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Instructional Coaching and Effective Mathematics Teaching Practices

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Abstract

This classroom action research project compares the impact of instructional coaching with the focus on effective mathematics teaching strategies as outlined by the National Council of Teachers of Mathematics in the text *Principles to Action*. Two 3rd grade classrooms were studied with one being a control classroom and the other whose teacher enrolled in a 6-week coaching cycle focusing on student centered goals around two effective mathematics teaching practices. Those effective mathematics teaching practices are posing purposeful questions and facilitating meaningful mathematics discourse. A pretest and posttest from FastBridge's MCAP was used to determine the growth over the 6-week study period and were also compared to a control group in a classroom where the teacher chose not to enroll in a 6-week instructional coaching cycle. Data from this study indicated students in the class whose teacher participated in the coaching cycle around implementing effective mathematics teaching practices made more instructional gains as compared to the students in the class whose teacher did not participate in any professional development in mathematics instruction.

Instructional Coaching and Effective Mathematics Teaching Practices

Expectations for mathematics instruction have changed greatly due to the college and career ready shifts in the Common Core State Standards (n.d.). Focus, coherence, and rigor are three shifts in the Common Core State Standards implemented to build college and career ready students. According to Leinwand (2014), these shifts put an emphasis on students developing mathematical ways of think so they can solve real life mathematics problems. These shifts are complicated and must be deeply understood by teachers to ensure they are being implemented fully (McGatha, Bay-Williams, Kobett, & Wray, 2018).

In 2014, the National Council of Teachers of Mathematics, NCTM, released eight mathematics teaching practices to support the college and career ready shifts in the Common Core (Leinwand, 2014). These eight mathematics teaching practices are as follows: establish mathematics goals to focus learning, implement tasks that promote reasoning and problem solving, use and connect mathematical representations, facilitate meaningful mathematical discourse, pose purposeful questions, build procedural fluency from conceptual understanding, support productive struggle in learning mathematics, and elicit and use evidence of student thinking. According to Leinwand (2014), these eight mathematical practices equip teachers to engage students in tasks that promote reasoning and problem solving. The eight mathematical teaching practices are high-leverage practices the NCTM sees necessary to promote a deeper learning of mathematics (Leinwand, 2014). Huinker and Bill (2017) state these mathematics teaching practices are backed up with many years of research in mathematics instruction.

The implementation of these eight mathematics practices are critical for student success, but create a overwhelming challenge for teachers. According to Leinwand (2014) and NCTM, many teaching professionals, including mathematics teachers, have inadequate professional learning opportunities such as coaching, collaboration, and professional development. Without these professional learning structures, teachers are professionally isolated and make little forward progress. To help combat this need for teachers to shift the way they are teaching mathematics, many schools have implemented instructional coaches. Knight's instructional coaching process uses coaches as a partner for teachers to enhance their practices and ultimately impact student learning (Knight, 2018). Coaches typically work one on one with a teacher around a student-centered learning goal the teacher has set for himself or herself. According to Sweeney and Harris (2017), schools across the nation are experiencing growth in student proficiency when their teachers utilize instructional coaches to improve teaching and learning.

Effective partnerships between teachers and instructional coaches focused on successfully implementing the eight mathematics teaching practices is a powerful combination in achieving the college and career ready shifts in the common core. The purpose of this research is to determine if instructional coaching around the eight effective mathematics teaching practices impact student growth in regards to student learning.

Literature Review

Instructional Coaching

This project studies the effects of an instructional coach on elementary teachers' ability to implement effective mathematical teaching practices. Various experts have published their extensive work on the value and impact of an instructional coach on positively impacting teacher practices and ultimately student learning. While the research is extensive, the research closely parallels each other to suggest instructional coaches have an enormous impact on classroom practices. In the paragraphs below, different experts and extensive work will be reviewed to prove the lasting impact instructional coaching can have in regards to reach practices and student learning.

