The Influence of Co-Teaching on Marginalized Elementary Students' Mathematics Performance



Land Acknowledgement

In the spirit of reconciliation, I acknowledge that I live, work and play on the traditional territories of the Blackfoot Confederacy (Siksika, Kainai, Piikani), the Tsuut'ina, the Îyâxe Nakoda Nations, the Métis Nation (Region 3), and all people who make their homes in the Treaty 7 region of Southern Alberta.

Abstract

This single case study explores the influence of co-teaching on marginalized elementary student performance in mathematics. The ability of marginalized students to perform successfully in a mathematics classroom grants affordances in consequential learning. Marginalized communities historically perform poorly on standardized tests. There is a need for an intervention model that responds to the diverse needs of marginalized populated classrooms. Co-teaching is a model of teaching that supports a greater ability to personalize learning and support complex diverse classrooms. Whilst co-teaching has been shown to be effective, there is little research on how co-teaching influences students' learning. When assessing students, authentic assessment has been shown to support the learning and sensemaking process for learners, as opposed to a standardized test. Thus, it is important that this study integrated understanding student success within a co-taught classroom by incorporating authentic assessment compared to a standardized test.

The study explored the instructional processes that linked co-teaching to students' mathematics performance using qualitative and quantitative data. Data sources included pre- and post-observation semi-structured interviews of co-teachers and surveys with open-and closed-ended questions administered to co-teachers and their students. Student data were also collected from the authentic assessment and standardized test. Qualitative data included field notes from periodic observations of teachers' lessons and co-teaching planning sessions. To gain an in-depth understanding of the complex dynamics of a co-taught classroom, the Cultural Historical Activity Theory (CHAT) was utilized to guide data analyses. The CHAT framework encapsulates a sociocultural constructivist understanding which corresponds to the diverse marginalized population within the co-taught classroom. The analysis established from these methods offered a comprehensive insight of co-teaching mathematics processes that directly influenced students' mathematics learning and performance.

The findings from this exploratory case study highlight three major themes. The first thematic finding was that co-teaching allowed for flexible group work to personalize learning. The second thematic finding was that time and space were shared between co-teaching and assessment, allowing for more formative assessment that was in real-time and ongoing. This led to the co-teachers' perceived professional learning in assessment practices. The final thematic finding was that although there were low expectations from the co-teachers, student participants achieved a higher level of mathematics performance. The higher level of mathematics performance amongst marginalized students compared to the low expectations of their teachers may attribute to the co-taught environment that enabled flexible group work and formative assessment.



Marginalized students perform low in Mathematics

• (Bachman et al., 2015; Gutiérrez, 2008).

Co-teaching Purposes

Supports diverse learners through more opportunities to accommodate and personalize (Solis et al., 2012)

Improves teacher practice and advance student outcomes (Chanmugam & Gerlach, 2013; Fisk & Dunbar; 2017; Roth & Tobin, 2004; Scruggs et al., 2007).



Ideally a co-taught environment and the activity system operates efficiently and effectively and becomes automatic in its day-to-day routines. Co-teaching, however, is not without its contradictions, misalignments and ongoing need to support ever-evolving diverse learners. The research has outlined how cogenerative dialoguing can support the co-teaching model in the complex co-teaching activity system. It is clear in the co-teaching literature that co-teachers require training and further investigation into the instructional co-teaching processes that lead to better students' outcomes. Physical space is debated in the research and remains to be an area of exploration as a factor that impacts the co-teaching environment. Co-teaching is used to improve instructional practice and provide extra support to diverse learners. Co-teaching has been leveraged to support marginalized students, but the influence on student outcomes has yet to be explored. Marginalized students historically underperform and have been underrepresented in the discipline of mathematics. Co-teaching and its unique ability to provide more learning opportunities to students as an intervention to support diverse marginalized populations in mathematics has not been adequately explored. When looking at student outcomes amongst marginalized students, especially in mathematics classrooms, in order to properly assess students, there is a need to utilize practices in mathematics assessment that align with current theory and research. Authentic assessment is a tool that can accommodate the needs of marginalized diverse learner populations and provide appropriate insight into student outcomes in mathematics. Compared to standardized tests, I was unable to locate studies where authentic assessments were utilized as a measure of student outcomes in co-taught mathematics classrooms. To triangulate the data on students' mathematics performance in a co-taught classroom, standardized tests were utilized, but only insofar as a tool that highlights a particular type of achievement. My review of the literature has led to my design and execution of this case study to explore the influence of co-teaching on marginalized students' mathematics learning from a CHAT



