An Examination of Grade 2-4 NWEA MAP Growth Assessment RIT Scores in Mathematics During Pandemic-Related School Closures

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Abstract

The Covid-19 pandemic led to an unprecedented era of public school for most American children as approximately 55 million students were affected by abrupt school closures that moved almost all students into some form of online learning in March of 2020. The purpose of this causal-comparative study was to examine to what extent student learning in mathematics for grades two through four at one midwestern urban school district was impacted by pandemic-related school closures and interrupted instruction. The mean composite RIT scores in mathematics on the NWEA MAP Growth Assessment for mid-year 2019-2020 and mid-year 2020-2021 were compared to examine the extent to which there were mean differences for grades two through four combined, for each grade level separately, for Title I schools and non-Title I schools, and for students who chose the district's Online Academy option and students who chose the in-person learning model, who experienced a combination of in-person, hybrid, and virtual instruction. Lastly, the four mathematics Goal Area mean RIT scores for winter benchmark 2020 were compared to winter benchmark 2021 Goal Area mean RIT scores for grades two through four combined to examine the extent to which there were mean differences for each of the tested: Data and Statistics, Number Sense and Operations, Relationships and Algebraic Thinking, and Geometry and Measurement. The analysis of the NWEA MAP Growth Assessment data for mathematics revealed that school closures during the pandemic had a significant negative impact on mean composite RIT scores for the mid-year NWEA MAP Growth Assessment in mathematics from 2019-2020 to 2020-2021 for all students in grades 2-4 combined, and for each grade level separately. Student mid-year mean composite RIT scores in mathematics for grades 2-4 combined at both

Title I and non-Title I schools were also significantly negatively impacted. Students who opted for the district in-person learning model and experienced a combination of in-person, hybrid, and virtual instruction showed a significant decrease from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment, but students who opted for the district Online Academy showed the only significant increase in mathematics mean RIT composite scores. School closures also had a significant negative impact on mean RIT scores in mathematics for all four Mathematical Goal Areas tested on the mid-year NWEA MAP Growth Assessment (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics) for students in grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021.

Dedication

To all the teachers who took the phrase, ‘do what’s best for kids’ to the next level during this unprecedented time in history. We had no idea what we were going into and we did it anyway…with optimism, enthusiasm and a drive-by parade.

To my family for inspiring me to reach greater heights and encouraging me every step of the way. You are my why, my reason, and my rock.

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loved when an AMI day for our district occurred after your review and you knew what that was. You are also to blame for this process since I never would have been inspired to go back to school for an advanced degree when I had teenaged kids, except you did the same thing when I was in middle school. Thank you for setting the bar high for women and being an incredible role model.

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I must note that the date of submission of this document is nearly two years to the day of the beginning of the pandemic and the uncertainty surrounding this unprecedented time in America. We learned perspective, the importance of our people, and to appreciate the little things in life. What's more important than that?

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Chapter 1

Introduction

In the spring of 2020, the United States experienced unprecedented challenges due to the novel coronavirus, Covid-19. This virus was so contagious, and the threat of infection so great, that communities quickly established policies to prevent large gatherings and social contact in response. Sweeping national regulations went into effect in March of 2020. At that point, the public had little knowledge of how the virus spread or how to avoid infection. It was a time of great precaution and unknown. March of 2020 was the beginning of what has grown into a years'-long national crisis for most areas of life in America. National sports organizations canceled sporting events, as entertainment venues and stores closed. Local government entities enacted regulations to minimize contact and limit business capacities. Contactless payments, curbside pick-up, and delivery services quickly became the norm. Plexiglass dividers, standing spots placed on floors designating social distance, and personal protective equipment became commonplace in public. For the most part, local-level agencies urged people to follow stay-at-home guidelines and limit any excursions outside the home.

The Covid-19 pandemic also led to "an unprecedented and sweeping shift in the landscape of K-12 public schooling" as schools throughout the United States were forced to close and adopt "distance learning supports that varied in degree and type" (Hamilton, Grant, Kaufman, Dilberti, Schwartz, Setodji, and Young, 2020, p. 6). Approximately 55 million students across the nation were affected by abrupt school closures that moved almost all students into some form of online learning in March of 2020 (von Hippel, 2020).

According to Time Magazine, “by late March, 46 states had closed all schools, and approximately 55 million K-12 students were either trying remote learning or not getting any instruction at all” (Reilly, 2020, para. 9). School districts mandated that teachers and students pivot from traditional in-person classroom instruction to embark on a virtual learning model without a plan in place in most cases and with little to no notice for school personnel or families. Across the country, school districts instructed students and instructors to pack their books, school supplies, and computers (where possible) to use at home, not knowing when the students and faculty would return to the school building. Concurrently, school districts scrambled to navigate internet connectivity for underserved students, coordinate meal delivery for under-resourced students, and ensure that educators had technological hardware and software needed to provide instruction virtually. Many teachers across the nation began to deliver lessons and content over a virtual platform on or about March 30, 2020, with little preparation, minimal professional development, and no precedent or model to follow. Education Week called this “an historic upheaval of K-12 schooling in the United States” (Education Week, 2020a, para. 1).

On March 23, 2020, Missouri Governor, Mike Parsons, ordered schools closed for the remainder of the 2019-2020 school year (Parsons, 2020). School closures impacted 2,424 schools and 915,040 students across the state of Missouri (Education Week, 2020a). According to a Rand Corporation report, a minority of school districts were prepared for a crisis of this magnitude, with only 46% of schools nationally having had a plan of any sort to address a pandemic (Diliberti, Schwartz, Hamilton, & Kaufman,

2020). Before the widespread school closures due to the pandemic, most American public-school students primarily received their education through an in-class educational experience (Dorn, Hancock, Sarakatsannis, & Viruleg, 2020b). Virtual learning was not commonplace in America's classrooms.

Parents scrambled to make spaces for their students to learn at home, managed their personal work-from-home schedules as workplaces were also abruptly disrupted, and attempted to assist primary-age students navigate learning through their electronic devices. Nationwide instructional activities at this time included combinations of the following methods: virtual instruction, recorded videos, instructional packets, and assignments given and submitted via online learning management platforms such as Schoology, Google Classroom, Seesaw, Canvas, and Clever, and delivered primarily via Zoom or Google Meet (Harris, Liu, Oliver, Balfe, Slaughter, & Mattei, 2020). Through this pedagogical upheaval, teachers learned how to host video conferencing with students as young as five and adapted their traditional classroom interactions, assessments, independent practice, and interventions for student learning to a digital format (Lieberman, 2020). This abrupt change in the delivery of educational content and instruction happened across the nation for almost all public-school children (Garbe, Uzeyir, Logan, & Cook, 2020).

These massive shifts in learning models and heroic actions by school districts and teachers, coupled with varying amounts of family support, created a unique school experience for almost all students across the United States. Faced with these unprecedented challenges, teachers and school administration had many concerns

regarding the effectiveness of unfamiliar instructional models for student learning, and specifically how effective educators were at meeting the needs of at-risk student populations. The pandemic shifted the American education system into an experiment of enormous proportions.

Background

As many as 55 million students in the United States changed from traditional school settings and experienced a new educational model beginning in March of 2020. This model of instruction continued into the 2020-2021 school year due to the Covid-19 pandemic (Kuhfeld, 2021). Teachers and students across the nation were forced to quickly adapt to a virtual learning model that varied by classroom, school, district, city, and state. In a nationwide survey of more than 1,200 U.S. teachers in mid-March, 2020, "more than half of teachers say they do not feel prepared to facilitate remote and online learning" (Ascione, 2020, para 2).

School District ABC (ABCSD) is located in suburban Kansas City, Missouri, and during the 2019-2020 school year served approximately 19,000 pre-K-12 grade students in 18 elementary, three middle, and three high school buildings. ABCSD was reorganized in 1949 when 16 rural elementary districts combined with a surrounding school district to serve approximately 1,200 students ([redacted] History, 2022). According to data publicly available at Great Schools.org, during the fall of 2019 the ABCSD demographics included 75% of students who identified as white, 13% of students who identified as black, 4% of students who identified as Hispanic, and smaller percentages identifying as Asian, Native Hawaiian, or Native American. Students who

identified as female represented 49% of the population with students identifying as male represented 51%. Students who come from low-income families represented 21% of the total student population. Three of the district elementary schools were identified as Title I buildings because these schools met U.S. Department of Education guidelines with more than 40% of students qualifying for free/reduced lunch.

In anticipation of potential school closures based on increasing news coverage warning of pandemic-related shutdowns, the ABCSD sent students home with backpacks loaded with computers, library books, and some instructional materials when students left on March 13, 2020, for an already designated week-long spring break. During spring break, district leaders consulted with state and local health officials to plan for instruction following local guidelines related to reducing the spread of Covid-19. For students, spring break was then extended to allow teachers preparation time to plan for remote instruction, which began the following week on March 30, 2020.

At that time, it was not known how long schools would operate remotely or for how long school buildings would be shuttered. Each week, the school district updated the community, teachers, and parents about plans regarding instructional models. The ABCSD did not, however, reopen for in-person learning for the duration of the 2019-2020 school year. The school district opened for in-person learning in the fall of 2020, but only for a small population of students which included all kindergarten through third-grade students plus special education students at all levels, K-12. Full in-person reopening for all students at all levels in the district did not occur until January 2021. For the 2020-2021 school year, families were given the option to enroll in a fully online

education model, the Online Academy, or opt for in-person learning with the understanding that the in-person model would be dependent on state and local guidelines regarding the pandemic. Ultimately, students who chose the in-person learning model experienced a combination of in-person, hybrid, and virtual instruction.

The learning management system, Schoology, was in place in the ABCSD before the pandemic, but was primarily used at the middle and high school levels prior to school closures. The Schoology platform allows teachers to post assignments, discussion questions, tests, quizzes, and videos. This platform's capability was beneficial for a virtual learning format due to the integration with other school management databases for enrollment, attendance, and grading (Common Sense Education, n.d.). This platform was used by elementary teachers to a very limited extent prior to the pandemic and was mostly unfamiliar to elementary-aged students. There were substantial challenges for elementary teachers to successfully utilize Schoology during the period of virtual learning. Elementary teachers were simultaneously connecting with students via the Schoology platform while teaching the functionality of the platform remotely with a group of young students. There was little to no prior training for families of students at home to help navigate Schoology in advance of the school shutdowns, at times leading to older siblings becoming the technology support for younger students when possible. Students without the benefit of a sibling or a parent to help them had to navigate on their own and may or may not have been successful at connecting with their teacher or coursework (Huffman, 2020).

The ABCSD established a policy that no student would be penalized for their academic performance during the period of school closures, and that grades as of March 13, 2020, would either stand or improve (Bergen, 2020a). This policy was created by the ABCSD in response to the question of equity of access to virtual learning for all students. It allowed students to keep their grades from the time prior to school closure, regardless of online participation, which led many students and parents to simply opt-out of continued online learning involvement for the remainder of the 2019-2020 school year (Bergen, 2020a). In a communication to staff, the ABCSD superintendent reported that as many as 25% of students did not participate in online learning provided during this time (Miller, 2020).

For the fall of 2020, the ABCSD offered two options for student enrollment. Students could enroll in the Online Academy for a fully online learning environment or select the in-person option (Bergen, 2020c). The district planned to open in-person, but this model experienced numerous changes and interruptions. The school calendar and learning models were continually changing throughout the year. The start of school was delayed by two weeks past the original start date as administration waited for local Covid-19 infection rates to decline. Ultimately, because infection rates did not fall, on September 8, 2020, the school district opened in-person only for students in kindergarten through grade 3 and remotely for students in grades 4-12. At that time, the ABCSD had revised expectations for student attendance, assignment completion, and participation from the previous year (Buck, 2020b). Students in grades 4-12 were expected to be present online during school hours, participate in a schedule that mirrored an in-person

school schedule, and complete assignments as if they were in the classroom. Students had a schedule of live classes, independent work time, class meetings, and breakout sessions for groups and students were expected to be online at designated times for instruction and were accountable for work completion during the school day (Buck, 2020b).