Knight is one of the many leaders in regards to the initiative of instructional coaching. The work from Knight is extensive, but is also evident throughout many other publications and research studies. In an article by Thomas, Bell, Spelman , & Briody (2015), Knight, a leading researcher and author in instructional coaching maintains, by teachers and coaches partnering up and having challenging conversations, they are able to help teachers change beliefs. He goes on to say these conversations help teachers to rethink their beliefs and revise ineffective teaching practices. The role of the instructional coach is to encourage teacher reflectivity over current practices, setting goals, and increasing teacher learning to increase student learning. Knight also has published other studies to prove the effectiveness of instructional coaching. In one of his many publications, Knight discusses the importance of Visible Learning, which is linked to Hattie and Zierer's mega study regarding highly impactful practices linked to student achievement. According to Knight (2019), Visible Learning is about teachers who reflect on diagnosis, intervention, and evaluation of their students. Teachers who are effective in this practice are able to diagnose their students needs, motivations, and ability to engage in the learning. Teachers have also prepared various interventions and opportunities for students when learning doesn't occur and have the ability to evaluate those intervention practices collaboratively. According to Knight (2019), one of the best ways to enhance professional learning is by cooperation, the exchange of ideas, and sharing responsibilities among colleagues. The collaboration piece is expedited when instructional coaches are effectively working with teachers to avoid teacher isolation. With the demands put on the 21st century teacher, an instructional coach is the missing piece to ensure positive collaboration is occurring to ensure impactful practices are occurring so student achievement is being impacted.

To foster positive collaboration between teachers and instructional coaches, Knight (2018) provides a three-step framework with the three cyclical steps in his suggested coaching cycle. These three steps are to identify, learn, improve, and provide a continuous framework to offer opportunities for teachers and coaches to continuously engage and grow professionally in unison. In this process teachers have the opportunity to reflect on their current practices to identify a true understanding of their current reality by reflecting with a coach and identify a specific student-focused goal. The collaboration continues when both the teacher and coach learn together when they implement new strategies to impact student learning. In the best-case scenario, this involves modeling of highly effective practices by the coach so the teacher can learn by first observing. The teacher then works to implement this practice independently or with supports determined in the coaching cycle. In the last step, the teacher independently implements new strategies effectively with the use of collecting student data. The coach partners with the teacher by analyzing student work together to ensure the new implementation of effective teaching strategies are truly impacting student learning and ultimately student achievement.

Knight's coaching cycle is verified by other research as well. Gibbons & Cobb (2017) highlights productive activities for teachers and coaches to engage in. Those activities include: engaging in the discipline, examining student work, analyzing classroom video, and engaging in the lesson study. Gibbons & Cobb also suggests two other productive activities, which are co-teaching and modeling instruction. It is easy to see the similarities between Gibbons & Cobb's and Knight's coaching cycle. Both publications suggest the importance of utilizing video to identify the current reality, engaging in deep professional collaboration, developing an understanding or common goal of student learning outcomes, and utilizing student work to prove the effectiveness of the work.

Another well-known leader in the initiative of instructional coaching is Sweeney (2017). Sweeney's work is best known as student-centered coaching. According to Sweeney, one time professional development does little to enhance student achievement. Utilizing full coaching cycles where student data is at the center of the cycle is a much more powerful tool for moving student learning forward. The extensive work from Sweeny validates the importance of keeping the work between instructional coaches and teachers rooted on student learning and student outcomes. Professional collaboration can be highly impactful, but fruitless if student learning isn't impacted. Sweeney's provides structures, templates, and protocols to ensure student learning is impacted and the driving force in teacher to coach collaboration. Sweeney's work is not the only literature or practical application model pinpointing student achievement to be at the focus. According to Tanner, Quinton, & Gamboa (2017), student achievement has to remain at the center of all interactions with an instructional coach. If goals or focuses stray from this, the focus becomes about fixing teachers, which will only create a division between teachers and coaches. It's simple to see how the research parallels itself and consistently proves the importance of utilizing student data to drive teacher growth. McGatha & Rigelman (2017) maintain it is important to understand students thinking in order to drive instructional decision-making and support rich instructional coaching interactions.

Another component found within the research is the debate of content driven coaches or general instructional coaches. This topic has different perspective and various school districts across Iowa will have their own approach in how they established roles of their instructional coaches (Thomas et al., 2015). Knight supports instructional coaching where coaches are not content driven, but instead focus on effective instructional strategies. Other researchers maintain content driven coaching is also effective. McGatha & Rigelman (2017), discuss the need for mathematics content coaching because there was a need to job-embedded professional learning where teachers could focus on mathematics. Current research proves the effectiveness of instructional coaching and content specific coaches alike.