 Strand 4
 Strand 5
 Strand 6

 Teacher Expertise
 Relationships
 Summative

Co-teaching influence on marginalized studentse math performance

Mastropieri et al. (2005) discusses co-teacher compatibility and that it had a direct correlation with student success, and that healthy co-taught situations were "built upon a mutual trust and respect for one another's expertise in each respective field" (p. 268). The concept of trust was often mentioned by the co-teachers in my study as a key element that led to not only their collaboration, but their connection to learn from each other. Ms. Crowflower discussed what she called the "trust factor" and that she was able to receive feedback because Ms. Sharma trusted her. Assessment was referred to as a category that both co-teachers felt they grew professionally due to being in a co-taught classroom. Ms. Crowflower mentioned that she learnt about differentiation and collecting ongoing data more with student assessments and Ms. Sharma mentioned that she learnt more about implementing more ongoing data collection as well. The temporal element in ongoing assessment also surfaced when real-time support was discussed.

The assessment practices were part of the mathematics classroom routine that was not only established by the co-teachers but arguably made possible due to co-teaching and group work. Formative assessment was frequent and ongoing due to two co-teachers being in the same physical space. Franklin's (2015) study referred to co-teachers continuously being active supporting students due to the co-taught environment. Real-time formative assessment in my study was understood as supporting the fluidity in group work to target and personalize learning. Group work was a factor that was leveraged within the classroom community for learning and continued timely assessment. As noted earlier in the first thematic finding, group work was used as part of the classroom routine to implement supporting students with a variety of accommodations or particular curricular focus (Aldridge-West's, 2014; Cook & Friend, 2004). Groups of students would be mindfully selected to work with the teacher or each other for reciprocal student learning opportunities. This was also facilitated by the physical space that was shared.

Physical Space

The physical space was shared between the co-teachers and the students. The physical space connected not only co-teaching modes, the subjects in co-teaching and learning, but also to assessment practices. As noted earlier, there was little research on the physical space in a co-taught classroom. Cook and Friend (2004) note that space and how it relates to both students and teachers was a topic for co-teachers to discuss in a co-taught environment. The physical classroom space was designed by the co-teachers to support learning (see Figure 7 in Chapter 4). Hackett et al. (2020) found that when co-teachers discussed the design of the learning environment that they could discuss tensions within the activity systems in the classroom. This aligns with the sub-thematic finding of physical space connecting the co-teaching activity triangle and the assessment activity triangle as organized using CHAT.

The physical space was socially co-designed by the co-teachers purposefully. The furniture was arranged in a way to foster supportive dialogue between all subjects in the classroom. Another means to the design of the physical space was to have breakout spaces for small groups to gather. Both co-teachers obviously shared being in the same physical space, but also there was a shared responsibility and ownership of the physical space. Scruggs et al. (2007) note that co-teachers discussed turf issues, whereby if one co-teacher entered another co-teacher's space that it contributed to a relative subordinate role. The co-teachers indicated that they did not own a particular side of the classroom and the students had all their desks organized in the middle of the dyad classroom. Cook and Friend (2004) notes that for co-teaching parity to be conveyed to students both teachers have a space for personal-belongings and both teachers have a lead role in the classroom and work with all students. In the dyad in which co-teaching took place in the study both co-teachers have a lead role in the classroom and work with all students. In the dyad in which co-teaching took place in the study both co-teachers have a lead role in two space on either side of the larger room (Figure 7), but the entire classroom was understood as primarily a single classroom or joint workspace (Cook & Friend, 2004).

The physical space was socially understood as being shared, but it was also designed and construed by the co-teachers in a way to foster learning together. For example, as noted earlier to purposely situate and orient students together, or through creating spaces whereby students could gather and learn together fostering reciprocal teaching. The classroom space was a dyad of two classrooms with no curtain to divide them. Although the physical space was socially understood it also existed prior to Ms. Sharma and Ms. Crowflower and there was a sense that the dyad dictated the need to co-teach.

At the same time, the shared physical space was noted by both co-teachers as a hinderance to co-teaching. One teacher due to being particular about how things were organized and the other due to noise. Noise in the shared space was discussed by one co-teacher participant as something that inhibited their desire to co-teach. They noted that with two rosters of students in a dyad that the noise level was louder day to day than what they preferred in a single taught classroom. Noise also came up in Franklin's (2015) study as a factor that impacted implementing group work in the co-taught classroom. Cook and Friend (1995) stated that noise was a main factor in how co-teachers can maintain a collaborative working relationship in a classroom. They go on to note that teachers have different tolerance levels for noise and that an acceptable noise level should be agreed upon, including signals used to quiet the class beyond the acceptable noise limit (Cook & Friend, 1995). The co-teachers in my study also noted that during assessment there was no difference in the noise level as it was kept almost silent. In my observations I found the noise level to be fairly quiet considering the amount of group work that was happening. Noise can be understood as a tension or contradiction between the subjects and the classroom routines or norms within the co-teaching activity system. When considering noise during assessment within a co-taught classroom the tension did not exist within the sub-system.