By October 2020, ABCSD students in grades 4-12 returned to school in a hybrid school model. In this model, classes were divided into two sections: an A and B class. Students in "A class" attended in person at the school Monday and Tuesday, while students in "B class" attended on Thursday and Friday. Teachers were expected to instruct at a pace that reflected five full days of the curriculum; two days in person and two days accessible in an online format, plus a whole group virtual class on Wednesdays. Teachers taught an in-person lesson to students in school and provided the same content to students at home either in the form of an actual recording of the lesson presented at school or an online version of the same learning objective obtained from YouTube or another instructional site. Students at home accessed the instruction via their Schoology courses. The expectation was to keep up with the learning targets at the same pace as in-person students. Both classes would have the same assignment for independent practice on the math objective. The next lesson would be presented the next day to whichever class was in person. On Wednesday, lessons were presented to the whole class at home by the teacher at school. In theory, students received instruction in person on their in-school day, could access recorded lessons, videos, and online assignments on their virtual days, and could come together as a whole group as a virtual class in a midweek virtual

setting. This type of instructional model was unprecedented in the ABCSD and similar versions of this hybrid model were created in schools across America (Bergen, 2020b).

All grade 4-12 learners returned to their respective classrooms for in-person instruction on November 17, 2020 (Bergen, 2020c). Fourth through sixth-grade students resumed a five-day-per-week schedule, 7-12 grade students resumed a four-day-per-week in-person schedule with Wednesdays as a flexible learning day for asynchronous learning, office hours, and school cleaning. This model was implemented for one week until infection rates and county health directives required a return to virtual education for all students K-12. Students remained in a virtual learning model until January 11, 2021, when grade K-6 students returned to an in-person model. Middle and high school learners returned to a hybrid model on alternating days beginning on January 25 and to a four-day in-person model on February 8, 2021.

Teachers were creating new class protocols and reinventing their teaching methods to provide virtual instruction based on the continually changing instructional models. Students had to learn how to access lessons, assignments, discussion groups, and resources online, as well as navigate when and where to be present in-person. Students in intervention groups had to learn how to participate with resource teachers when in a virtual setting, often requiring them to navigate to another virtual room or location online. For many students, especially at-risk elementary students, this was a challenging experience. Parents had to help students navigate between the differing expectations for each learning environment. Additionally, there were individual classes, grade levels, and entire school buildings that experienced periods of quarantine and closures due to Covid-

19 exposure and infection levels during the period of in-person learning. Teachers, parents, and students had to keep track of the continually changing educational models and schedules.

As an added challenge, the ABCSD experienced a period of extreme weather that resulted in five Alternative Method of Instruction (AMI) days. These were online learning days during the period in which school was supposed to be back in-person, but school buildings were not open due to extreme weather. AMI days were virtual asynchronous days, meaning that teachers provided lessons and assignments, but students were to access the content independently, as no live lessons were available from the teachers. When vaccines became available in March of 2021 for educators, the district scheduled an additional three AMI days so staff could attend mass vaccination events. In summary, after school resumed in-person, students had eight AMI days. On these asynchronous days, students had assignments and content provided by educators to be accessed virtually from home. There was a general sense of fatigue among parents, teachers, and students, as nearly every week presented a new instructional model or schedule change.

For the 2020-2021 school year, the ABCSD offered a fully Online Academy option for students in grades K-6 for families who preferred a completely online learning option for their students (Miller, 2020). These students participated remotely via computer using the Schoology platform. Students who enrolled in this method of instruction, for the most part, experienced a constant and predictable educational format,

especially when compared to the continued interruptions and challenges their in-person counterparts experienced during the same instructional period.

Statement of the Problem

Given the unprecedented shift from in-person to virtual learning in March of 2020 due to the Covid-19 pandemic nationwide, students, teachers, and families were widely affected. American families and the American educational system made the single most significant shift since the one-room schoolhouses became school buildings with multiple classrooms (Education Week, 2020b). Learning models included virtual, hybrid learning, synchronous, and asynchronous learning designs. Before this unilateral shift to virtual schooling and teachers providing digital lessons with parents and caregivers' support at home, homeschooling was isolated and virtually unregulated (Mineo, 2020).

In March of 2020, most households in America with school-age children experienced having their children learning from home, while juggling work from home, and the many other challenges that accompanied the pandemic and its associated stay-at-home orders. Education leaders struggled to provide a wide variety of supports, including learning management software, internet-connected devices for students, meal delivery, interventions for low-performing students, special education accommodations, and special services in ways that had never been done on such a large scale. Teachers attempted to connect with students, teach content, offer remediation and support, and keep children learning in some fashion through extended shutdowns that lasted from mid-March of 2020 until the end of the 2019-2020 school year. As the pandemic dragged into the 2020-2021 school year, the educational models implemented across America varied

widely. Students across the nation switched between various instructional models including versions of online, in-person, school for two days a week, or only mornings or afternoons, with few weeks following the same instructional models (Lehrer-Small, 2021).

The instructional model and schedule were continually changing for students who opted for the in-person learning model in ABCSD for the 2020-2021 school year as well. The ABCSD employed a variety of instructional models depending on the age of students, including fully in-person, fully online, hybrid, synchronous learning, and asynchronous learning. All in-person ABCSD students experienced a combination of all these models at some point during the 2020-2021 school year. In February of 2021, all in-person students in ABCSD had the opportunity to attend school in person for four days a week for the first time during the 2020-2021 school year. Concurrently, students who had opted for the district fully online, Online Academy, experienced continuity in their instruction. These students had a predictable class schedule, knew the setting for their instruction, and had routines and procedures established in their Online Academy virtual classroom.

The Washington Post reported in March of 2020 that "the United States is embarking on a massive, months-long virtual-pedagogy experiment, and it is not likely to end well" (Huffman, 2020, para. 1). Therefore, the extent to which students in ABCSD show learning growth during this time of interrupted learning, various learning models, and changes to how schooling occurred in response to the pandemic is of great interest. Research has shown that students lose ground over the summer, known as the summer

slide (Quinn & Polikoff, 2017). The question of how student achievement was affected by the interrupted school models and unprecedented upheaval of schooling guided this researcher's inquiry. In a report by the Rand Corporation in 2020, researchers examined the effects of school closures following Hurricanes Harvey and Irma, which highlighted that very little research has been done on the use of virtual learning during events of "prolonged school closure" (Schwartz, Grant, Diliberti, Hunter, & Setodji, 2020, p. 4).

Using mid-year assessment data from the NWEA MAP Growth Assessment in mathematics administered in January 2020, the benchmark test before the widespread school shutdowns, and the same assessment results a year later, the current study sought to identify where the most substantial gains and losses occurred for students in mathematics and identify whether students in grades 2-4, students in Title I schools, or students in the in-person model versus Online Academy were impacted. Additionally, the current study sought to identify which goal areas tested on the NWEA MAP Growth Assessment in mathematics (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics) showed the greatest changes from mid-year 2020 to mid-year 2021.

Purpose of the Study

The purpose of this causal-comparative study was to examine to what extent student learning in mathematics for grades two through four in ABCSD was impacted by school closures and instructional delivery disruptions due to Covid-19, and to determine which student subgroups and Mathematical Goal Areas were most impacted. Student progress in mathematics during the pandemic was measured by Rasch Interval Unit (RIT)

scores on the NWEA MAP Growth Assessment mid-year administrations. The RIT scale ranges across all grades and across all grades equally, making it possible to compare a student's score at various points throughout his or her education. The RIT score represents the level where a student is ready to learn, also known as the Zone of Proximal Development, and measures student progress and growth over time (NWEA, 2020). The NWEA MAP Growth Assessment is a computer-adaptive test that provides each student a unique set of test questions based on their prior responses (NWEA, 2017), and assesses four Mathematical Goal Areas: Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics (NWEA, 2022).

Most schools in the country, including the ABCSD, shifted to a virtual learning model in March of 2020. The mid-year 2019-2020 administration of the NWEA MAP Growth Assessment, winter benchmark 2020, reflected student learning prior to school closures and interruptions. The mid-year 2020-2021 administration of the NWEA MAP Growth Assessment, winter benchmark 2021, reflected the amount of learning as impacted by school closures and interruptions due to the global Covid-19 pandemic. The mean composite RIT scores in mathematics for mid-year 2019-2020 and mid-year 2020-2021 were compared to examine the extent to which there were mean differences for grades two through four combined, and for each grade level separately. The mid-year NWEA MAP Growth Assessment mean composite RIT scores in mathematics for grades two through four combined were also compared by Title I school status to examine the extent to which student learning in mathematics was impacted at Title I schools and non-

Title I schools, and compared by instructional delivery model to examine the extent to which learning in mathematics was impacted for students who chose the district's Online Academy option and students who chose the in-person learning model, who experienced a combination of in-person, hybrid, and virtual instruction. Lastly, the four mathematics Goal Area mean RIT scores for winter benchmark 2020 were compared to winter benchmark 2021 Goal Area mean RIT scores for grades two through four combined to examine the extent to which there were mean differences for each of the Mathematical Goal Areas tested: Data and Statistics, Number Sense and Operations, Relationships and Algebraic Thinking, and Geometry and Measurement.

Significance of the Study

The current study identifies and quantifies changes in the amounts of mathematics learning for students in ABCSD who experienced school shutdowns, interrupted learning, various learning models, and extended virtual learning. Results will add to the greater body of knowledge for all educators as the pandemic-related changes to schooling are investigated. There could be substantial practical applications of this study's findings that could benefit school district leaders, inform instructional practices, and help teachers address student instructional needs. Due to the unprecedented nature of school shutdowns, findings of the current study could create new knowledge in the field of education pertaining to pandemic-related changes to school structures and teaching methods. The results of the current study could inform future decision-making for ABCSD leadership planning professional development, designing curriculum, and creating additional supports needed for mitigating student learning loss.

School district leaders could use the results obtained from this research to plan professional development for teachers to address students' learning needs post-pandemic. Instructional leaders could use subgroup analysis results to identify the extent to which student subgroups were affected and provide training for teachers on how to address at-risk subgroups' needs and provide supports. Using insights gleaned from this study, training for teachers might be developed to improve instructional practices for teaching mathematics in an online environment for specific Mathematical Goal Areas identified as low by the study results.

This research will specifically quantify student learning loss in mathematics by identifying which subgroups were most affected and which mathematical curricular areas were most impacted by the various instructional models employed. The current study examined the achievement levels of students in an online-only environment versus achievement levels of students who experienced an in-person model that was continually changing. Results from the current study could help teachers identify which subgroups of students experienced the greatest change in their learning so that additional supports could be made available for these subgroups. Furthermore, this research could help identify in which mathematics goal areas the most substantial loss occurred to guide intervention groups and remediation. Educators could use the information revealed from this study to make future educational planning decisions for each subgroup and grade level. Determining the extent to which students experienced learning loss could help educators assess content learning deficiencies and plan instruction to address student knowledge gaps.

The practical applications of the study results could inform future curriculum development for ABCSD and add to the research knowledge of the effects of virtual learning and interruptions to the learning model for elementary students in mathematics. Findings could also provide a deeper understanding of Mathematical Goal Areas in which virtual learning seemed to be effective, and the areas of less effectiveness. Results of the current study could help district leaders better understand which mathematical areas students benefit most from in-person instruction. Curriculum development and resources for in-person and online learners could be tailored to better address best instructional practices for each learning environment. By identifying areas in which students were able to perform well in mathematics regardless of learning environment, research results might inform the district of Mathematical Goal Areas that are essential to teach in person and in a classroom setting whenever possible, and which Mathematical Goal Areas can be of successfully taught virtually or with online tools.

Delimitations

Delimitations are boundaries set by the researcher to narrow the focus of the research. Lunenburg and Irby (2008) defined delimitations as, "self-imposed boundaries set by the researcher on the purpose and scope of the study" (p. 134). For the current study, the research included the following delimitations:

- The study was conducted in one midwestern, suburban school district.
- The study was conducted only for students in grades 2-4.
- Mathematics was the academic content area of focus, and overall growth was analyzed, as well as mathematic growth in four Mathematical Goal

Areas (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics).

- Only one academic measure, NWEA MAP Growth Assessment for mathematics, was used to assess changes in the levels of student learning.
- Only RIT scores from students in grades two through four on the mid-year NWEA MAP Growth Assessment were analyzed.
- The four Mathematical Goal Areas on the NWEA MAP Assessment were only examined with grades 2-4 combined, not disaggregated by subgroups.

Assumptions

"Assumptions are postulates, premises, and propositions that are accepted as operational for purposes of the research" (Lunenburg & Irby, 2008, p. 135). These factors are outside the control of the researcher and cannot be checked quantitatively. Several assumptions were made surrounding this quantitative study of NWEA MAP Growth Assessment RIT scores in mathematics for a suburban, midwestern elementary school population. The following assumptions were made concerning this research study:

- Data from mid-year assessments in January 2020 were unaffected by the school closures that occurred in March of 2020.
- Data from the mid-year assessments in January 2021 would reflect learning loss or gain following the period of school closures.