Content specific coaches give the opportunities for teacher leaders to specialize in specific content and be a valuable leader for teachers and teacher teams. According to Vale et al. (2010), the effective mathematics teaching content knowledge of the teacher leader, or instructional coach, allowed the coach to more effectively support the professional learning of individuals and teams in the school. Research suggests the effectiveness of instructional leaders and potential impact they have in moving an entire school forward in implementing professional practices. The foundation in professional growth in teachers is effective and purposeful collaboration between teachers and peers, which is also evident in successful instructional coaching models (Vale et al., 2010). According to Vale et al., teacher leaders have to continually effectively collaborate with teachers within their schools as well as continually research effective practices so they are able to positively impact student learning.

One of the most important aspects to instructional coaching is effective leadership and support from school administration. Sweeney (2018) discusses the importance of school leaders not only encouraging teachers to participate in coaching cycle but encourages school leaders to lead the charge in instructional coaching as well. She continues to emphasize the importance of school leaders to build strong partnerships with instructional coaches and to make that partnership visible to all teachers. Within this strong partnership, it is important to separate evaluation from coaching and to make sure the coach is structured within the school to be a valued member of professional learning (Sweeney & Mausbach, 2018).

School administrators' positive attitudes can play a large role in teachers participating in instructional coaching cycles. According to Palardy & Rumberger (2008), teachers' instructional practices have such a large impact on student growth; they should always be learning and adjusting their beliefs and practices, even after college. It is highly necessary for administrators to set the expectation that all teachers can grow and improve. This culture of continual learning can help make extremely large gains in regards to student learning (Sweeney & Mausbach, 2018). Administrators who hold teachers accountable for their professional growth will see a trend in teacher attitude towards instructional coaching and more than likely, an increase in student achievement. (Sweeney & Mausbach, 2018).

One struggle instructional coaches are constantly facing is what their daily schedule should look like in comparison to what it actually ends up being. Polly, Algozzine, Martin, & Mraz (2015) conducted a study where they found coaches desired roles were much different than the current roles the coaches fulfilled. There are many different interpretations as to what an instructional coach does throughout the day (Polly et al., 2015). Many other duties and responsibilities are attached to the instructional coaching job. There is a need from administrative leaders to clearly define coaching roles. Sam & Caliendo (2018), discuss the importance of instructional coaches being highly visible, following through on promises, and aligning coaching cycle work with school initiatives as a way to implement themselves as a resource to teachers. These strategies, along with administrative support and encouragement to teachers, can lead to a seamless implementation and accelerate the work of coaches and teachers (Sam & Caliendo, 2018).

Effective Mathematics Teaching Practices

Instructional coaches are becoming an integral part of professional development models within schools (Knight, 2019). Much of instructional coaching is focusing on improving pedagogy and part of important pedagogy is the effective mathematics teaching practices. These practices are highly regarded by the National Council of Teachers of Mathematics, but are also evident throughout current publications (Leinwand, 2014). Research parallels these eight practices. It falls to instructional coaches to help bring about shifts in teacher beliefs that NCTM has published. These beliefs work to shift unproductive teacher practices from memorization of procedures, being the one to tell students exactly what mathematics rules to know and follow, and guiding students through problem solving situations by taking students step by step (Leinwand, 2014). Instead, Leinwand (2014) feels productive beliefs in mathematics instruction include learning that is more student centered and focused on understanding of the concepts with more problem solving, reasoning, and student discourse (Leinwand, 2014). Mathematics classrooms should start to look differently than what has been traditionally expected. An ideal classroom has students who are using a range of available tools to support thinking and collaboration with peers, simply applying a known procedure cannot solve tasks, and most importantly, students are communicating with each other about the mathematics. They are making arguments and conjectures and working to justify, clarify, and make sense of others' thinking. Teachers are now the facilitators where they are helping students make sense of each other's ideas and valuing misconceptions and errors because they provide the best opportunity for shifts in student learning (Leinwand, 2014). The practices NCTM published in their text in 2014 are high-leverage practices that when implemented into instruction, can bring about an increase in student achievement and more importantly, helps instill skills needed for students to become productive members of a society that is constantly evolving and changing.