Little research on the influence of Co-teaching in schools

 (Dwyer, 2018; Franklin, 2015; Mastropieri et al., 2005; Scruggs et al., 2007; Solis et al., 2012).

 Little research on Authentic Assessment vs. Standardized Testing in Mathematics

 (Buabeng et al., 2019; Suurtamm et al., 2016).

The **purpose** of the single case study was to explore the phenomenon of co-teaching in an elementary school mathematics classroom and its influence on marginalized students' performance in mathematics.

Research Questions

This research sought to explore how co-teaching in an elementary marginalized classroom contributes to students' mathematics performance. The following overarching research question and sub-questions were answered:

Overarching research question:

• How does co-teaching influence marginalized elementary students' mathematics performance?

Sub-questions:

- 1. How can elementary teachers co-teach mathematics to marginalized students?
- 2. How does co-teaching influence marginalized elementary students' mathematics performance
- as measured by standardized mathematics tests and authentic mathematics assessment?
- 3. What are the factors that facilitate or hinder elementary teachers' co-teaching of mathematics to marginalized students?





Merriam and Tisdale (2016) defined a case study as being a bounded system such as one particular classroom of learning. In this case study, it was a co-taught mathematics dyad classroom. The study took place during a single unit of mathematics being co-taught by two teachers to two rosters of students in an elementary mathematics inclusive dyad classroom. Most of the students came from a marginalized community. Many have also been identified as having learning disabilities; however, since the students were still young or new to Canada, they have not been formally assessed or diagnosed as having special needs. In my experience, having co-taught in a marginalized community, many students came from diverse backgrounds consisting of a combination of low socio-economic status, English Language Learners that were Canadian born, foreign born, sometimes with refugee status and visible minorities. The classroom was composed of learners with varying needs and performing at differing ability levels within the curriculum. The class size was 24 in each class roster, for a total of 48 students. The dyad classroom selected was two split grade 3 and 4 classrooms.

The unit of mathematics selected was dependent on the unit being covered at the time the study took place. The mathematics curricular unit was on Number. Merriam (2001) noted that the researcher may create a collaborative partnership with the participants in the research process. As such, the co-teacher participants in my study were given assessments and co-teaching resources that involved cogenerative dialoguing to support the co-teachers' co-design of their co-taught model. The co-teachers could decide how the assessments and resources informed their practice and implementation of the math unit being observed. They designed a collaborative, co-operative co-taught environment focusing on co-designing instruction. The two teachers co-designed and co-taught the mathematics unit. The co-teachers had access to a number of instructional resources, some of which were provided by the researcher. The standardized test and authentic assessment, designed by the researcher and her supervisor, were also given to the teachers. In doing so, it allowed the co-teachers to co-design the mathematics lessons to be delivered and to focus on their co-teaching.

The curricular outcomes in the current mathematics unit included both grades 3–4 Specific Outcomes (Alberta Education, 2007) as outlined in the Mathematics Programs of Study. They included the following specific outcomes:

Grade 3:

1) Represent and describe numbers to 1000, concretely, pictorially and symbolically.

2) Compare and order numbers to 1000.

3) Illustrate, concretely and pictorially, the meaning of place value for numerals to 1000.

4) Apply mental mathematics strategies and number properties in order to understand and recall basic addition facts and related subtraction facts to 18.

5) Demonstrate an understanding of addition and subtraction of numbers with answers to 1000.

Grade 4:

1) Represent and describe whole numbers to 10 000 pictorially and symbolically.

