledge and skills necessary to ensure the academic achievement of students in mathematics.

Chapter 3: Summary, Recommendations, and Conclusions

Students' mathematical understanding has been shown to be a strong predictor of their future academic success and career options (National Mathematics Advisory Panel, 2008). It has been discovered that principals must, therefore, take the actions necessary to ensure mathematics students achieve at high levels (NCTM, 2014). Although responsible for supervising mathematics instruction and learning, many principals do not have a background in mathematics (Balka et al., 2010; Cummings, 2016; Stein & Nelson, 2003). The purpose of this capstone was to ascertain how principals without a background in mathematics can ensure the academic success of students in mathematics. Further research in this area is supported by Balka et al. (2010) as they maintained that in order to increase the academic achievement of students in mathematics, principals must understand the relationship between quality mathematics teaching and effective instructional leadership practices. As such, Chapter 2 was a review and examination of current literature related to the teaching and learning of mathematics, as well as a description of instructional leadership practices demonstrated to improve the mathematics achievement of students. Ultimately, it was discovered that there are concrete steps that can be taken by principals who lack a background in mathematics in order to ensure the academic success of students in mathematics (Balka et al., 2010; Clark, 2013; Katterfeld, 2013; Stein & Nelson, 2003; Williams, 2013).

The initial portion of Chapter 2 was a review of current literature regarding teaching practices which have been found to improve the academic achievement of students in mathematics. It was found that the content knowledge of teachers is an essential component of quality instruction, as it provides the basis on which teachers can make informed instructional decisions (Alberta Education, 1997; McDonald et al., 2013; O'Connor et al., 2016).

Additionally, teachers must implement research-based instructional strategies which are selected based on student need, content complexity, and ongoing formative assessment (Alberta Education, 1997; NCTM, 2014; OECD, 2016b). Finally, teachers must ensure students are provided with a learning environment in which students feel safe and secure in taking the risks necessary to learn mathematics (Alberta Education, 2016; NCTM, 2014). Based on this understanding of teaching practices that improve the academic achievement of students in mathematics, principals can further enhance student achievement by implementing related instructional leadership practices.

The second portion of Chapter 2 was an examination of the instructional leadership practices which have been found to improve the academic achievement of students in mathematics. The instructional leadership knowledge and skills of principals were found to have a more significant impact on student achievement than the content knowledge held by principals (Balka et al., 2010; Katterfeld, 2013; Marzano et al., 2005). Furthermore, principals must have a personal vision of mathematics education which fosters a collective vision and culture of high expectations (Balka et al., 2010; Katterfeld, 2013). Principals can then work to increase teacher efficacy through instructional leadership practices such as (a) analyzing data, (b) completing classroom observations and providing feedback, (c) arranging targeted PD for teachers, and (d) ensuring teachers have access to collaborative opportunities (Balka et al., 2010). Finally, Balka et al. (2010) argued that principals looking to increase student achievement in mathematics must understand the connections between quality mathematics teaching and effective instructional leadership practices.

Findings and Implications of the Research

The central finding of the literature review is that through the use of effective instructional leadership practices, principals can compensate for a lack of mathematical content knowledge. This is significant as principals, regardless of content knowledge, are mandated to provide teachers with the instructional leadership necessary to ensure students have access to appropriate programming based on research-based pedagogy and curriculum (Alberta Education, 2009). Although content knowledge in mathematics is beneficial, researchers have also demonstrated it was not required for principals to positively impact teacher efficacy or student achievement in mathematics (Balka et al., 2010; Clark, 2013; Katterfeld, 2013; Williams, 2013). Moreover, the ability of principals to increase student academic achievement by understanding and utilizing instructional leadership practices remains effective regardless of the content area (Marzano et al., 2005). It follows that Alberta Education's (2009) expectation that principals must demonstrate the skilled use of instructional leadership practices would help principals to ensure the academic achievement of students. Therefore, the understanding that the effective use of instructional leadership practices can increase student learning may help principals to understand how they can fulfill the role of instructional leader in any area where they lack content knowledge. This ability of principals to compensate for a lack of content knowledge strikes at the core problem addressed throughout this capstone.

Summary Remarks

The problem addressed in this capstone was how principals without a background in mathematics can ensure the academic success of students in mathematics. An examination of related research demonstrated that the effective utilization of research-based instructional leadership practices by principals enables them to positively impact student achievement in

mathematics (Balka et al., 2010; Clark, 2013; Katterfeld, 2013; Williams, 2013). Although a background in mathematics was shown to enhance the decisions and actions made by principals, the impact of content knowledge was secondary to the utilization of effective instructional leadership practices (Balka et al., 2010; Clark, 2013; Katterfeld, 2013; Williams, 2013). Ultimately, it is by understanding the relationship between quality teaching and effective instructional leadership practices that principals are able to positively impact student achievement (Balka et al., 2010). Application of this understanding will help principals, regardless of their background in mathematics, to increase their knowledge and skills in an effort to ensure the academic success of students in mathematics. Those principals without a background in mathematics, however, may find greater value in the recommendations that follow.

Recommendations

As principals must hold themselves accountable for the academic achievement of students, it is essential they take the necessary steps to ensure the success of all students (Alberta Education, 2009; DuFour & Marzano, 2011). Therefore, the recommendations that follow are designed to assist principals without a background in mathematics to develop the knowledge and skills necessary to ensure the academic achievement of students in mathematics. Based on the literature review in Chapter 2 and the findings of researchers, principals must focus on increasing their skills and understanding in three main areas: instructional leadership practices, the quality teaching of mathematics, and mathematical content. Due to the impact principals have on the academic achievement of students, it is important that principals take steps to increase their instructional leadership and mathematical knowledge and skills.