One of those practices is to engage students in productive struggle when learning mathematics. According to Aljaberi and Gheith (2018), it is essential to provide professional learning for teachers so they can engage their students to reflect, evaluate, and understand mathematics. Aljaberi and Gheith go on to explain the importance of the constructivist theory where students need to be actively engaged in their learning, which includes developing a deep understanding of how to manipulate mathematical concepts (2018). Research suggests the importance of highly effective foundational concepts to create rich learning for students.

Mathematics teaching has evolved through the years. An emphasis on a less traditional style of teaching mathematics is becoming to be emphasized more and more. According to Sapkova (2014), a teacher's beliefs about mathematics instruction are extremely important. They state that the more constructivist a teacher's beliefs are, the higher their students' mathematics achievement is. According to Georges & Pallas (2010), if teachers are continuing to trend their beliefs and practices towards a less traditional approach, teachers should see a continual upward trend in their students' achievement. They found that students who were taught more reasoning skills maintained the best growth from school year to school year with less back sliding through the summer. NCTM's list of productive beliefs provide shifts in teacher beliefs that, coupled with effective teaching practices, will ultimately lead to higher student achievement (Leinwand, 2014). These beliefs and practices work to shift teaching practices towards a more student-centered classroom where students work to problem solve and make sense of each others work.

Gningue, Peach, & Schroder (2013) published a study which suggests teachers do not even need to be highly versed in mathematics content knowledge to push their students mathematical thinking forward. They discuss the importance of student engagement in the content in making the greatest impact in student achievement. Currently, the United States is putting more of an emphasis on mathematics instruction becoming less traditional and more student centered (Bodovski & Farkas, 2007). This greater emphasis on teachers changing their beliefs in teaching mathematics could lead to the achievement gap in mathematics becoming lesser and lesser.

It is essential for teachers to embrace the eight instructional practices from NCTM, which includes promoting student thinking, posing purposeful questions, creating environments for students to share different approaches in solving mathematical challenges, utilizing mathematical representations, and utilizing mathematical goals to focus learning (Leinwand, 2014). Frid and Sparrow (2009) echo the importance of taking risks to push students to deeper learning in regards to mathematics learning. Teachers expect their students to take risks in the challenging learning environments they try to create in classrooms. As professionals, teachers need to echo those risks by making sure to critically examine their professional practice so as to take action on implementing instructional changes. These changes enhance mathematics teaching and learning. (Frid & Sparrow, 2009).

In the eight effective mathematics teaching strategies, one of the strategies is to identify learning goals to focus and create a purposeful invitation for students. This simple step is also proven as a successful teaching strategy to engage student learners. According to Murtafiah, Sa'dijah, Candra, Susiswo, and As'ari (2018), clarifying expectations and learning goals is essential for student learning. Murtafiah et al. go on to explain the importance of establishing clear learning objectives and having purposeful dialogue with students with their learning goals embedded. This research echoes the importance of having clear learning goals and creating student dialogue when learning mathematical concepts. These two concepts are evident in the NCTM teaching practices.

Another of NCTM's effective mathematics teaching practices is building procedural fluency from conceptual understanding (Leinwand, 2014). According to O'Connell & SanGiovanni (2011), past teacher practices for teaching skills such as multiplication and addition facts have included teachers drilling students on facts until the facts were deemed memorized. While possibly effective for memorizing facts for the current school year, this lack of attention to conceptual understanding has led to students to be without a deeper knowledge of the mathematics they are doing and inhibiting flexible thinking and problem solving (O'Connell & SanGIovanni, 2011). This push for students to memorize facts or a series of steps in a procedure can destabilize a students' confidence, cause anxiety, and ultimately not prepare students to be the productive citizens who creatively solve problems that society will need them to be. Current mathematics teaching practices are emphasizing the importance of teaching both procedures and concepts, making sure concepts are understood before procedures are expected (Leinwand, 2014). NCTM expects teachers to be granting students the opportunity to flexibly use strategies and make judgments and reflections on which of those procedures work best for certain types of mathematics problems. According to Bay-Williams & Kling (2019), students must understand

and be able to use various strategies when solving problems. Once they are able to apply these strategies, students are then able to truly develop procedural fluency.