																Stand	Standardized Tests have less		
									Co-Teaching Mode		Tru	Trust			accommodations				
	Stando	Standardized Test and Authentic Assessment Data Summarized Standardized Test Authentic Assessment, Curricular Outcomes									Passion		Confidence in Learning						
											Group Work Know kids as learners								
		Out of 18 Out of 4									Accommoda	tion							
		Number Mental Grade 3 Score (n) Percent Place value Representation Ordering Addition Subtraction Math									Note. Strands b	egan with th	e first facto	or listed foll	owed by	connecting the	oughts, factors, <u>c</u>	ategories or them	
	Grade																		
	μ	14.73	81.82	3.38	3	3.17	3	2.95	3.24										
	σ	2.93	16.26	0.95	0.87	1.17	0.82	0.95	0.75		Student Perfo	ormance							
		Out of 45									Grade				Total				
				Num	oor						Level	Below	At	Above		At+Above			
	Grade	Grade 4 Score (n) Percent Place value Representation Ordering Addition Subtraction									Teacher Surv				(11)				
	μ	41.06	91.24	3.88	3.12	3.53	2.94	2.76			Number	20	13	15	48	28			
	μ										%	41.7	27.1	31.3		58.3			
	σ	3.11	6.92	0.47	0.58	0.7	1.16	1.16			Authentic								
	Note. I	Note. The standardized tests were composed of all the curricular outcomes and the score was considered as an									Assessment								
		f h	1	d on the whole u							Number	9	22	7	38	29			
	mulcald	n of now a stud	ient periorine	a on the whole u	EII L.						%	23.7	57.9	18.4		76.3			
											Standardized								
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'heme 1											Number	1	24	16	41	40			
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Co-teaching c	s a m	eans foi	r flexib	le group	work to	o pers	onaliz	e learn	ina		Number	, 19			48	29			
															10	60.4			
Flexible group implementation Accommodations and strategies to personalize learning												47.7							
												Note. The data are presented in the order it was collected. The Authentic Assessment considered any 1s in any							
								to po	rconali	70	curricular outcome as below grade level from school board defined indicators (see the rubric in Appendix E).								
rolession	rofessional learning in the implementation of group work to personalize											me as below	grade level	trom school	board def	ined indicators	(see the rubric in	Appendix E).	

learning

make sense of the categories of factors on the CHAT it was separated. Similarly, the Assessment category of fa

Theme 2

- Time and space as shared between co-teaching and assessment - Co-teaching for more formative assessment
- Co-teaching modes for real-teime formative assessment
 Ongoing routine of formative assessment
 Group work for real-time formative assessment
- Increased formative assessment Physical space shared supporting instruction and assessment



Theme 3

Students' mathematics ability

Co-teachers' expectations

The notion of sharing a physical space became not only an important factor in student learning, but also an integral factor in facilitating the co-teaching experience for co-teachers. The space was shared between the students and co-teachers and was leveraged for co-taught mathematics instruction and assessment.

Time and Physical Space Connecting Assessment in a Co-taught Classroom

As discussed earlier the physical space played a role in the co-teacher's perception as well as researcher observation as a factor in the co-taught mathematics classroom. This is consistent with the common definition of co-teaching involving two professional teachers sharing responsibilities in the same physical space (Cook & Friend, 1995). Jurkowski and Müller (2018) state that cooperation and collaboration between co-teachers increases over the course of the year, noting that the more time co-teachers have to prepare and work together the higher rate of cooperation. The implication of this study suggests that organizationally, more time together also influences co-teachers ability to cooperate in order to personalize learning (Jurkowski & Müller, 2018).

In this case study, the personalization of learning seemed to be made possible not only by the flexible group work, but also the ongoing formative assessment that took place. Being in the same physical space allowed for ongoing opportunities to formatively assess and support students in real-time. The study's findings on real-time formative assessment are in line with King-Sears and Strogilos (2018) who found that during the observed dominant co-teaching mode they note as one teach, one observe or drift that the division of labours between the two teachers was such that one co-teacher managed students' behaviour while the other co-teacher taught. Also, if one co-teacher was teaching one co-teacher was continuously providing assistance to students (King-Sears & Strogilos, 2018).

It was observed and discussed with the co-teachers in the semi-structured interviews that formative assessment was ongoing and that this was possible due to two co-teachers being in the same physical space at the same time. When co-teaching was used to implement group work it also supported opportunities for each co-teacher to gather formative assessment. Mastropieri et al. (2005) found that in a co-taught environment it was common for co-teachers to circulate around the room to work with small groups of students. In my study, I observed that when there was large group instruction, one co-teacher would lead, whilst the other co-teacher would be using the opportunity to formatively assess student understanding during the lesson.

Magiera's (2002) work concluded that in 11 co-taught environments, students received more individual instruction when a co-teacher was present. King-Sears and Strogilos (2018) noted that the students' perceptions were that co-teachers were available to help and that there was a value on their co-teachers' responsiveness to assistance. This is in line with the findings of this study in which the greatest factor that students noted as supportive in a co-taught classroom on the surveys was teacher one to one support.



The final main thematic finding was a response to the overarching research question; How does co-teaching influence marginalized elementary students' mathematics performance? It is also a response to the sub-question; How does co-teaching influence marginalized elementary students' mathematics performance as measured by standardized mathematics tests versus authentic mathematics assessment? The authentic assessment revealed that nine out of 38 students could be construed as being below grade level in one or more outcomes that were assessed. The standardized test that was implemented after the authentic assessment suggested that one student was below grade level. On average students in grade 3 scored 81.82% on the standardized test and students in grade 4 scored 91.24% on the standardized test. These results may be related to the continuing and extra support by the co-teachers, which is consistent with Aldridge-West (2014) and Fisk and Dunbar (2017) who found that co-teachers' provision of continuing and extra support is key to improving students' achievement.