- Students worked independently on NWEA MAP Growth Assessments in mathematics regardless of whether they took the test at home or in school.
- NWEA MAP Growth Assessment in mathematics accurately measured mathematics learning.
- Student RIT scores accurately measured and compared academic growth and progress over time.
- Students participated in instruction.
- Teachers followed NWEA standardized testing protocols when administering the NWEA MAP Growth Assessment.
- The assessments were scored and recorded accurately by the testing company, NWEA.

Research Questions

Lunenburg and Irby (2008) called the research questions the "directional beam for the study" (p. 126). In the research questions, the variables of interest are identified along with the focus of the investigation into each variable or set of variables. According to Roberts (2004), quantitative research questions must contain a clear specification of variables or concepts and an indication of the nature of the analysis: description, relationship, or difference. The following five questions guided the current study:

RQ1. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics for all students

grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

RQ2. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics by grade level (grades 2, 3, and 4) from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

RQ3. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics by Title I school status (Title I and non-Title I schools) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

RQ4. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics by instructional model chosen (Online Academy and in-person) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

RQ5. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean RIT scores in mathematics for students in grades 2-4 combined by Mathematical Goal Areas (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics) from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

Definition of Terms

The definition of terms includes the operational definitions that are essential to understanding the current study for terms, which may vary depending on the educational,

cultural, or geographical context. The researcher chose to use the ABCSD's definitions as those provided the most accurate representation of the concepts related to this research study. The following terms are operationally defined for the current study:

Alternative Method of Instruction (AMI). Alternative method of instruction, or AMI, was created to address weather-related closures. AMI days allow teaching in a virtual environment because of school district cancellations for weather or other reasons. Instruction was administered using the Schoology platform and students did not report to school. In this model, students participate asynchronously (Missouri Department of Elementary & Secondary Education, 2021).

Asynchronous Learning. Asynchronous learning refers to learning that does not occur at the same place and time. This phrase has become commonplace to describe learning models in which teachers prepare lessons and share through an online platform for students to access from home. Students can access the lessons and learning opportunities on their schedules and includes prerecorded lessons or game-based learning that is not delivered in real time, and can include email, discussion boards, and assignments through learning management systems, and other options (Tophat Online Glossary, 2022a).

Chosen Instructional Model. Chosen instructional model refers to the educational method of instruction determined by parents for the 2020-2021 school year in response to the pandemic. Parents in the ABCSD were offered two choices: In-person Learning or Online Learning through the ABCSD Online Academy. Online Academy

offered students virtual learning through a combination of synchronous and asynchronous instruction (Bergen, 2020c).

Distance Learning. An educational learning model that is "institution-based, formal education" in which learners were separated and "interactive telecommunications systems" are in place to connect instruction with learners and resources (Barbour & Reeves, 2009, p. 402).

Hybrid Learning. Hybrid learning refers to a learning model in which students learn through a mix of in-person and online interactions. Hybrid learning models vary by district with the typical design including some students attending school in-person while others participate with the class electronically or asynchronously (Bonderud, 2021). Hybrid, or blended learning, refers to using both virtual and in-person settings for education. During the period of pandemic-related school closures, hybrid learning allowed for greater social distancing by reducing class size. In this model, students complete assignments or supplemental learning experiences outside of the classroom independently, while students in school learn the content from a teacher in school (Tophat Online Glossary, 2022b).

Hybrid learning in ABCSD District. The ABCSD utilized a hybrid learning model for grades 4-12, which allowed for greater social distancing by reducing class size by approximately half. In this model, half of the students attended school in-person two days a week and participated in classroom instruction in-person with the classroom teacher. At-home students participated in instruction asynchronously from home, completing assignments, using computer-aided instruction, and game-based learning

activities, completing independent work, and watching recorded lessons. Students attended school on an alternating schedule. Wednesday was whole class virtual instruction using the Google Meets platform to hold whole class meetings and lessons (Bergen, 2020b).

In-person Learning. In-person learning is defined as any instruction that occurs face-to-face with students and teachers in real-time in the classroom (Tophat Online Glossary, 2022c).

Learning Management System. Web-based platform for teachers to post lessons, instructional materials, and assignments to be accessed by students (Tophat Online Glossary, 2022d).

Math Manipulatives. Physical objects used to help students develop conceptual understanding of mathematical concepts and engage students in hands-on learning of mathematics. Manipulatives can be any number of classroom tools for teaching math including counters, blocks, unifix cubes, Cuisenaire rods, fraction models, geoboards, and pattern blocks (McAnelly, 2020).

Mid-year Assessment. NWEA MAP Growth Assessments are administered in the fall, mid-year, and end of the school year. The mid-year assessment administration window is January through February as determined by the school district (NWEA, 2022).

NWEA. Northwest Evaluation Associates Measures of Academic Progress is a research-based, not-for-profit organization that offers assessment solutions to measure growth and proficiency and help educators tailor instruction (NWEA, 2022).

NWEA MAP Growth Assessment. The NWEA MAP Growth Assessment is an adaptive computer test that measures student achievement and reports scores on a Rasch Unit (RIT) scale with ranges from 100 to 350. The RIT scale was designed to be a consistent, precise tool that provides accurate measurement of each student's academic growth. This MAP assessment scale supplies educators with valid, reliable, and predictive data to help students learn and grow (NWEA, 2022). NWEA is used in over 9,500 schools in 145 countries (NWEA, 2021).

Online Academy. The Online Academy was created in the ABCSD during the 2020-2021 school year to provide a virtual learning model for any student who preferred an online learning option rather than return to school in-person. ABCSD has retained the Online Academy option indefinitely into the future to meet the needs of students and families who, for whatever reason, prefer a virtual learning environment (Buck, 2020).

Rasch Unit Score (RIT Score). A RIT score is an equal-interval scale that enables comparisons of student growth across grade levels, districts, and states. RIT scores indicate the level of question difficulty where students answer questions correctly 50% of the time (NWEA, 2017).

Remote Learning Environment. Used synonymously with virtual learning environment (Tophat Online Glossary, 2022e).

Schoology. Schoology is a web-based learning management system in which teachers can create and assign readings, embed videos, post discussions, assignments and assessments. Students can demonstrate learning by posting to discussion boards, completing assignments, embedding video and audio files, and connect with classmates.

This learning management system was purchased and implemented by the ABCSD for all students in grades K-12, but prior to pandemic-related closures was used primarily for middle and high school learners. Within this platform, teachers can post lessons, instructional materials, and make assignments. Students can complete assignments, access instructional content, and participate in class discussions (Common Sense Education, n.d.).

Synchronous Learning. Synchronous learning refers to real-time communication and instruction between students and teachers. Learners interact in a specific virtual environment at a set time with school personnel. Course materials can include video conferencing, chat-based discussions, teleconferencing, Google Meets, or live-streamed lectures that are broadcast at the same time. Teachers take attendance, and students are expected to be present and participate in real-time (Tophat Online Glossary, 2022f).

Virtual Learning Environment. A virtual or online school is a school at home via the internet. The student logs on to a computer and takes classes. A virtual school setting course is taught through online methods through the online learning platform offered by the educational organization. Teachers provide interactive learning activities for students to collaborate and experience with the advantage of technology to support learning (Tophat Online Glossary, 2022g).

Organization of the Study

This dissertation is organized into five chapters. Chapter 1 presented the study's background, statement of the problem, the purpose of the study, the study's significance,

delimitations, assumptions, research questions, and the definition of terms. Chapter 2 will present a literature review, which includes research on learning loss, effects of the pandemic on schools and other instances in which schools have experienced interrupted learning, and the consequences or impacts on students, families, and teachers. Chapter 3 will describe the methodology used for the current study, including the research design, selection of participants, sampling procedure, measurement, data collection procedures, data analysis and hypothesis testing, and limitations of the findings. Chapter 4 will present the results of the data analysis results. Chapter 5 will provide a summary of the study, key findings, the results related to the literature, implications for action, future research recommendations, and concluding remarks.

Chapter 2

Review of the Literature

This literature review examines research on the effects of school shutdowns and interrupted learning models in the United States during the initial period of school closures due to the Covid-19 pandemic and the potential impacts on student achievement in the following year in the subject area of mathematics. The Education Research Alliance described the pandemic as the "gravest crisis the country has seen in a century" and stated that "few institutions have been as affected as schools" (Harris et al., 2020, p. 2). Harris et al. (2020) stated that this unprecedented shift in the learning model for nearly all public schools in the United States will have long-lasting effects on America's educational experience. A report by Edge Research called this time in American education a "redefining moment" for students, parents, and schools (Wagner, 2020, para. 1), and The World Economic Forum stated that this period "changed education forever" (Li & Lalani, 2020, para. 1). In a report from the American Enterprise Institute, this educational shift was described by Malkus (2020a) as an "urgent instructional retooling" (p. 1) in which classrooms looked different, new learning models were put in place, and teachers and administrators faced new and unknown challenges as districts switched to online learning platforms. The Center for Reinventing Public Education (CRPE) reported on the wide variety of educational models and disparities of opportunities for students in the nation, based on the response of each school system to educating and continuing student learning due to pandemic-related school closures (Schwartz et al., 2020).

As the educational system reinvented itself in response to the pandemic, there was a substantial change to the way in which instruction was delivered to almost all students nationwide. But it is unknown how this change affected student learning, which students were affected to a greater extent, and in general, how successful these changes were for education. Chapter 2 of this dissertation includes a review of research surrounding the widespread disruption to the educational landscape in America in response to the pandemic and the history of virtual learning in America. This review of literature also includes research related to the unique challenges facing school leadership, educators, families, and children during the initial period of changes to the traditional learning model in American schools, which were implemented across the nation in response to the pandemic in the spring of 2020. This literature review examines other examples of interrupted instruction and presents the results discovered about student learning with specific attention to the effect of school shutdowns on students in districts with higher levels of poverty and minority students. Finally, chapter 2 explores the unique challenges teachers and parents faced when teaching and supporting student learning in mathematics during this period of interrupted learning.

Nationwide Disruption of Education Response to the Pandemic

In the spring of 2020, the Covid-19 pandemic led to "an unprecedented and sweeping shift in the landscape of K-12 public schooling" (Hamilton et al., 2020, p. 1), as schools throughout the United States were forced to close and adopt "distance learning supports that varied in degree and type" (p. 1). Before the widespread school closures due to the pandemic, most American public-school students in 2020 primarily

participated in an in-class educational experience (Dorn et al., 2020b). Virtual learning was the exception, not the rule. Most K-12 students in the United States experienced a change in their learning model from in-person learning in traditional classrooms to some form of remote or virtual learning environments due to widespread school closures (Kuhfeld, 2021). Closures affected 55.1 million students in 124,000 public and private schools in nearly every state (Education Week, 2020a).

This historic shutdown was "unprecedented in modern times," and school districts were "scrambling to meet the needs of schools and families" (Kuhfeld, 2021, p. 549). Education Week online published an interactive map of the United States starting March 6, 2020, and continued until October 2021 (Education Week, 2020a). This map showed the status of school closures across the nation by state and included public school enrollment, number of public schools, the start of closure, number of schools affected, and status of the closure. It was further broken down to show wheter the schools were ordered closed, recommended closed, or varied by school/district (Education Week, 2020a). The map was updated as state data and closures changed. With the majority of all K-12 students learning remotely, it was unknown how effective these virtual learning models were for student learning (Kuhfeld, 2021). The Deputy Director of Education Studies for the American Enterprise Institute, Nat Malkus, described this historic pivot as tasking educators with "trying to build the plane as it went down the runway" (Malkus, 2020a, para. 4).

Spring of 2020 was a time of widespread disruption in many areas of life for most Americans and was stressful for everyone, including children. Seemingly overnight,

cities, counties, and states issued “stay at home orders;” business and schools were shuttered; and phrases like “social distancing” and “contactless delivery” became commonplace. In addition to extended school closures and children learning virtually from home, some parents were working from home while many workplaces were closed, but other parents were juggling their work in service industries or as essential workers with children at home (McNicholas & Poydock, 2020).

Local government agencies placed regulations on communities, including stay-at-home orders, citizens experienced health concerns over the pandemic, and racial tensions and widespread rioting occurred across the country (Harris, 2020). The world became divided into essential workers who left their homes to provide services and people who could work from home. While the perception was that many parents were working from home and homeschooling their children, according to the Economic Policy Institute (EPI), less than 30% of workers in America could work from home (McNicholas & Poydock, 2020). The majority of parents at home with their children for schooling identified as white or Asian (McNicholas & Poydock, 2020). Within the population of people able to work from home, less than one in five identified as black and one in six as Hispanic (Gould & Shierholz, 2020). This meant that students of color were most likely disproportionately represented in homes where there was not an adult to help them navigate the challenges of virtual learning (McNicholas & Poydock, 2020). There were many stressors that affected the remote classroom environments which families and students found themselves navigating during this shift to virtual learning (Harris et al., 2020).