The research discussed indicates the importance and urgency of this action research focus. The researcher was unable to find any direct research involving an instructional coaching focus on the effective mathematics teaching strategies, leading to this action research. Mathematical learning and effective mathematical instructional strategies is not a new concept, but rather a continuous focus and struggle for educational leaders as instructional strategies shift. The research highlighted sets a strong foundation for this action research process and validates the essential professional support teachers need in moving towards more effective mathematical instructional practices. While the research sets the foundation, the action research should shine light on working beside teachers in the trenches while they work to engage students in deep mathematical learning.

Methods

Participants

As table 1 describes, participants in this study involved 41 students of a rural school in Oskaloosa, Iowa. Two classes amongst 7 in this grade level were chosen to participate in this study. They were in 3rd grade, which is usually between the age of 8 and 9 years old. Nineteen of the students were male and 22 were female. Amongst the two classes that were studied, no students were receiving ELL services and five were receiving special education services with class sizes being 20 and 21 students. Class A was considered the control class, which did not work with the instructional coach in a coaching cycle and did not participate in any other professional development involving mathematics instruction. The teacher in Class B enrolled in a coaching cycle with the instructional coach with the focus being effective mathematics teaching practices. The two practices specifically chosen were pose purposeful questions and facilitate meaningful mathematical discourse.

Both classrooms have access to the same technology and resources, which are, 1:1 Chromebooks, an interactive white board, the same mathematics resource for teaching materials, the same sets of manipulatives, and the same assessments. The 7 classroom teachers in this grade level plan their instruction together during their common planning time every Thursday. Class A has 20 total students with 8 male and 12 female. Two of the students receive special education services in mathematics. Class B has 21 total students with 11 male and 10 female and 3 students receiving special education services in mathematics. Both classroom teachers have been teaching for five years and have been in this district for five years.

Table 1

Student demographics from the study

Class breakdown	Class A (Control)	Class B (Teacher enrolled in coaching cycle)
Male	8	11
Female	12	10
ELL	0	0
Special Education Services	2	3
Class Size	20	21

The school these students attend serves 931 students preK to 5th grade. 53.2% of the students qualify for Free and Reduced services. Each grade level has 7-8 sections and each teacher has the same resource to use in their mathematics teaching. The mathematics resource utilized for mathematics instruction across the elementary school is Everyday Mathematics 4 (EM4). EM4 has been the mathematics resource for 3 years. Third through fifth grade students have 1:1 computers with Chromebooks. The staff in this building includes 80 certified teaching staff and over fifty support staff including paraprofessionals, cooks, custodians, maintenance workers, secretaries, and bus drivers. Of the 80 certified staff the building holds, there are three guidance councilors, two student success coaches, seven specials teachers, eight title reading teachers, nine special education teachers, one ELL teacher, two talented and gifted teachers, a head principal, an assistant principal, and 46 classroom teachers.

Measures

Quantitative data was compiled in this study in order to determine if student learning is increased in response to instructional coaching around the effective mathematics teaching strategies. To collect the quantitative data, the researcher utilized the CBMmathCAP (MCAP) assessment from FastBridge Learning. The MCAP is an assessment used both for screening and progress monitoring and is taken on the computer. Each student gets the same set of questions however the set of questions changes each progress monitoring or benchmarking period. Every student uses a set of headphones, either their own or borrowed from the school, for the assessment and can choose to have portions of the test read to them. For 3rd grade, both the screening and progress monitoring is 15 minutes in length. Students complete as many questions as they are able. These questions are based on the Common Core State Standards (FastBridge Learning, 2016). The MCAP was given as a pretest before the coaching cycle began and as a posttest after the instructional coaching cycle ended to compare growth. Expected weekly growth is .1 therefore, through six weeks, which is the duration of this study, students should grow at least .6. At the beginning of the coaching cycle 3rd grade students were expected to score a 6.8 or higher indicating they averaged 6.8 questions correct per 10 minutes. By the end of the coaching cycle students are expected to score 7.3 or higher. A score of 7.3 at the end of the coaching cycle would indicate student mathematical proficiency is growing appropriately.