Understanding the Shared Outcome of Mathematics Performance

Theoretical Framework Guiding This Study

Vygotsky's (1987) theory on the zone of proximal development was understood as being mediated socially by cultural tools. Engeström (2001) discusses the generations of activity theory and how he built on this theory by noting how other components create and shape a collective activity system. He further discusses the concept of expansive learning and its crucial role in binding activity systems for horizontal learning and development. As co-teachers continuously navigate unique ways to implement actions that influence marginalized students' mathematics performance, this can be understood as ongoing expansive learning happening . Engeström and Sannino (2010) note that how the theory of expansive learning builds on the foundations of Vygotsky's theories and CHAT.

Roth and Lee (2007) state that the CHAT framework allows for a means to establish more humane forms of education and overcomes problematic dualisms in education. Franklin (2015) discusses how Vygotsky incorporated mediation into traditional research dichotomies and how Leont'ev validated collective activities. Engeström (2001) graphically represented the activity system showcasing the interrelations in complex communities. Franklin (2015) was granted authorization from Engeström to adapt his third-generation activity system figure to apply in making sense of a co-teaching environment. Franklin (2015) then applied CHAT to make sense of the mixed methods data by utilizing the activity theory for analyzing the qualitative data, as well as examining the quantitative data and qualitative data holistically based on the tenets of the activity theory.

Hence, I find CHAT an important theoretical framework for understanding the phenomenon of co-teaching in a classroom with marginalized students. Roth and Lee (2007) pointed out that CHAT enables educators to close the gap between theory and practice, and that the "framework allows for questioning the structural determinations of current educational practices" (p. 217). Therefore, this sociocultural framework has allowed me to explore the influences of instructional process between co-teaching, curriculum materials, assessment tools and student outcomes. The CHAT framework and co-teaching will be further explored in the literature review section.

Esmonde (2017) notes that CHAT is a unit of analysis for activities centered around the same goal that involves more than one person. The co-teachers as subjects in this study had a shared goal of improving marginalized students' mathematics performance. When I applied CHAT to make sense of the classroom, it enabled me to gain a better understanding of the actions of co-teaching as a mediating tool. The subjects include the participants in a co-taught environment that could impact the activity system. In this case study, it included the two teachers and their marginalized students. The rules included system policies, legislation, school guidelines, and classroom routines and norms, but also the rules attributed to the discipline in which they teach. For the purpose of this study, rules also included the mathematics curriculum and the field of mathematics. The community within the CHAT model included the class culture. The division of labours refers to how the co-teachers organized their roles within the collaborative environment. Other tools in my CHAT case study were the assessment tools and the conceptual tool of cogenerative dialoguing. As such, the activity triangle associated with assessment was also considered and where it aligned with the activity triangle of co-teaching was explored in this case study.



2) Compare and order numbers to 10 000.

3) Demonstrate an understanding of addition of numbers with answers to 10 000 and their corresponding subtractions.

The grade 3 and grade 4 standardized tests, as well as the authentic assessment were developed based on assessing the curricular outcomes that were identified in the co-planning sessions.



Data Processing and Analysis

The data analysis process used a comparative strategy with a holistic approach for interpreting the findings in this case study (Merriam, 2001; Merriam & Tisdell, 2016; Yazan, 2015). The data analysis process involved consolidating, reducing, and interpreting the data (Merriam, 2001; Merriam & Tisdell, 2016). Consolidating and reducing data was done in the first cycle of coding and interpreting in the second cycle (see Figure 4) (Miles et al., 2020; Saldaña, 2013). Schwandt and Gates (2018) noted that case study serves as a unifying force to bring "qualitative and quantitative dimensions of the social sciences together" (p. 617). Merriam (1985) stated that quantitative data contributes "to developing the fullest picture possible of the phenomenon under study" (p. 208) and alongside qualitative data enhances the validity and credibility of the findings through triangulation. Qualitative and quantitative data were collected independently but simultaneously. Merriam (1985) refers to this as a parallel model. Data analysis naturally occurred once data collection began, but the final analysis and consolidation were conducted when all the data sources were collected (Merriam, 2001).





school teachers co-teach mathematics to marginalized students? The first main thematic finding considers co-teaching as a tool in the activity system that is used for the shared outcome of successful student mathematics performance on assessment. Within this case study it was found that co-teaching as a tool was used to provide flexible grouping for the purpose of personalizing learning in mathematics. This is in line with one of the main purposes of co-teaching to increase instructional opportunities by individualizing student learning (Brendle et al., 2017; Cook & Friend, 1995; Rexroat-Frazier & Chamberlin, 2019; Roth & Tobin, 2004; Solis et al., 2012).