It was widely stated that schools were overwhelmed and unequipped to handle the abrupt change to remote learning (Dorn et al., 2020a). School districts faced logistical challenges to connect with students, offer access to online resources, provide internet-connected devices, train teachers to provide remote learning, provide materials for learning, coordinate remote interventions, deliver special education services, track data, and more (Harris et al., 2020). Robin Lake, director for the Center for Reinventing Public Education (CRPE), went so far as to state that "leaders innovated on the fly," no one was prepared, and "public education will never be the same" (Lake, 2021, p. 1). At the onset of the pandemic-related school closures, Forbes Magazine (March, 2020) published an article entitled *Most Teachers Say They are 'Not Prepared' to Teach Online* (Newton, 2020). The article stated that schools have had to convert to remote or online options and that this "massive shift will have generational reverberations" (Newton, 2020, para. 1). A report published by the Brookings Institution in the fall of 2020 stated, "the pandemic has introduced uncertainty into major aspects of national and global society, including for schools" (Kuhfeld, Soland, Tarasawa, Johnson, Ruzek, & Lewis, 2020, para. 1). This uncertainty about how student achievement was impacted by school closures and the move to online learning, as well as the "rapid conversion to an online learning platform, will continue to affect academic achievement" (Kuhfeld et al., 2020, para. 1).

In short, K-12 schooling was "blindsided by the jarring transition to online schooling" (Newton, 2020, para. 3). In a nationwide survey conducted in spring of 2020, more than half of the teachers across the nation felt they were "not prepared to facilitate

remote learning," and only a few could name a product or platform they would be using to communicate with students other than Google Docs (Lotkina, 2020). State and district leaders, at that time, speculated that the shutdowns could last a few weeks to a few months (Dorn et al., 2020b). After the first six months of school shutdowns, a study by the Evidence Project described schools as unprepared for the challenge of virtual learning, and in their assessment of instructional effectiveness, found that students received very little instruction that was meaningful (Gross & Opalka, 2020). Individual school districts responded to the pandemic at the local level with offerings and expectations varying greatly from one district to the next (Malkus, 2020a).

History, Origin, and Recommended Best Practices for Virtual Learning Models

Before the pandemic, opportunities were increasing in online learning for elementary students. However, "while there has been exponential growth in K-12 online learning, there exists a lack of research into best practices for K-12 online teaching" (Linton, 2016, p. 420). The United States Department of Education launched the Web-Based Education Commission in 2000 to explore web-based learning opportunities to address classroom overcrowding, equal access to educational opportunities, funding shortages, and alternative education routes (Rice, 2006). At that time, distance learning was defined as "institution-based, formal education" in which learners were separated and "interactive telecommunications systems" were in place to connect instruction with learners and resources (Barbour & Reeves, 2009, p. 402).

In the late 1990s and early 2000s, online learning models included statewide supplemental programs, district-level supplemental programs, single school district

cyber-schools, multi-district collaborative cyber-schools, and cyber-charters (Watson & Ryan, 2007). These programs were initiated to provide increased opportunity for course offerings, offer supplemental services to students in remote areas, support home-schooled students, provide services to hospitalized or medically-homebound students, and to accommodate schedules for working students, professional athletes, and incarcerated students (Watson & Ryan, 2007). Virtual schooling was also an option for students who wanted to further enrich their education or work at their own pace, and students for whom the traditional classroom was not a fit for their learning style (Rice, 2006). The benefits of online learning at that time were accessibility of course offerings, opportunities for tutoring and remediation, and flexibility of scheduling (Setzer & Lewis, 2005).

In 2001, it was estimated that 14 states had implemented some level of online learning programs, and approximately 40,000-50,000 K-12 students were enrolled in online courses of some description (Picciano & Seaman, 2007). By 2004, it was estimated that all 50 states had some form of online learning in place (Picciano & Seaman, 2007). The United States Department of Education (2004) published *Toward a New Golden Age in American Education: How the Internet, the Law, and Today's Students are Revolutionizing Expectations*. In this document, seven main objectives were outlined, including the encouragement for using e-learning options. The growth of e-learning was seen as a viable option to address requirements of the No Child Left Behind legislation (United States Congress, 2001). The increased participation in online learning programs was due in part to the No Child Left Behind legislation which fueled numerous state and local level organizational policy briefs, initiatives, and existing distance

education program evaluations (Watson & Ryan, 2007). In 2006, Rice and other researchers from the North Central Regional Educational Laboratory (NCREL) concluded that few states had established policies for K-12 online programs and that online learning was not well understood by the policymakers (Rice, 2006).

Further evaluation by NCREL in 2005 recommended that virtual learning programs needed standard measures across states, data gathering protocols, reporting requirements that inform future policy decisions, and a formal plan to document best practices across programs (Rice, 2006). These reports and others led to the creation of the North American Council for Online Learning (NACOL) in 2005. NACOL represented administrators, teachers, and students involved in online learning (Rice, 2006). At the onset of virtual learning in early 2000, the term "virtual learning" referred to a state-approved and/or regionally accredited school that offered secondary credit courses through distance learning delivered via the internet (Cooze & Barbour, 2007).

The majority of studies conducted at that time focused on virtual learning centered on secondary schools with slight mentions of the benefits for elementary students. The students who were identified as benefitting from online schooling were students who were unsuccessful in traditional classrooms and homeschooled students who needed content at a greater depth than their parents could provide (Bracey, 2004). Researchers pointed out that virtual learning required high degrees of autonomy, structure, and direction from teachers, which made virtual schooling for younger students more challenging and less practical for widespread implementation (Cooze & Barbour, 2007). Additionally, researchers identified characteristics that virtual learners would

need to be successful and suggested that successful online models needed teachers to instruct students on how to be successful in an independent, remote learning environment (Barbour & Reeves, 2009). The Education Success Prediction Instrument (ESPRI) was created to identify students' aptitude for online learning, and measured areas in which students needed strengths for academic success in a virtual learning environment. These necessary characteristics included a high level of autonomy, being a self-directed learner, experience with successful learning in other settings, and readiness to learn with a focus on the application of acquired skills for a purpose (Barbour & Reeves, 2009.) The researchers who created the ESPRI suggested that most students would need to have remediation strategies to learn the skills to be successful in this educational setting (Barbour & Reeves, 2009).

As early as 2005, researchers were advocating for conducting studies to assess and improve virtual learning with the goal of creating teaching and learning plans, solving performance problems, and designing the principles of instructional design to make recommendations for future virtual learning plans (Wang & Hannafin, 2005). While citing the benefits of virtual learning, advocating for expanding access to high-quality learning opportunities, and offering educational choice, there were also problems inherent in virtual learning from the beginning (Barbour & Reeves, 2009). According to Barbour and Reeves (2009), numerous studies have shown that the students who would benefit most from virtual learning opportunities were students who showed independence and motivation for learning, strong time management, literacy, and technology skills that are typically identified with adult learners (Barbour & Reeves, 2009). Barber and Reeves

(2009) declared that the need for improving virtual learning was urgent and while the availability of virtual schooling grows, virtual learning needed substantial improvement to be successful for widespread use.

Challenges to School Leadership Due to Pandemic-Related School Closure

There were innumerable challenges for students, teachers, and school districts when schools shifted to remote learning in the spring of 2020. Students and teachers had little or no experience with online learning models, and the shift was abrupt without time for students or teachers to adequately prepare (Harris et al., 2020). As Barbour and Reeves (2009) revealed from their research, creating a high-quality remote learning plan would ordinarily take months or even years of preparation and planning. Still, this crisis forced schools to create remote learning plans and attempt connectivity within weeks (Gross & Opalka, 2020). Following state and local mandates, school districts changed into remote learning environments with little consistency or oversight (Malkus, 2020b). Students, teachers, and families were faced with a learning model that operated unlike previous school experiences with little notice, training, or preparation (Gross & Opalka, 2020). School districts also faced additional logistical challenges to connect with students, and offer access and provide internet-connected devices, train teachers to provide remote instruction and materials, as well as provide remote interventions and special education services (Harris et al., 2020).

An ongoing question for the duration of the pandemic was when and how school would be open (Malkus, 2020b). A report from McKinsey and Company in the fall of 2020, stated that the “first priority of every school system must be to reduce virus

transmission rates and protect the health and safety of staff" (Dorn et al., 2020b, p. 1), which indicated that health and safety took precedence over teaching and learning in American schools. School leaders grappled with the concept of school spread versus community spread in terms of the COVID-19 virus, as outlined in lengthy memos from the Centers for Disease Control and Prevention (CDC), and the need for schools to remain closed based on extensive health data (Centers for Disease Control and Prevention, 2020). School leaders interpreted and communicated CDC guidelines related to school reopening and learning modality changes, and then regularly communicated plans for school attendance to the community (Bergen, 2020a). President Biden made reopening schools safely part of his campaign promises in 2020, and his First 100 Days plan was revealed in January 2021 (Biden, 2021a). On March 2, 2021, via Twitter, Biden encouraged states to prioritize educators' vaccinations and "treat in-person learning like the essential service that it is" (Biden, 2021b).

Schools that had reopened or partially reopened with a hybrid learning model during the fall of 2021 were forced to return to virtual learning as infection rates rose in November of that year (Shafer, 2021). Shafer, from Education Week, called this a "blow to the overall push for broader school opening" (2021, p. 1). School districts faced the reality that communities depend on schools for more than education; schools are a resource for meals, counseling, childcare, health assessments, and safe spaces (Dorn et al., 2020a).

Student Access to Technology

One of the greatest immediate challenges that faced educational leaders at the time of pandemic-related school closures was student access to technology. The 'homework gap,' as it was widely known, referred to the millions of students who lacked adequate access to the internet and computers to do their school work (Fazlullah, 2021). Prior to the pandemic, 15-16 million students and about 400,000 educators lacked adequate internet connectivity, and this problem "disproportionately affected communities of color" (Fazlullah, 2021, p. 3). The pandemic exacerbated this social divide of high-speed internet access along racial and economic lines (Gross & Opalka, 2020). This "fundamental matter of equity" placed internet access "as important as running water and electricity" in homes for children to access education (Fazlullah, 2021, p. 3). Federal Communications Commission research conducted by Common Sense Media estimated that as many as 12 million students were caught in this homework gap (Fazlullah, 2021). In response, a 2020 report by McKinsey and Company reported that school districts responded with "herculean" efforts to distribute devices, provide internet access, and reconnect with students who had "fallen off the radar" (Dorn et al., 2020a, p. 7).

Most students faced challenges when schools moved to virtual learning, but students who came into the pandemic with fewer opportunities were likely more affected by these changes (Gross & Opalka, 2020). Internet access proved an even more momentus challenge for students than lack of devices, with lack of access to high-speed broadband internet access three times worse for students in schools with high levels of

family poverty or high percentages of minority students (Harris et al., 2020). At the time of Harris et al.'s study, research showed that approximately 15% of households with school-aged children lacked high-speed internet, and in low-income homes this percentage increased to about 35%, with an even greater lack of access in black and Hispanic households (Auxier & Anderson, 2020). This digital divide was more problematic when coupled with the statistic that at the time of pandemic-related school closures in March of 2020, approximately 58% of students reported using the internet nearly every day for school (Auxier & Anderson, 2020). In 88% of school districts surveyed by the National Center for Research on Education Access and Choice (REACH), the districts responded to student technology needs by providing laptops, tablets, and internet hotspots (Harris et al., 2020). Additionally, as families struggled through the myriad difficulties caused by the pandemic, internet connectivity and access to virtual schooling may have been less of a priority for lower-income families facing more pressing issues of health, safety, employment, and income (Harris et al., 2020).