The first of these recommendations is that principals must continually work to enhance their instructional leadership skills (Alberta Education, 2009; Balka et al., 2010; DuFour & Marzano, 2011; Marzano et al, 2005; Williams, 2013). When these skills are utilized effectively by principals, student achievement in mathematics has been shown to increase (Balka et al., 2010; Williams, 2013). As reviewed in Chapter 2, instructional leadership skills that impact the achievement of students through increasing the efficacy of mathematics teachers are (a) using data analysis to inform instruction, (b) performing classroom walkthroughs and providing feedback, (c) providing targeted professional development, and (d) ensuring teacher collaboration. Williams (2013) suggested that principals should work to increase their instructional leadership skills through participation in leadership related PD. She also recommended principals be provided skilled mentors who have demonstrated an ability to increase the academic achievement of students in mathematics (Williams, 2013). Principals could also access release time in order to observe and meet with their mentor (Williams, 2013). Prior to William's (2013) research, O'Donnell and White (2005) emphasized that once principals are taught effective instructional leadership techniques, they must practice these techniques and be prepared to learn from their mistakes. As the effective use of instructional leadership skills has been demonstrated to increase teacher efficacy and thereby positively impact student achievement in mathematics, it is important principals develop an understanding of effective teaching practices (Balka et al, 2010; Katterfeld, 2013).

As quality instruction is key for student achievement in mathematics, the second recommendation is that principals work to ensure their understanding of effective teaching practices (Balka et al., 2010; Katterfeld, 2013, Williams, 2013). As discovered in the research, teaching practices which have been demonstrated to positively impact student achievement in

mathematics include teachers' knowledge of mathematics and their students, the creation of an effective learning environment, and a research-based approach to instruction. To increase their knowledge of effective mathematics instruction, principals can participate in mathematics related PD (Cummings, 2016). Additionally, observing highly effective mathematics teachers enables principals to increase their knowledge of teaching practices (Balka et al., 2010). Katterfeld (2013) also suggested that principals may benefit from having a support person within their school with knowledge of mathematics teaching. Ultimately, the ability of principals to be effective instructional leaders in mathematics is enhanced by a greater understanding of mathematics instruction (Cobb & Jackson, 2011). When this knowledge of effective teaching practices is grounded in an understanding of mathematical content, however, principals are able to increase their effectiveness as instructional leaders (Stein & Nelson, 2003).

The third recommendation for developing the knowledge and skills of principals is that principals should work to increase their understanding of mathematics content as a method of enhancing their instructional leadership abilities (Balka et al., 2010; Cummings, 2016; Katterfeld, 2013; Stein & Nelson, 2003). To do this, principals can participate in professional development related to mathematical content knowledge (Cummings, 2016; Katterfeld, 2013). Additionally, observing highly effective mathematics teachers can also provide principals with opportunities to increase their knowledge of mathematics content (Balka et al., 2010). Alternatively, principals can consult with a team of teachers who possess mathematical content expertise in order to help inform leadership decisions (Stein & Nelson, 2003). Similarly, Katterfeld (2013) suggested that principals may benefit from augmenting their personal knowledge of mathematics by having a support person within their school with knowledge of mathematics teaching. It is important principals understand that increasing their knowledge of

mathematics content positively impacts the leadership actions they take regarding mathematics teaching and learning (Balka et al., 2010; Cummings, 2016; Stein & Nelson, 2003).

In conclusion, it is essential that principals understand how they can gain the necessary knowledge and skills to improve their instructional leadership effectiveness in mathematics. By accessing related professional development, instructional leadership mentors, and highly effective mathematics teachers, principals can develop the leadership, instructional, and content knowledge necessary to ensure the academic success of all students in mathematics. Although the use of instructional leadership techniques enables principals without mathematics content knowledge to positively impact student achievement in mathematics, it is by connecting these skills with an understanding of mathematics learning, teaching, and content that principals are able to further enhance their effectiveness as instructional leaders (Stein & Nelson, 2003).

Suggested Research for the Future

Although the findings of this capstone indicate principals without a background in mathematics are able to increase the academic achievement of students through the use of effective instructional leadership practices, further research is needed. As the mathematical abilities of students have a significant impact on their futures, it is important that principals have efficient methods of developing and refining their abilities to ensure the academic success of students in mathematics. Therefore, a study on district level implementation of strategic programs designed to teach administrators research-based instructional leadership techniques would be beneficial. Additionally, research on how principals can supplement their mathematical knowledge by leveraging the mathematical knowledge of teachers and district level coaches would also be of value to principals who are responsible for supervising mathematics instruction.

Final Statements

Although many principals do not have a background in mathematics, they are still responsible for ensuring the academic achievement of students in mathematics. This led to the identified problem of how principals without a background in mathematics can ensure the academic success of students in mathematics. Furthermore, following a review of the literature on teaching and leadership practices that have increased student achievement in mathematics, it has been discovered that principals do make a difference on the academic achievement of students. As such, several recommendations for principals were ascertained. Based on the findings of researchers, through accessing related professional development, instructional leadership mentors, and highly effective mathematics teachers, principals can develop the leadership, instructional, and content knowledge necessary to ensure the academic success of all students in mathematics. These recommendations are put forth to provide value and direction to principals responsible for the academic achievement of students in mathematics. Finally, due to the impact principals have on the academic achievement of students, it is important that principals take steps to increase their instructional leadership and mathematical knowledge and skills.

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