Co-teaching as a tool and co-teachers orienting themselves in a co-teaching mode was connected to utilizing teacher expertise, group work, and the physical space. Teacher expertise played a pivotal role in the division of labours within the co-taught classroom and the co-teaching mode that was selected within the co-teachers model.

The first main thematic finding is a response to the sub-question: How can elementary

Co-Teaching Mode

Group work and differentiation of instruction that ensued from the co-teaching modes was one of the instructional processes that one co-teacher identified as pushing her practice forward. Teacher growth was understood also as being connected to the ability to provide a variety of accommodations in flexible groupings and was due to their experience in co-teaching from the beginning of the school year until the observed unit. This is in line with the literature on one of the purposes of co-teaching was to build instructional capacity for student success (Chanmugam & Gerlach, 2013; Fisk & Dunbar, 2017; Henderson, 2009; Roth & Tobin, 2004; Scruggs et al., 2007).

Henderson (2009) discusses how co-teaching promotes instructional change and is effective in developing tacit knowledge. Roth and Tobin (2004) also note that co-teacher learning is not one-sided, but a reciprocal experience. Both co-teacher participants in my study revealed that they learnt from each other and that they teach each other. This is in line with Roth and Tobin's (2004) discussion that in a co-taught classroom each teacher experiences the actions of the other teacher, which in turn become resources for teaching the students and for learning how to teach.

This resonates with research involving teacher perceptions of co-teaching. Scruggs et al. (2007) found that co-teachers mostly felt that they benefitted professionally from the experience of co-teaching. Aldridge-West (2014) found that co-teaching provides co-teachers opportunities to learn side by side and directly from each other. In one learning experience mentioned by Ms. Crowflower, trust was highlighted as a key element. In that moment of co-teaching, Ms. Sharma observed the learning interactions and was able to share it with Ms. Crowflower as a resource for personalizing learning in the future with those particular students. This however, was only made possible due to their trusting relationship and respect for each other.

Hackett et al. (2020) found that "psychological safety is an important precursor to co-teaching barriers" (p. 118) as it is necessary for co-teachers to "work towards a safer space where criticism can be delivered, and professional risks can be taken" (p. 123). Both co-teachers mentioned that they valued each other's way of teaching and frequently mentioned care work as a factor. They each commented numerous times that they supported each other when they felt stressed, overwhelmed, or frustrated and that there was trust and respect between them. Mastropieri et al. (2005) discusses collaboration and the roles and responsibilities of each co-teacher in a co-taught classroom and noted a mutual respect between co-teachers and the unique skills each co-teacher brought to the class. As in the current study, one of the co-teachers mentioned that it was nice to have someone to talk to about their similar experiences with the students.

Rabin (2019) found that through dialogue co-teachers model caring and value one another over the content appreciating their differences and sharing interpretive power. Rabin (2019) goes on to note that power is involved in a co-teaching relationship and if there is a differential it can interrupt collaboration. Rexroat-Frazier and Chamberlin (2019) note that although co-teachers can have conflicting beliefs, and not volunteer to co-teach, they can still be a successful co-teaching arrangement.

The findings around teacher growth and care work through dialogue aligned with the literature (Rabin, 2019; Roth & Tobin, 2004). Wassell and LaVan (2008) note that through co-generative dialogues co-teachers share reflection to grow and adapt philosophies and practice. Cook and Friend (2004) note that during co-teacher observation that one co-teacher can gather information during instruction to analyze together afterwards. Co-teaching approaches that did not necessarily utilize group work, so One Teach One Observe, or One Teach One Assist, or Collaborative Team Teaching allowed for one co-teacher to experience teaching and learning from a different perspective gaining insight as a resource to support student need and support pushing teacher practice forward. Thus, certain co-teaching modes, and how co-teachers co-construct their teaching model with the modes and orient themselves, can be understood as a unique resourceful opportunity to support student success. Aldridge-West (2014) found that co-teaching is one way to improve student achievement in mathematics. Aldridge -West (2014) noted that the co-teaching modes involving group work partnered with students receiving more attention led to higher achievement rates. Fisk and Dunbar (2017) note that co-teaching certainly leads to extra-support for classroom teachers, but also leads to greater student learning gains. In my study, the students performed at a higher rate of success on the standardized test compared to the authentic assessment as measured by students' ability to achieve curricular outcomes. A possibility is that the co-teaching activities prior to the authentic assessment were more related to the standardized test. However, the co-taught authentic assessment was executed prior to the standardized test and was implemented utilizing the co-teaching model co-constructed by the co-teachers. Although the authentic assessment was used as a summative data collection, it supported furthering student learning of the math curricular concepts covered. This is in line with Newmann et al.'s (2001) work in disadvantaged schools, which found that students exposed to authentic work achieved greater gains on standardized tests. This impacted the ordering of the assessments in this study. On both assessments students performed at a higher level than was perceived by the teachers.