Remote Learning Varied by District

There was no national model, platform, curriculum, or accountability system for what students learning remotely should receive (Harris et al., 2020). In an extensive report published by the American Enterprise Institute entitled, *Too Little, Too Late: A Hard Look at Spring 2020 Remote Learning,* Malkus examined the effects of the pandemic using descriptive statistics from districts across the country to quantify lost instructional time, differences in remote offerings across districts, and how poverty affected school offerings (Malkus, 2020b). According to Malkus (2020b), there were

vast differences in expectations for remote learning across the country and that "districts serving more disadvantaged students offered less robust remote-instruction platforms" (p. 6). The findings of Malkus' 2020 research predicted that damage to student learning would be dramatic and would disproportionately affect students already at risk for learning challenges (Malkus, 2020b). Malkus quantified lost instructional days due to school closure and student nonparticipation and found that the higher the poverty level in the school, the greater the number of lost instructional days (Malkus, 2020b). In schools with higher poverty levels, students were more likely to depend on instructional packets and asynchronous instruction than were higher-income districts that engaged in mostly online platforms with synchronous, or live, instruction (Malkus, 2020b). In a synchronous model, students engaged in real-time communication and instruction between students and teachers while in an asynchronous model, students accessed school materials online when they were able, with no interaction with school personnel or classmates. Malkus identified the disparate effects of online schooling for students from lower socioeconomic homes, single-parent homes, parents with lower levels of education, students without reliable broadband access, students from lower-income school districts, minority populations, students of color, and even voting records of the regions from which students came (Malkus, 2020b). Findings revealed that, for some students, the shortcomings of online learning may have been compounded by other factors affecting access to high-quality education (Malkus, 2020b).

Experiences for Students Varied Widely

Each school district created independent policies, which resulted in a wide range of experiences for students across each state and across the nation (Gross & Opalka, 2020). Expectations varied widely with each school district interpreting and following state health guidelines, while the level of instruction and monitoring of student achievement was left up to each school district's discretion (Lake, 2021). Diliberti et al., in a report by the Rand Corporation entitled *Prepared for a Pandemic?* noted that schools were "unequally prepared to meet this challenge" and that there were substantial disparities in schools' curriculum, teacher training, and technology access (2020, p. 1). Hennick (2020), in an article on how to provide professional training for teachers to teach virtually, described teachers in the spring of 2020 as working in "emergency mode" (para. 1). With varied learning models came wide variance in how instruction was delivered, how students were assessed, and even how attendance was calculated (Harris et al., 2020).

CRPE conducted a review of 477 school districts across the country and sampled a representative cross-section of U.S. schools to create a record of school districts' expectations for educators and students during the school closures (The Evidence Project, 2020). The study examined publicly available information and considered free and reduced lunch rates, racial demographics, and school location to reflect a representation of school districts in the country. Results revealed that schools in urban areas were significantly more likely to expect teachers to provide asynchronous learning for students during the immediate period of school closures, in the spring of 2020 (Gross & Opalka,

2020). More affluent districts were more than twice as likely to keep attendance records and provide learning synchronously, live or in real-time compared to districts with high concentrations of low-income students (Gross & Opalka, 2020). As a result of the CRPE findings, researchers advised that students in rural and smaller districts would be at a disadvantage for the 2020-2021 school year, and recommended that schools and educators prepare to address substantial student learning loss (Gross & Opalka, 2020).

Challenges to Educators Due to Pandemic-Related School Closures

Teachers transformed their homes into classrooms for teaching remotely (Goldstein, 2020), and this response, within days and weeks of the shutdown orders, could be described as the greatest shift in the American educational system (Hamilton et al., 2020). Students learned to video conference, and to use digital platforms to connect and learn with their teachers and classmates from their bedrooms, kitchen tables, and couches (Fazlullah, 2021). In a CRPE report entitled, *The Teachers are Not Alright*, researchers cited high-stress levels for all teachers, "but especially those teaching remotely and in high poverty schools, are struggling to provide instruction, engage students, manage technology, and much more" (Kauffman & Diliberti, 2020, para. 3). The report examined the increased workload and work levels of teachers as they adapted to the new learning models (Kauffman & Diliberti, 2021). Many teachers had to quickly learn their districts' learning management system technology and seek out new strategies for engaging students virtually (Kauffman & Diliberti, 2021). Teachers worked more to gather resources and knowledge on the technology and learning management platforms, but were less engaged with effective teaching or instruction strategies for a virtual

learning model (Kauffman and Diliberti, 2021). A survey conducted by the Rand Corporation found that teachers reported spending an average of more than 30 hours per week on instructional planning at the time of the "initial scramble to provide remote instruction amid the outbreak of the pandemic" (Kaufman & Diliberti, 2021, p. 2). The same survey found that 48% of all teachers who responded reported working more than 48 hours per week, and an additional 24% reported working 56 hours per week or more to respond to the demands of teaching virtually (Kaufman & Diliberti, 2021).

The survey results from the Rand Corporation (2020) also identified the ongoing challenges for teachers due to the ever-changing instructional models. As the pandemic continued, schools adopted a variety of teaching models, and teachers had to adapt and learn to deliver content to students in a multitude of ways (Kaufman & Diliberti, 2021). Teachers shifted their mode of instruction between in-person and remote learning, plus a hybrid model of instruction, in many instances across the nation (Dorn et al., 2020b). Dorn et al. (2020b) described how the nature of the hybrid model, in particular, had challenged teachers as they planned methods to engage in-person learners and delivered content to at-home learners simultaneously. For the hybrid model, two sections of each class or course had an in-person and a remote class group participating in the learning at the same time, which required teachers to adapt curricular materials to be used in both settings for two different groups (Dorn et al., 2020b). There was a misconception for the learning community that remote and hybrid learning could be a "digital version of the classroom" in the school building, presented online (Dorn et al., 2020b, p. 11). For elementary-aged children, a hybrid classroom model was not ideal because of the "level

of guidance, social interaction, and tactile-learning opportunities that are difficult to replicate in an online classroom" (Malkus, 2020b, p. 4). Teachers in settings with a higher population of students from low-income and minority homes without support of adults in the home, stable broadband access, a device to use, or a workspace conducive to learning may have had additional challenges with students expected to participate half time in-person and half time working independently at home in the hybrid learning model (Dorn et al., 2020b). Kaufman and Diliberti (2021) revealed that teachers faced challenges "even more profound" due to the technology issues, lack of contact with families, family support, and access to resources for social and emotional well-being for struggling students (p. 3).

Student Work Expectations and Accountability

An important finding of the research conducted by CRPE, presented in a report entitled *Too Many Schools Leave Learning to Chance During the Pandemic*, was that school districts set low expectations and accountability for student work completion, attendance, and assessment during the period of school closures (Gross & Opalka, 2020). CRPE found that only one-third of districts expected teachers to engage and interact with students in a whole-class setting; instead, districts counted live video lessons, recorded lessons and lectures, phone support, email, and online feedback as instructional time (Gross & Opalka, 2020). The CRPE study also found that approximately half of the districts expected teachers to only track student attendance and participation during the period of school closures in spring 2020, while not recording grades for student performance on academic tasks or assessing progress on learning objectives (Gross &

Opalka, 2020). Technological challenges may have prevented students from participating in live lessons or real-time learning with educators (Harris et al., 2020), but only half of the districts studied expected teachers to make regular contact with students by any means. Tools for monitoring student engagement, work completion, and progress toward skill mastery varied widely among the schools surveyed (Gross & Opalka, 2020). The CPRE study further revealed that approximately half of the districts surveyed did not expect teachers to assess students' progress or work samples against district standards, return graded work to students, or provide parents with progress reports (Gross & Opalka, 2020). Results also showed that at middle and high school levels, some student work was assessed for mastery, but students in elementary grades were more likely to have lessons and assignments disseminated to them via an online platform, but not collected; and grades, if given, were based on whether or not the student accessed the online learning platform, rather than assessing completion or quality of the schoolwork (Gross & Opalka, 2020). Elementary students received little feedback on the assignments or little one-on-one assistance on learning objectives, and very few examples of small group instruction were noted. Rather, teachers only monitored for students logging onto school learning platforms at some point during the school day for any length of time to track attendance and participation (Gross & Opalka, 2020).

Disparities in Services, Engagement, and Course Offerings by District

In a report published by the Rand Corporation entitled *Covid-19 and the State of Schools,* researchers Hamilton et al. (2020) presented results based on surveys administered to principals and teachers nationwide in the spring of 2020 and focused on

how school leadership navigated Covid-19 related school closures and virtual learning in each district. Hamilton et al. (2020) compared schools serving large populations of students of color and from lower-income households with other schools serving different populations. Results showed disparities in the support and resources available for the two different school groups identified (Hamilton et al., 2020). Researchers recorded how schools were operating, what supports were available for teachers, how frequently school districts communicated with families, and plans for the following school year (Hamilton et al., 2020). Approximately 30% of all teachers surveyed indicated that students received pass or fail grades, approximately 50% of teachers indicated that students received feedback but work wasn't graded, and according to Hamilton et al. (2020), about 15% indicated teachers only monitored for completion. Only 35% of teachers responding to the survey indicated that students received letter grades (Hamilton et al., 2020). Teachers surveyed were asked to mark all responses that applied which accounts for the greater than 100% rate, but indicated that grades and feedback were not a priority in virtual schooling (Hamilton et al., 2020). When asked how much content was new versus review of previous learning, only 9% of teachers surveyed indicated teachers were presenting almost all new content (Hamilton et al., 2020). When disaggregating the survey data to show high poverty schools, the percentage of teachers presenting new content to online learners dropped to 5% (Hamilton et al., 2020). When asked to indicate the amount of curriculum that would have been presented if school were open in-person versus what was presented virtually during online learning, Hamilton et al.'s 2020 results showed 11% of teachers responding to the survey indicated none or almost none of the

originally planned content was presented. In the study, 32% of the responding teachers reported about one-quarter of curriculum was covered and 24% reported that half or less of the curriculum was covered in the online learning format (Hamilton et al., 2020). Respondents were asked to rate the level of need for strategies to address replicating hands-on learning activities in the classroom. Eight percent of surveyed teachers reported moderate to major need for help in this area while, 51% of respondents reported a moderate to major need for support with social or emotional learning strategies while the school was closed (Hamilton et al., 2020). Of the teachers responding, 71% reported a moderate to major need for help with keeping students engaged and motivated during virtual learning (Hamilton et al., 2020).

The results of the Rand Corporation survey of teachers provided evidence that collecting grades and presenting new content to further the school curriculum was not a priority in most virtual learning environments, and that teachers were struggling to keep students engaged in learning (Hamilton et al., 2020). National research results confirmed that grades were not kept, and students were, for the most part, presented material but not assessed on their comprehension of this material (Gross & Opalka, 2020).

Assessment and Feedback

According to John Hattie (2012), the most important aspect of learning is actually not the teaching, but giving feedback to students on their work toward clearly stated educational learning targets or goals. The extensive research conducted by Hattie indicated that the most valuable time teachers can spend with students is spent discussing their learning, and their understanding of concepts (2012). Teachers can differentiate

lessons through small group settings or individually to address student misconceptions, gaps in prior knowledge, and to take learning to a deeper knowledge level. According to Hattie (2012), feedback is more than twice as impactful as all other schooling effects and "therefore places feedback among the top ten influences on achievement" (Hattie, 2012, p. 48). Goal setting, feedback, and high expectations are keystones of academic success for students based on how their teacher interacts with them in the classroom (Hattie, 2012). These factors would indicate that teachers for these students who experienced Covid-19 interruptions in the school year 2020-2021 would have little information about their students' present learning level or what learning gaps existed for these students due to lack of assessments, grades, and work samples from the period of online learning and varied instructional models (Gross & Opalka, 2020). Content was made available via online learning management systems; yet little was known about whether students received the content, were able to understand, or could demonstrate their learning during this period, as learning was not assessed (Gross & Opalka, 2020). There was no goal setting, feedback, differentiation, or assessment of student learning, which research has shown to be key for student academic growth (Hattie, 2012.)

Disparity in Parental and Family Support Available

Families were affected by the interrupted school model and ever-changing model of in-person learning for students during the Covid-19 pandemic. Students who chose the in-person learning model experienced a combination of in-person, hybrid, and virtual learning. Media outlets frequently presented anecdotal coverage of the experiences of Americans during the pandemic. Less than one month into the pandemic, for example,

The Today Show addressed widespread school closures' effects on parents (Abrahamson, 2020). Working parents expressed frustration with managing online school in addition to working full-time from home. There were challenges for parents who had to work outside the home and manage online learning, plus parents who had to choose between leaving kids home alone or working outside the home (Abrahamson, 2020). Abrahamson interviewed many parents who expressed a similar sentiment that school shutdowns and virtual schooling was unsustainable and were concerned about learning loss for their children and the negative experiences with virtual school (2020). Among these anecdotal stories was a mother who drove her four kids to a parking lot to access high-speed access from an internet-connected school bus parked in neighborhoods for this purpose, another parent who had tweeted that their family was opting out of online first grade because their child's mental health was more important, and a parent who said she had to choose between working to earn a living and leaving her children home alone for online school (Abrahamson, 2020). In the New York Times in late April of 2020, education columnist Harris stated that remote learning "is breaking parents" and that for many adults helping children with schoolwork "has become one of the most trying aspects of the pandemic" (Harris, 2020. para. 1). Harris stressed that parental engagement has always been seen as "critical to student achievement" (2020, para. 1), yet, not all parents were able to assist their children with virtual learning during this time. To further explain the challenges, Harris described at-home parents as "teacher's aide, hall monitor, counselor, and cafeteria worker" in addition to their jobs as a parent, family member, and worker (2020, para. 2). Essential workers faced a greater challenge, as they attempted to support learning while

being away from home during school hours when their children needed support (Harris, 2020). According to Harris (2020), parents expressed the frustration that existed between parents and students when they did things differently from the teacher or when parents were not capable of doing things "the right way" in the eyes of their children (para. 8).