Procedures

This study took place over 6 weeks during trimester two at Oskaloosa Elementary. It involved one 3rd grade classroom teacher who enrolled in a coaching cycle over the effective mathematics teaching practices with an instructional coach and one classroom teacher who was not enrolled a coaching cycle.

The first week of the study the instructional coach and teacher from Class B set a student centered goal involving two of the effective mathematics teaching practices as outlined in *Principles to Actions*. The teacher chose to implement posing purposeful questions and facilitating meaningful mathematical discourse. After the teacher set the goal, the teacher and coach discussed different data that could be collected that would be meaningful to this coaching cycle. The teacher chose to have the instructional coach monitor questions that were asked during whole group math instruction as well as student to student discourse prompts and times. The teacher and instructional coach collected this information to be used through the coaching cycle to monitor progress toward the goal and teacher professional learning. It allowed the instructional coach and teacher to reflect on current practices in the classroom and plan for implementing student discussion and teacher questions. This information is not shared as part of the study due to the nature and confidentiality of the coaching cycle. The teacher also chose to utilize the MCAP as a means of preassessment and post-assessment of the coaching cycle. The instructional coach and teacher then set up a weekly meeting occurring every Tuesday to reflect and Friday to plan during the teacher's 9:15 planning time. They also set up times for the instructional coach to be in the classroom every Tuesday and Thursday during math whole group lesson from 12:20 to 1:00. The purpose of the instructional coach being in the classroom was to collect data and model the effective mathematics teaching practices. The instructional coach and teacher started to implement their professional learning from NCTM's text, *Principles to Actions*. The preassessment was given to students and results are provided in the findings section of this study.

During the second to fifth weeks of the coaching cycle, the instructional coach and teacher followed through with their set meeting times and continued professional learning. The instructional coach modeled lessons during week two and week four during which the teacher could monitor questions and student-to-student discourse. Weeks three and five involved the coach collecting data for the teacher to reflect on. During the planning sessions, the teacher reflected on progress of implementation of the effective mathematics teaching practices and continued professional learning around them. The coach and teacher also planned for specific opportunities to ask purposeful questions and exactly what the student mathematical discourse should look like.

The sixth week of the coaching cycle involved the instructional coach and the teacher administering the MCAP as a post-assessment. During this week, the instructional coach and teacher met to reflect on the coaching cycle. They discussed benefits, professional learning, and any missed opportunities during the cycle. Student benefits were discussed and the coach and teacher evaluated progress toward the student-centered goal. The teacher was asked to consider future learning for the students and the teacher was exited from the coaching cycle.

The teacher of Class A did not receive any professional development over mathematics instruction during the six week coaching cycle and continued to teach utilizing the same mathematics resource as the teacher in Class B. No adjustments were made to this teacher's instruction. Class A was given the MCAP as a preassessment during week one of the coaching cycle for the teacher of Class B and took the MCAP as post-assessment during week six of the coaching cycle.

Results

This research was designed as a quantitative study on the impact of a teacher working with an instructional coach to implement effective mathematics teaching practices in comparison with a teacher not working with an instructional coach and seeking no professional development in this area. In order to determine which class made the most growth over the 6-week study, student data was compiled through the MCAP to determine the effectiveness of the coaching cycle. Class A, the control class, had an average MCAP pretest score of 6.6. Class B, the class whose teacher was enrolled in the coaching cycle, had a class average of 6.4 for their pretest.

Through the 6 weeks, the teacher of Class A did not partake in any professional development in mathematics instruction. The teacher of Class B went through a 6-week coaching cycle with the focus being effective mathematics teaching practices. After the 6 weeks, both classes were given the MCAP as a posttest. The students were expected to grow at least .6 points. The average score for Class A was 7.1. The average score for Class B was 7.3.

Table 2 shows the points growth each class experienced from the pretest to the posttest. It appears Class B made more growth compared to Class A however more statistical analysis was needed to appropriately determine if this was true.

Table 2

Class average growth from pretest to posttest

	Class A (Control)	Class B (Teacher enrolled in coaching cycle)
MCAP Class Average	0.5	0.8

An independent groups *t* test revealed that there was a statistically significant difference in Class B, the class whose teacher participated in a coaching cycle (M = .80, SD = .31, n = 21), as compared to Class A, the class whose teacher did not participate in a coaching cycle (M =.50, SD = .30, n =20), with strong effect size, t(38.66) = -3.14, p < .05, d = . 0031.