Larsen's (2012) study on elementary mathematics coaching by co-teaching in an urban school found that co-teachers' perceptions were that it improved practice, but the co-teachers were not able to identify change in student learning. This study on teacher perception aligns with the findings in my study where the teachers indicated on the closed-ended survey that they strongly agreed that co-teaching supported student learning and achievement, but perceived minimal change in student learning by noting that only one student moved from being below grade level to at grade level at the end of the observed math unit. Larsen (2012) did not collect student achievement data, so could not effectively triangulate student performance with teacher's perception.

The co-teachers in my study felt as though they needed to teach to where each individual student was in their learning and the continuum of mathematics as it related to the program of studies and not necessarily focus on the summative unit assessments. This is in line with the study by King-Sears and Strogilos (2018), in which the co-teachers focused more on progress as it pertained to individualized learning as opposed to doing better than their peers. As discussed earlier, teacher perception of student ability was largely understood as being lower academically. The post-observation survey, which was done after the authentic assessment and standardized test, revealed that the co-teachers felt that 19 out of 48 students performed below grade level. This is significantly higher than the actual measurement of students' mathematics performance, in which, only nine students were found to have performed below grade level on the authentic assessment and one student performing below grade level on the standardized tests (Table 3). This discrepancy suggests that teachers' perceptions of marginalized students' mathematics performance tend to be lower than students' actual performance in mathematics. Although this discrepancy did not come up in the co-teaching literature it is in line with other findings on the perceptions of teachers on marginalized students and academic outcomes (Namrata, 2011; Redding, 2019).

Veldhuis (2019) found that by supporting teachers in classroom assessment techniques in multiple grade 3 mathematics classrooms, there was a significant increase in student achievement scores on the standardized math tests. Certainly, the training on classroom assessment techniques utilized diagnostic and formative assessments, but one of Veldhuis's (2019) concluding findings was that teachers were more inclined to utilize these assessments due to having more reflective discussions with other teachers. In a co-teaching environment where there has been an established shared responsibility with flexible group work, ongoing formative



Recommendations for Future Research

This case study researched the influence of co-teaching of mathematics on marginalized students' mathematics learning and performance. Students' mathematics performance was measured utilizing a standardized test and authentic assessment. The Cultural



Marginalized Students. Marginalized students are considered students that are at-risk of not completing their education, historically performing low on achievement tests, and belong to local marginalized communities composed of visible minorities such as Indigenous communities, English language learners, working class and students with special needs (Gutiérrez, 2008).

Co-Teaching. Co-teaching is defined by Cook and Friend (1995) as "two or more professionals delivering substantive instruction to a diverse, or blended, group of students in a single physical space" (p. 2).

Authentic Mathematics Assessment. An authentic mathematics assessment

is a performance-based task which requires students to showcase a deep understanding of the content, problem solve, and use higher order thinking as mathematicians (Koh, 2017).

Standardized Mathematics Assessment. For the purpose of this

study, a test where all students receive the same mathematical questions and is measured or scored consistently with a standard. It tends to measure students' knowing of mathematical facts and execution of routine mathematical procedures (Koh, 2014). The first cycle of analysis sought patterns or themes amongst the data collected independent of the research questions (Bloomberg & Volpe, 2019). The data were then consolidated and reduced through ongoing coding and a constant or continuous comparison approach in this cycle (Merriam, 2001). The theoretical framework helped analyze data and patterns, and extract themes from the codes (see Figure 5) (Bloomberg & Volpe, 2019). In essence, the patterns and themes were situated using CHAT on the co-teaching activity system or the assessment activity system in the co-taught classroom. Understanding the two activity systems holistically and where the patterns and themes aligned helped make sense of how the phenomenon of co-teaching influences marginalized students' mathematics learning and performance on assessment within the context (i.e., the mathematics classroom) as well as the other elements in the CHAT framework. This included tensions or contradictions within the activity system.



Co-teaching and how co-teachers orient themselves in the classroom into a co-teaching mode, was discussed also as a resource to implement flexible group work, leveraging teacher expertise to personalize learning more with students for individual student needs. The co-teaching modes recognized as needed for an effective co-teaching model to improve student achievement in mathematics was found by Aldridge-West (2014) to be parallel co-teaching and station co-teaching. In my study, both of these co-teaching modes include group work with the co-teachers and were observed and discussed with the co-teachers as integral to how the mathematics unit was taught.