The level of support parents were able to provide their students during the period of pandemic-related school closures and interrupted learning models varied greatly. Parental support for learning at home was dependent on parental work schedules, parental level of education, family socioeconomic status, and general stress related to the pandemic (Fazlullah, 2020). Described in Education Week in June of 2020 as "digital leapfrog," the schedules were frequently changing and parents had to manage when and where their children attended school in the hybrid model, how and when to access content when school was asynchronous, and when students needed to be online for live lessons for virtual learning, and to keep up with the ever-changing instructional models that changed from week to week (Lieberman, 2020, para. 1). Some families created classrooms for their kids to school at home, while other students attended from their beds or in living spaces with many other people, and often with background noise of family members or entertainment (Lieberman, 2020).

Not all families were able to provide optimal homeschool environments for students (von Hippel, 2020). Given that higher-wage workers were more likely to be in jobs that allowed for working from home, students in homes with parents able to work remotely had more academic support during online school (von Hippel, 2020). Higher-wage workers were over six times more likely to have the flexibility to work from home

than lower-wage workers (Gould & Shierholz, 2020). For an at-home learning model, especially for young children, it was generally expected that parents assume more responsibility for learning (Garbe et al., 2020). Parents in white-collar jobs were more likely to have flexibility in work schedules, college experience, and technology experience (Harris et al., 2020). Not all parents had the work schedule, the knowledge, or the capacity to help their children with online learning (Garbe et al., 2020).

Most schools responded with a one-size-fits-all approach to online learning models regardless of family status, income, or parent capacity; therefore, "student experiences are worse for students in poverty" (Harris et al., 2020, p. 8). Parents were expected to take on an increased role in their children's schooling during the period of school closures (Garbe et al., 2020). Results of a study conducted by researchers at the University of Wisconsin reported that parents' primary challenges were balancing the responsibilities of parenting and schooling, the lack of motivation their children exhibited for learning, and accessibility to resources to support learning (Garbe et al., 2020). Surveyed parents expressed that the remote learning model provided unique challenges for their students, and stated that "this model didn't match the child's learning style, was isolating, and that students were ill-prepared to be good e-learners" (Garbe et al., 2020, p. 52).

Student Experiences in Remote Learning Varied

According to CRPE researchers in March of 2021, surveys of students' experiences during virtual learning revealed that the "educational experience in the first months of the pandemic was a mess" (Lake, 2021, para. 1). Key findings of the research

indicated that students learning remotely struggled to stay engaged and interested in online learning. There were opportunity gaps for low-income students to connect with school personnel and concerns with digital equity and access to equipment (Lake, 2021). In the introduction to their report about the state of online learning, the authors explained, "As schools quickly implemented remote learning last spring, many students experienced little meaningful online instruction and were unhappy with online classes" (Lake, 2021, p. 1). Results indicated that non-white students reported more substantial obstacles to learning with an online model compared to their white peers (Lake, 2021, p. 6). In the same CRPE survey, non-white students also reported greater feelings of depression, anxiety, stress, home challenges, family responsibilities, and concerns about themselves and their family members' well-being due to the pandemic (Lake, 2021). Student survey results also indicated that non-English speaking students and students in special education programs had a less positive experience with online school (Lake, 2021). Lake (2021) discovered a trend in student responses that indicated internet access, access to a computer device, and challenges accessing remote learning were of greater issue for non-white and low-income households, and results showed that this was a time of educational isolation for most students. Only 42% of students surveyed reported that a staff member checked in with them personally during the school day in real-time regarding their schoolwork, not via a message board, email, or voice mail; and 59% of students surveyed indicated that no one from their school checked in on their well-being at all (Lake, 2021).

Results from other nationwide research, Challenge Success, conducted by the Stanford School of Education, also identified the social isolation of students with 58% of

students surveyed reporting they never had individual check-ins with a teacher or staff member in real-time and 41% reported they never had an adult ask how they were doing at all (Challenge Success, 2021). Lower socioeconomic status schools reported that a majority of students indicated they did not have a trusted adult to go to for assistance with school (Challenge Success, 2021). Parents were also surveyed and 40% of responding parents of students needing special education services reported receiving no support during virtual school (Challenge Success, 2021), and only 20% of responding parents reported receiving the special education services their child received during in-person school.

A common complaint from teachers during the pandemic-related school closures and interruptions in learning was the lack of engagement from students, yet students and parents felt a lack of connection with teachers as well (Challenge Success, 2021). For a report published by the Rand Corporation entitled *Covid-19 and the State of Schools,* researchers Hamilton et al. (2020) presented results from surveys administered to principals and teachers, which focused on how school leadership navigated Covid-19 related school closures and virtual learning in each district. This research compared schools serving large populations of students of color and students from lower-income households with schools serving populations of students not identified as low-income or minority. Results revealed disparities in the support and resources available for the two different school groups identified (Hamilton et al., 2020).

For a New York Times article published, April 14, 2020, eleven-year-old reporter H. Dodd, the child of a New York Times writer who was assigned the article by his

parents as enrichment work in English language arts, asked kids for their perspectives of online school. Students reportedly found many positives for online school, but few mentioned learning-related benefits; instead students mentioned snacks, breaks, and outside time whenever they wanted as benefits of online learning (Dodd, 2020). A few students reportedly liked sharing their learning with their families, working at their own pace, and liked the safety of home (Dodd, 2020). However, the majority of students who responded had negatives to share, and reported they would rather be in school because they were bored, missed friends and teachers, missed routine and schedule, couldn't learn as well at home due to distractions, or had a hard time resisting cell phones and social media. One respondent stated, "staying home and doing distant learning has made me discover deep respect for teachers I didn't even know I have" (Dodd, 2020, para. 27). Dodd summed up their opinions of virtual learning: "Online school is the equivalent of no school. One-on-one time, the accountability, the schedule and routine are all gone…isolation, no routine, lack of repercussions for not doing work. All of this leads to a decline" (2020, para. 34).

Interrupted Learning and the Summer Slide

Never before in recent American history had there been such widespread school closures, but there have been some regional examples of school closures in the wake of natural disasters (Picou & Marshall, 2007). A study conducted in 2007 that examined issues related to school closures for students displaced by Hurricane Katrina identified serious psychosocial consequences including learning loss, mental health problems, decreased attendance, increased stress, inability to concentrate, and depression symptoms

in students who experienced extended time away from the classroom (Picou & Marshall, 2007). Following Hurricane Katrina, researchers found that students lost about two years of mathematics learning due to both school closures and the anxiety of the situation coupled with students' math anxiety (Sawchuk & Sparks, 2020). Another study followed student progress after New York City schools were closed for more than two months due to a teacher strike and discovered that students returned to school with test scores that reflected achievement levels about two months lower than students the previous year (von Hippel, 2019). During school closures due to the 2017 Hurricane Season, all learning was expected to be asynchronous. According to Schwartz et al. (2020), during hurricane-related school closures, district leaders did not expect that teachers would offer any new content. Instead, teachers were encouraged to review, preview, or provide enrichment activities when teaching students. There was an understanding that not all students, given the nature of a natural disaster, would have access or ability to learn at the level they would in an in-person instructional model. The purpose of any education during this period was to keep children academically engaged, but not necessarily continue moving students forward in the curriculum for the grade level (Schwartz et al., 2020). Researchers identified challenges with prolonged distance learning, citing that it became increasingly challenging to engage students in instruction without face-to-face interactions (Schwartz et al., 2020). A report evaluating virtual learning models noted that for online instruction to be effective, it was necessary to have, at minimum, a working learning management system, high-quality online course content, devices for all students, and training and support for teachers (Schwartz et al., 2020). Districts expected

student learning to be performance-based and allowed teachers and students the flexibility to participate on their own schedule, with no live meetings or synchronous learning expected (Schwartz et al., 2020).

Unlike natural disaster-related school closures, changes in learning models related to the pandemic did not involve a loss of electricity, family displacement, or physical destruction. However, similar to other natural disaster-related school closures, it was unclear when schools would be able to fully reopen, and many different instructional methods were employed to meet the needs of students displaced. Researchers evaluating the effectiveness of hurricane-related school closures advised that short-term school closures were preferable to long-term, due to the risk that students would become disengaged over time (Schwartz et al., 2020). Schwartz et al. recommended that the best case for virtual schooling options was short-term weather-related closures, with students doing an alternative virtual schedule for fewer than ten days, using a combination of online and offline learning, packets, or instructional materials prepared for take-home use (2020). The general evidence from these situations has indicated that, for virtual schooling to be effective, it should be more than a digital version of a classroom or packets and needs to include training for teachers and students to learn how to effectively do online learning. Based on research prior to the pandemic about the ideal model for virtual learning, studies of student learning following school interruptions due to weather-related disasters found that ongoing, long-term out-of-school learning scenarios were detrimental to student learning, caused students to experience gaps in learning, and

caused students to be significantly behind grade level expectations upon their return to school (Picou & Marshall, 2007).

As early as May 2020, NWEA researchers predicted that students would suffer substantial variances in academic skills following what was thought at the time to be the one-year school interruption caused by the pandemic (NWEA, 2020). Researchers at NWEA advised that learning loss related to COVID-19 school closures would cause pre-existing gaps in achievement to widen further (Kuhfield & Tarasawa, 2020). Researchers predicted that the instructional range in an average pre-pandemic fifth-grade classroom typically can span more than seven grade levels and that in the year following interrupted school models, teachers could expect an even greater range of ability (Kuhfeld, 2021). J. Brunor, the Vice President of Professional Learning at NWEA, stated that the "challenge facing our education community is immense" (NWEA, 2020, para. 10). It is crucial for educators to look for ways to tailor instruction to meet the varying needs of students following the pandemic (NWEA, 2020). Even mainstream publications warned that the learning gap was "getting worse" (Reilly, 2020, para. 1). According to Reilly (2020), mainstream publications widely publicized that the pandemic had increased an already wide disparity in education for non-white and socioeconomically challenged students. The Washington Post used the phrase "explode existing achievement gaps" to describe the effect that the pandemic-related school closures would likely have on disadvantaged students (Strauss, 2020, para. 1).

Teachers have long recognized that students 'slide' academically over the summer months (Quinn & Polikoff, 2017). Each school year, many students spend weeks at the

beginning of the school year to regain what they have lost over the summer, instead of building on previous knowledge and progressing in the curriculum, resulting in a knowledge gap (Downey et al., 2004). This gap in knowledge compounds as students move up levels within the education system, and tends to impact mathematics and science to a greater degree than other areas (Atteberry & McEachin, 2016). Researchers have referred to this summer slide as the summer learning effect, setback, or brain drain; and it has been widely accepted as a problem in education prior to the pandemic (Quinn & Polikoff, 2017).

Pre-pandemic research found that some students were subject to more substantial achievement loss over summer breaks (Atteberry & McEachin, 2016). Researchers have described the effects for underprivileged students using the faucet theory (Entwisle, Alexander, & Olson., 2001). The faucet theory makes the analogy that students' learning and resources are like a faucet that essentially gets cut off for some students over the summer (Entwisle et al., 2000). Disadvantaged and minority students may not have access to high-quality summer programming, enrichment experiences, field trips, or other supports that would extend their learning and results in greater summer loss than students with such support (Entwisle et al., 2000). According to a 2007 report on the lasting effects of the summer learning gap, results showed that low-income students tend to have a lasting consequence in future success in school and work due to the loss in learning over the summer (Attebery & McEachin, 2016). Research has indicated that the learning gap for lower-income students begins before first grade and grows each year over the summer and accounts for the long-term disparity in academic achievement between

learners (Attebery & McEachin, 2016). A study that assessed over half a million grade 2-9 students in southern states from 2008-2012 found that students, on average, lost between 25 – 30% of their school-year learning over the summer (Atteberry & McEachin, 2016). Additionally, "Black and Latino students tended to gain less over the school year and lose more over the summer compared to white students" (Atteberry & McEachin, 2016, p. 35). According to Dumont and Ready (2020), multiple studies have shown significant differences in summer learning loss for white and non-white students which may contribute to the achievement gap throughout the school years. Burkam and Lee's 2002 research indicated that students who are non-white or lower socioeconomic status, may begin their schooling approximately one year behind their peers and continue to fall behind.