Through this analysis it appears there is a significant difference in student growth as a result of the classroom teacher working with an instructional coach to implement effective mathematics teaching strategies.

Discussion

Summary of Major Findings

The findings of this study indicate that the teacher who participated in the coaching cycle with the focus on effective mathematics teaching practices students' had more academic growth in comparison to the students of the teacher who did not participate in any type of professional development during the course of this study. The data shows that students who were in the class whose teacher participated in a coaching cycle made more academic growth in comparison to the student whose teacher did not participate. The results indicate that instructional coaching is an effective means of professional development and can greatly impact student learning. The results also indicate the importance of effective mathematics teaching practices. It is important to note the National Council of Teachers of Mathematics put forth the effective teaching practices in their text *Principles to Actions* in 2014 and the text maintains a great need for educators to implement these practices in their instruction (Leinwand, 2014).

Limitations of the Study

There are numerous limitations to this study, which could affect he validity and reliability of the results. The first limitation is the sample size. This study had a small sample size of just two classes and 41 students total. One class whose teacher worked with an instructional coach and the other whose did not. A larger sample size of more classes and multiple grade levels could give more accurate data.

Another limitation of this study was the participants. The participants of this study were of one grade level, thus it is difficult to generalize the results to subjects that are outside of this grade level. Ability of each class is a consideration. It is possible that one of the classes could have been more advanced by nature.

Each teacher and their teaching style, classroom management practices, and buy-in of effectiveness of the implemented practice could also impact the results. The relationship with the teacher and the instructional coach can play a part in getting different results. If a teacher and coach have a good working relationship and are comfortable with each other, there is a level of trust and fidelity that the teacher will have when implementing the practices chosen. Since the instructional coach is the researcher, the bias of the instructional coach in the effectiveness of the mathematics teaching practices can impact the effectiveness of the coaching cycle. The instructional coach in particular would also impact the results of the study. Different instructional coaches with different instructional coaching models and different beliefs could alter the results.

It is also possible students could have rushed through the assessments giving a false score. Some students may become frustrated by the timed nature of the test. While the time is not displayed, students know the test takes 15 minutes. They could also become flustered at the types of questions being asked. To get an accurate picture of where students are at in their learning, questions aligning to standards from higher and lower grade levels are included in the assessment. Other design flaws in the MCAP assessment include the test picking and choosing different standards for each assessment round. Depending on the standards chosen, students' scores could change although since this is a standardized assessment, FastBridge will have taken measures to ensure this does not happen.

The length of the study impacted the length and possible quality of the coaching cycle. It also limited the number of effective mathematics teaching practices that could have been implemented. A longer study would allow extensive instructional coaching and professional development of all eight effective mathematics teaching practices. A longer study would also allow for more formative measures to be taken to make adjustments to the instructional coaching cycle.

Further Study

Further studies would need a longer length of study to ensure the fidelity of the implementation of the effective mathematics teaching practices and to allow for more data points. Longer study would allow for more time to implement all eight of the effective mathematics teaching practices rather than what this study did, which was only two.

It is also known that growth mindset, resilience in productive struggle, and the Standards for Mathematical Practice can also play a large roll in increasing student achievement (Leinwand, 2014). A study measuring these mindsets and standards would complement the information gathered in a study about effective mathematics teaching practices as these go closely hand in hand. Further study could explore the relationship of the chosen curriculum resource to the ease of implementing the effective mathematics teaching practices. This study could shine light on the effectiveness of some curriculum resources.

Conclusion

Based on this study, it would appear that implementing the effective mathematics teaching strategies as outlined by the National Council of Teachers of Mathematics in the text *Principles to Actions* (2014), is effective in moving student learning forward. In the current shifts in the Core, the authors of the Common Core State Standards call for teachers to alter the way they are teaching mathematics. Mathematics has not changed. Math is still math. What has changed is what we want our students to get from mathematics instruction. It is no longer about procedures. These shifts in mathematics teaching practices seek to put the instructional focus on problem solving, student discourse, and reasoning (Leinwand, 2014). This study helps to shine light on the intense need to adjust teachers' practices in order to produce citizens who are able to think flexibly and problem solve.

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