Because co-teaching and the different modes of co-teaching yielded opportunities for co-teachers to observe teaching and learning as well as accommodate students' learning through group work, both of these experiences in the classroom were built upon to push practice and student success forward. In one example mentioned earlier, developing a consistent language together by observing one another teach was perceived to support student learning. It was found by Hickendorff (2013) that elementary students' language level effected mathematical abilities in computational skills and applied mathematics problems. This is similar to Mastropieri et al. (2005) who found that reducing language and literacy requirements was an adaptation that was discussed between co-teachers as a learning need for specialized student learning. In Mastropieri et al.'s (2005) study, it was achieved by having one co-teacher work with those students identified. Similarly, in. my study the co-teachers would continue their flexible group work once the consistent languaging of the lesson was established between the co-teachers.

The notion of co-teachers observing each-other in the teaching and learning process is only made possible because the co-teachers and students are in the same physical space. Not only are the co-teachers in the same physical space with the students, but how they are oriented also impacts the teaching and learning process. The co-teaching mode that is established is also understood between the co-teachers as how they orient themselves in the physical space.



The second main thematic finding was a response to the sub-question; What factors facilitate or hinder teachers' co-teaching of mathematics to marginalized students? The second thematic finding considers the activity sub-system of assessment within a mathematics co-taught classroom and that having two co-teachers may allow for more ongoing formative assessment to occur than if there were a single teacher. The ongoing and consistent formative assessment facilitated personalizing learning more. When looking at assessment holistically, it was connected to a co-taught mathematics classroom in all the nodes or vertices on the activity triangle. Conceptually, the assessment activity sub-system being analyzed was understood as being situated inside the co-taught classroom and the co-teaching activity system.

During analysis, when the categories of factors within a co-taught mathematics classroom were situated on the co-teaching activity system and the assessment activity sub-system, each category or a particular factor of a category was connected to each corresponding vertex or node. The second thematic finding explores the connections between the assessment activity sub-system within the co-taught mathematics classroom and the notion of time and space being shared. Scruggs et al. (2007) note that co-teaching was regulated by administrators through fixing a time and space. Physical space and time were found to be categories of factors in a co-taught classroom that also played a large role in understanding assessment. Time and space connected the subjects (co-teachers and students) within the corresponding co-taught activity system and assessment activity sub-system.

There existed a shared or collective responsibility between the co-teachers in the observed case study that is in line with Roth and Tobin (2004) who note that with a collective responsibility that co-teachers teach together. Both co-teachers expressed that the current co-teaching arrangement benefitted themselves and students and was a positive experience. Ms Crowflower stated that "I'm enjoying [co-teaching] more than I thought I would." Ms. Sharma stated "It is nice to be teaching with [Ms. Crowflower] ..., because we do get along so well together." This is in line with Brendle et al. (2017) who found that the co-teachers' willingness to share the classroom and instructional responsibilities was key to a positive co-teaching relationship. Historical Activity Theory provided a framework to make sense of the complex phenomenon of co-teaching to a marginalized student population. Throughout the study additional questions surfaced as having potential for future research. These questions include:

- How does co-teaching influence other divisions in mathematics performance?
- How does co-teaching influence other demographics in elementary students' mathematics performance?
- How does co-teaching influence elementary students' performance in other subjects such as Science, English Language Arts, or Social Studies?
- How does physical space and time influence other classroom environments and dynamics in learning as a shared outcome in the CHAT?



Co-teaching is understood as two teachers sharing responsibilities to teach a group of students in the same physical space. This exploratory case study was set in a grade 3/4 dyad classroom with two co-teachers and two rosters of students. The case study focused on a mathematics Number unit taught over a period of 7 weeks. The case study explored how co-teaching benefits student learning and achievement as well as teacher professional development. Co-teachers leveraged teacher expertise to learn from each other and group students to work with according to need. Through ongoing formative assessment and real-time support, co-teachers were able to personalize learning. The students engaged in typical assessment practices, authentic assessment and adapted standardized tests and showcased improved mathematics performance. Co-teaching can be used to promote teacher professional development as well as be used to personalize learning and support assessment practices which may support student success in mathematics. Ongoing formative assessment and reflection through co-generative dialogue between co-teachers and with students played a large role connecting teacher and student learning and student performance. Co-teaching seems to be a promising model of instruction for more effectively supporting marginalized students' mathematics learning and performance as well as a means for teachers' continuing professional learning while working with diverse students.





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