Covid-19 Slide Predictions

The school closures due to the pandemic were not exactly a summer break because students weren't out of school, yet it was a time of interrupted learning due to the unprecedented changes to the instructional model that students experienced. As early as May of 2020, a headline on the advocacy site for education reform, The 74, announced "start planning now for a precipitous 'Covid slide' next year" (Hawkins, 2020a). A May 2020 report from NWEA projected staggering learning loss for students returning as early as the 2020-2021 school year (Hawkins, 2020b).

There were no definitive answers on how much learning students have lost, but utilizing metrics based on summer slide data, which assumes students did not have instruction, NWEA developed a Covid-slide prediction scale to prepare educators for the

degree of learning loss in mathematics and reading for students entering school in the fall of 2020 (Kuhfeld & Tarasawa, 2020). According to the NWEA Covid-slide projections, students in mathematics were especially at risk, losing enough skills that they could fall nearly an entire grade level behind where they normally would be (Kuhfeld & Tarasawa, 2020).

Leaders at NWEA predicted school closures would increase the need for differentiation in the classroom to meet the varying needs of students considering they may have been an entire year behind where they would have been academically (Hawkins, 2020b). NWEA predicted that students would likely only retain approximately 70% of their gains in reading, and less than 50% of their mathematics gains (Hawkins, 2020b). During the spring and summer of 2020, researchers with NWEA sent urgent messages, and provided toolkits to help school districts prepare for the dramatic learning losses that teachers were expected to face due to the pandemic-related school closures and interrupted learning models when students returned for the 2020-2021 school year (Hawkins, 2020b).

Learning loss, achievement gaps, and the lack of summer learning experiences contribute to the ongoing gap in student achievement, which will exacerbate disparity for historically underserved populations (Dorn et al., 2020a). Drawing on summer loss, research has shown that students from disadvantaged backgrounds experience a greater amount of learning loss, which would lead researchers to predict a more substantial loss for disadvantaged students during this prolonged, pandemic-related period of school closures (Kuhfeld & Tarasawa, 2020). Learning is a continuous process, and

interruptions to it can hinder students' progress (Martin, 2021). Research would indicate that while the exact extent of learning loss during pandemic-related school closures is unknown, it is known that interruptions in schooling can cause learning loss in students. There will most likely be dire academic consequences for many students as a result of the interrupted and changing learning models they have experienced due to pandemic-related school closings.

Preliminary studies by NWEA using data from the nationally-normed MAP Growth assessments indicated that students would show greater learning loss in mathematics than in reading due to the pandemic-related interrupted instructional models (Kuhfeld & Tarasawa, 2020). According to some prediction models, students could lose up to an entire year of math learning (Sawchuk & Sparks, 2020). In the case of pandemic-related school closures, there was instruction happening; however, the strategies were continually changing and lacking a consistent format (Sawchuk & Sparks, 2020). Research has suggested that students' mathematics scores would be affected to a greater extent, perhaps, because parents felt they could help with reading, but not with math (Sawchuk & Sparks, 2020). Mathematics is mainly taught formally in school settings, and parents may not know how to assist students with mathematics, as readily as with reading (Sawchuk & Sparks, 2020). In a remote school environment, it is more challenging for teachers to engage in effective mathematics instruction, which could decrease the efficacy of student math learning (Sawchuk & Sparks, 2020).

Challenges in Math Instruction in Virtual Environment

During in-person learning, especially at the elementary level, mathematics instruction has traditionally benefitted from the use of manipulatives, concrete visuals, inquiry-based learning, and problem-based learning to help students understand more foundational or complex concepts (Sawchuk & Sparks, 2020). On top of all the other challenges of teaching in an unfamiliar virtual learning model, math teachers had the additional challenge of finding ways for students to show their work, providing computer-aided models, and ways to make connections between concepts (Sawchuk & Sparks, 2020). Jon Star, a professor at Harvard School of Education, warned that elementary students would have fewer math experiences resulting in less conceptual understanding, and could lose the deep understanding of math due to learning remotely (Sawchuk & Sparks, 2020). Concepts that were already challenging and anxiety-producing for students were a more substantial challenge in a remote setting, accounting for the predicted greater amount of learning loss in math (Sawchuk & Sparks, 2020). Remotely, teachers had more challenges providing small group instruction and remediation around math concepts, and gaps in understanding that were already present in mathematics would only continue to grow as teachers attempted to teach students in a virtual environment (Kuhfeld, 2021).

Mathematics was a heightened challenge for families during virtual learning. Parents struggled to help their children with mathematics even before the pandemic, expressing that they "felt helpless when confronted with first-grade worksheets" (Rich, 2014, p. 1). When faced with distance learning and helping students with math during

virtual learning, parents expressed frustration with current teaching methods and were possibly met with their own anxieties about math in their school experience fearing they would mess up and make things worse (Garbe et al., 2020). Barshay, from Teachers College at Columbia University, indicated that students did not learn as much math as they would normally during a school year, and stated that families were frequently engaged in reading activities at home, but that doing higher mathematics at home was less common (Martin, 2021). While studies from the pandemic and measuring learning loss continue to emerge, Barshay explained that students in low-income schools, students of color, and English language learners were falling farther behind in math than white students or students in schools with higher socioeconomic levels (Martin, 2021). Parents surveyed nationwide reported feeling unsure about how to support student learning at home and worried that their child was missing essential instruction (Gross & Opalka, 2020). An additional challenge facing families supporting their students in mathematics was parental anxiety or fear of teaching the common core mathematics strategies that may look different than when parents themselves learned in school (Sawchuk & Sparks, 2020). Research has shown that families were less likely to have the confidence, capacity, or skillset necessary to support their children in mathematics to the extent that they could participate in reading, which will likely contribute to a more substantial loss in math (Sawchuk & Sparks, 2020).

Greater Impact for Lower Income Students

Some students seemed to be at greater risk for learning loss due to the interrupted learning models and school closures, while others may have flourished (The Evidence

Project, 2020). According to the research compiled by CRPE, affluent districts were twice as likely to expect teachers to provide live instruction than districts identified as high poverty (Gross & Opalka, 2020). Synchronous learning was only expected in about 20% of the districts sampled nationwide and instructional time was expected in only about 15% of schools that had high concentrations of students receiving free and reduced lunch (Gross & Opalka, 2020). According to the same research, students in higher-poverty districts would likely receive fewer opportunities for interactions with peers through technology, small group instruction, remediation, or conferencing with a teacher (Gross & Opalka, 2020). Teachers surveyed reported concerns about generally lower administrative expectations for student learning, accountability, and learning loss, while also reporting lower student engagement during the instruction provided (Gross & Opalka, 2020). School closures and interrupted instructional models will likely have repercussions for students throughout their academic career, especially in the area of mathematics.

Summary

Chapter 2 provided an overview of the nationwide responses of school districts to the Covid-19 pandemic with particular attention to elementary education. The literature review examined the dramatic shift to virtual learning for nearly all public schools in the United States, affecting approximately 55 million children (Malkus, 2020a). The majority of studies conducted have indicated that the educational system was ill-prepared to make this dramatic change to the delivery method for schooling (Goldstein, 2020). There were widespread inconsistencies in the instructional methodology nationwide

(Hamilton et al., 2020). School districts' responses and the accountability for student learning was extremely varied nationwide, and there was little evidence of high expectations for student learning or achievement (Hamilton et al., 2020). Chapter 2 reviewed the history of online learning and research, which has indicated that, while there were recommendations for preparing to design models for virtual learning, few of the recommendations presented in the research literature were in place at the time of the widespread adoption of virtual learning in March 2020, especially for elementary students (Rice, 2006; Malkus, 2020a). The literature regarding the unique challenges for parents, students, teachers, and district leaders responding to elementary students' academic needs, given the other priorities and turmoil in the country responding to other aspects of the pandemic, was summarized and synthesized. Other examples of learning loss due to school closures, primarily scheduled school closures, and the predicted learning loss for students as a result, were also examined. Particular attention was placed on the unique challenges faced by low-income communities and families of essential workers during the school closures and virtual learning. Chapter 2 also addressed research surrounding learning loss in mathematics, specifically, and the challenges of teaching and learning math in a remote learning model, along with the challenges placed on families to assist students in mathematics.

In summary, "gaps in educational opportunity—by race, income, and class—are likely widening as a result of school closures" (Harris et al., 2020, p. 3). Many students faced more than one disadvantage during the time of virtual learning. Students may have experienced any combination of challenges, such as living in a home without internet,

parents who needed to work outside the home, or parents who lacked the educational background to support schooling at home (Harris et al., 2020). Overall, the research supports that interrupted learning and school closures will most likely cause significant learning loss for all students, especially in the content area of mathematics. Students from lower socioeconomic backgrounds, or students from families of essential workers during the pandemic will likely be affected to a greater extent. Chapter 3 describes the methodology used for the current study, including the research design, population and sample, hypotheses, limitations, data collection procedures, and statistical analysis.

Chapter 3

Methods

The purpose of this causal-comparative study was to examine to what extent student learning in mathematics for grades two through four in ABCSD was impacted by school closures due to Covid-19, and to determine which student subgroups and Mathematical Goal Areas were most impacted. Student progress in mathematics during the pandemic was measured by Rasch Interval Unit (RIT) scores on the NWEA MAP Growth Assessment mid-year administrations. The mid-year 2019-2020 administration of the NWEA MAP Growth Assessment, winter benchmark 2020, reflected student learning prior to school closures and interruptions. The mid-year 2020-2021 administration of the NWEA MAP Growth Assessment, winter benchmark 2021, reflected the amount of learning as impacted by school closures and interruptions due to the global Covid-19 pandemic. The mean composite RIT scores in mathematics for mid-year 2019-2020 and mid-year 2020-2021 were compared to examine the extent to which there were mean differences for grades two through four combined, and for each grade level separately. The mid-year NWEA MAP Growth Assessment mean composite RIT scores in mathematics for grades two through four combined were also compared by Title I school status to examine the extent to which student learning in mathematics was impacted at Title I schools and non-Title I schools, and compared by instructional delivery model to examine the extent to which learning in mathematics was impacted for students who chose the district's Online Academy option and students who chose the in-person learning model, who experienced a combination of in-person, hybrid, and virtual

instruction. Lastly, the four mathematics Goal Area mean RIT scores for winter benchmark 2020 were compared to winter benchmark 2021 Goal Area mean RIT scores for grades two through four combined to examine the extent to which there were mean differences for each of the Mathematical Goal Areas tested: Data and Statistics, Number Sense and Operations, Relationships and Algebraic Thinking, and Geometry and Measurement. This chapter presents the methodology used to conduct the research study. Included is a description of the research design and the population sample studied. The data collection process is described with a detailed explanation of the procedures observed during the study. The data analysis and processes for hypotheses testing are discussed, and the chapter concludes with the limitations of the study.

Research Design

The current causal-comparative quantitative study examined to what extent student learning in mathematics for grades two through four at ABCSD was impacted by school closures and interrupted instruction due to the Covid-19 pandemic in order to inform professional development and instructional planning for future ABCSD school programming. According to Creswell, a quantitative research design is best to address the current problem being studied by identifying the factors or variables that could influence an outcome (Creswell & Creswell, 2018).

The dependent variable for the first four research questions was the mean composite RIT scores in mathematics, and the dependent variable for the final research question was the mean RIT scores for each of the four Mathematical Goal Areas, as measured by mid-year NWEA MAP Growth Assessment. These dependent variables

were compared by the independent categorical variable of administration year of the test, mid-year of the 2019-2020 school year and the 2020-2021 school year overall and for various demographic groupings to examine changes in the amount of mathematics learning. Student progress in mathematics during the pandemic-related school closures and interrupted instruction was measured by test scores on the NWEA MAP Growth Assessment for students in grades two through four at the mid-year administration before school closure, winter benchmark 2020, and the following mid-year administration, winter benchmark 2021. It can be accepted that data from mid-year assessments in January 2020 were unaffected by the shutdown in March 2020. It can also be assumed that scores in the mid-year of 2021 would reflect student achievement following the period of school closures and interrupted learning.

Mathematics scores on the Mid-year NWEA Map Growth Assessment prior to the pandemic-related closure, 2019-2020, and the following year, 2020-2021, were compared to examine the student growth trends during a year without academic interruption and the year following the academic interruption. The demographic variables creating the groupings of students compared in the study were the students' grade level, Title I and non-Title I school status, and students' chosen instructional model of Online Academy learning model or the in-person learning model, who experienced a combination of in-person, hybrid, and virtual learning.

Selection of Participants

The students selected for this study were all elementary-aged students in the ABCSD attending grades 2-4 during the 2019-2020 and 2020-2021 school years who

completed the NWEA MAP Growth mid-year assessments. All scores for students in attendance during the mid-year testing window for those two years in the three grades at the time of testing were included in this research. Archival test scores were used in the analysis and students' scores were not personally identifiable. Student data was coded to indicate if the student attended a Title I or non-Title I school, if the student chose the Online Academy learning model versus students who chose the in-person learning model, who experienced a combination of in-person, hybrid, and virtual learning. This included all 18 elementary schools in the ABCSD, and those students that chose the Online Academy in 2020-2021.

Measurement

The researcher used data provided by the Northwest Evaluation Association Measures of Academic Progress (NWEA, 2021). NWEA is a research-based, not-for-profit organization that offers assessment solutions to measure growth and proficiency and help educators tailor instruction (NWEA, 2021). NWEA is used in over 9,500 schools in 145 countries (NWEA, 2021). The NWEA MAP Growth Assessment is an adaptive computer test that measures student achievement and reports scores on a Rasch Interval Unit (RIT) scale, ranging from 100 to 350. A RIT score is an equal-interval scale that enables comparisons of student growth across grade levels, districts, and states. RIT scores indicate the level of question difficulty where students answer questions correctly 50% of the time (NWEA, 2021). According to NWEA via the organization website, the RIT scale was designed to be a consistent, precise tool that provides accurate measurement of each student's academic growth. This assessment scale supplies

educators with valid, reliable, and predictive data to help students learn and grow (NWEA, 2021). NWEA MAP Growth Assessments are administered in the fall, mid-year, and spring of the school year. The scores analyzed in this study were from the assessment administered during the mid-year assessment window recommended for January through February by NWEA as determined by the ABCSD. The researcher analyzed the differences between mean RIT composite scores from 2019-2020 and 2020-2021 mid-year assessments overall and for each grade level, Title I and non-Title I schools, students who chose in-person instruction or the Online Academy, and mean RIT scores for each of the four Mathematical Goal Areas.

Validity and reliability are essential to any research. Validity refers to the accuracy of the measurement, in this case, NWEA MAP Growth RIT scores. Reliability refers to the consistency of the scores (Middleton, 2019). According to Lunenberg and Irby, "most standardized tests have good content validity" (p. 181). The NWEA MAP mathematics assessments yield content validity by incorporating content standards employed by the educational entity commissioning the assessment, and using software that combines artificial intelligence and key word matching to ensure all the necessary standards and skills are incorporated in the assessment (NWEA, 2022). Concurrent validity for the NWEA MAP mathematics assessment has also been established in the form of a Pearson correlation coefficient comparing RIT scores to scaled scores on other established tests (NWEA, 2022). The RIT value indicates the most difficult question a student can answer 50% of the time. According to Shudong, McCall, Hong, and Harris (2013), the content of NWEA MAP Growth Assessment is one of the best examples for

validity in achievement tests because all items match a set of quantifiable set of academic content standards in breadth and depth. Validity across grade levels is an essential requirement for interpretation of student growth based on test scores (Shudong et al., 2013). By design, NWEA MAP Growth RIT scores can be interpreted across grade levels. Shudong et al. (2013) found that the results show the consistency and reasonableness of interpretation of the MAP RIT scale across grades and academic calendar years for the different states. The marginal reliabilities of the MAP tests across all 50 states and grades are consistently in the low to mid 0.90s (NWEA, 2022).

Data Collection Procedures

Before beginning data collection for the current research study, the researcher applied to the Baker University Institutional Review Board for permission to conduct the research (see Appendix A). Following approval from Baker University, a formal request to conduct research in the ABCSD was completed and approved by the school district's Instructional Operation Team (see Appendix B). Following school district approval, the researcher requested assistance from the Director for Assessment at the ABCSD to begin data collection (Appendix C).

Upon request, the researcher received archived data from the ABCSD School District's Director for Assessment. Data consisted of NWEA MAP Growth Assessment mathematics RIT composite scores, the RIT scores for each of the four tested mathematical subject areas of the NWEA, and the student demographic variables of interest. The data sets were downloaded from the NWEA MAP Growth Assessment database and entered into two Excel spreadsheets containing mid-year scores from school

years 2019-2020 and 2020-2021. Categorial demographic variables were identified and coded: grade level, Title I or non-Title I school, and Online Academy learning model versus in-person learner for each tested student. On each spreadsheet, personally identifiable information was removed for each tested student, and an individual student number was utilized instead of names to protect privacy for both tested years, 2020 and 2021. The two spreadsheets were matched by student number from mid-year 2020 and mid-year 2021.

Data Analysis and Hypothesis Testing

Data analysis and hypothesis testing procedures were developed to address each of the research questions in the study. Each research question is listed below, followed by the appropriate hypotheses tested, and the statistical procedure used for analysis.

RQ1: To what extent have widespread school closures due to the Covid-19 pandemic had an impact on all students in grades 2-4 and by grade level combined on the mean composite RIT scores from the 2020 to 2021 mid-year NWEA MAP Growth Assessments in mathematics?

***H1*:** There is a significant difference in the mean mathematics RIT composite scores on NWEA MAP Growth mid-year assessment, for all students in grades 2-4 combined from mid-year 2020 to mid-year 2021.

An independent-samples *t*-test comparing mean RIT composite scores in mathematics on the mid-year NWEA MAP Growth Assessment by year, 2019-2020 and 2020-2021, for all students in grades 2-4 was conducted to test *H1*. Students in grades 2, 3, and 4 for both mid-year assessments were selected and analyzed. The categorical

independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups of students (treated as independent samples), tested mid-year 2019-2020 and mid-year 2020-2021.

RQ2. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics for each grade level (grades 2, 3, and 4) from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

***H2*:** There is a significant difference in the mean composite RIT scores in mathematics for students in grade 2 from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores for students in grade 2 from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment in mathematics was conducted to test *H2*. Students in grade 2 for both mid-year assessments were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean

difference on a continuous variable between two mutually exclusive independent groups of grade 2 students, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

***H3*:** There is a significant difference in the mean composite RIT scores for students in grade 3 from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores for students in grade 3 from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment in mathematics was conducted to test *H3*. Students in grade 3 for both mid-year assessments were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two mutually exclusive independent groups of grade 3 students, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

***H4*:** There is a significant difference in the mean composite RIT scores in mathematics for students in grade 4 from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores for students in grade 4 from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA

MAP Growth Assessment in mathematics was conducted to test *H4*. Students in grade 4 for both mid-year assessments were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two mutually exclusive independent groups of grade 4 students, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

RQ3. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics by Title I school status (Title I and non-Title I schools) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

***H5*:** There is a significant difference in the mean composite RIT scores in mathematics for Title I school students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores for students grades 2-4 combined in Title I schools from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment in mathematics was conducted to test *H5*. Students in Title I schools for both mid-year assessments were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable

was the mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups (treated as independent samples) of Title I school students, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

***H6*:** There is a significant difference in the mean composite RIT scores in mathematics for non-Title I school students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores for students grades 2-4 combined in non-Title I schools from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment in mathematics was conducted to test *H6*. Students in non-Title I schools for both mid-year assessments were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups (treated as independent samples) of non-Title I school students, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

RQ4. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics by instructional

model chosen (Online Academy and in-person) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

***H7*:** There is a significant difference in the mean composite RIT scores for students in grades 2-4 combined who chose the Online Academy instructional model from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores for students grades 2-4 combined who chose the Online Academy instructional model from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment in mathematics was conducted to test *H7*. Students in grades 2-4 combined who chose the Online Academy for both mid-year assessments were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups (treated as independent samples) of Online Academy students, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

***H8*:** There is a significant difference in the mean composite RIT scores in mathematics for students in grades 2-4 combined who chose the in-person instructional model from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores for students grades 2-4 combined who chose the in-person instructional model from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment in mathematics was conducted to test *H8.* Students in grades 2-4 combined who chose in-person instruction for both mid-year assessments were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups (treated as independent samples) of in-person students, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

RQ5. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean RIT scores in mathematics for students in grades 2-4 combined by Mathematical Goal Areas (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics) from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

***H9*:** There is a significant difference in mean RIT scores for Mathematical Goal Area 1 (Number Sense and Operations) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT Goal Area 1 scores in mathematics for students grades 2-4 combined from mid-year 2019-2020 to mid-year

2020-2021 on the NWEA MAP Growth Assessment was conducted to test *H9*. Goal Area 1 mean RIT scores for students in grades 2-4 combined were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT Goal Area 1 scores on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups (treated as independent samples) for Goal Area 1, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

***H10*:** There is a significant difference in mean RIT scores for Mathematical Goal Area 2 (Relationships and Algebraic Thinking) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT Goal Area 2 scores in mathematics for students grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment was conducted to test *H10*. Goal Area 2 mean RIT scores for students in grades 2-4 combined were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT Goal Area 2 scores on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups (treated

as independent samples) for Goal Area 2, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

***H11*:** There is a significant difference in mean RIT scores for Mathematical Goal Area 3 (Geometry and Measurement) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT Goal Area 3 scores in mathematics for students grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment was conducted to test *H11*. Goal Area 3 mean RIT scores for students in grades 2-4 combined were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT Goal Area 3 scores on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups (treated as independent samples) for Goal Area 3, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

***H12*:** There is a significant difference in mean RIT scores for Mathematical Goal Area 4 (Data and Statistics) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT Goal Area 4 scores on the mid-year NWEA MAP Growth Assessment in mathematics by school year, 2019-2020 and 2020-2021, for students in grades 2-4 combined was conducted to test H_{12}. Goal

Area 4 mean RIT scores for students in grades 2-4 combined were selected and analyzed. The categorical independent variable used for grouping was test administration time, mid-year 2019-2020 and mid-year 2020-2021. The dependent continuous variable was the mean RIT Goal Area 4 scores on the NWEA MAP Growth Assessment. An independent-samples *t*-test was chosen for the hypothesis testing since it involves the examination of the mean difference on a continuous variable between two groups (treated as independent samples) for Goal Area 4, tested mid-year 2019-2020 and mid-year 2020-2021. The level of significance was set at .05.

Limitations

Limitations were present in this study and may impact the generalization of the results. These factors are not under the control of the researcher (Lunenburg & Irby, 2008). The purpose of including limitations is to reduce the misinterpretation of the findings of the study. The following limitations were identified for the current study:

1. Test scores were analyzed for one midwestern school district and therefore may not be generalized to other districts or states.
2. Only test scores from students in grades two through four were analyzed; therefore, the results may not be generalized to other grade levels.
3. The researcher focused on mathematics scores; therefore, the results cannot be generalized to other content areas.
4. The long-term effects of the unprecedented school closures and interrupted learning due to the Covid-19 pandemic are unknown;

therefore, the results of this study could add to that body of knowledge, but cannot be generalized to all pandemic-related school closures.

5. The pandemic-related school closures required districts to create a unique learning model to meet the needs of the students and families in each community. The model employed by the ABCSD was specific to this school district and may not be similar in design or format to models in other districts; therefore, results should not be generalized to all remote, hybrid, or online school models.

Summary

Chapter 3 provided an overview of the methods used for the current quantitative study. The purpose of this causal-comparative study was to examine to what extent student achievement in mathematics was impacted by school shutdowns due to Covid-19. Student progress during the pandemic was determined by Rasch Interval Unit (RIT) scores on the NWEA MAP Growth Assessment in mathematics for students in grades two through four at the mid-year assessment before school closure, winter benchmark 2020, and the following mid-year assessment, winter benchmark 2021. The research design was explained in detail, and the population and sample were thoroughly introduced. NWEA MAP Growth Assessment mid-year composite RIT scores were examined to determine to what extent there was a differential impact by grade level, by Title I school status, and for students who chose the district's Online Academy option compared with students who chose the in-person learning model, who experienced a combination of in-person, hybrid, and virtual learning. Additionally, the RIT scores for

grades 2-4 combined were compared by year for each of the four mathematical goal areas. The five research questions were outlined along with the hypotheses tested and description of the statistical analysis. Results of the hypothesis testing are presented in Chapter 4.

Chapter 4

Results

The purpose of this causal-comparative study was to examine to what extent student learning in mathematics for grades two through four in ABCSD was impacted by school closures due to Covid-19, and to determine which student subgroups and Mathematical Goal Areas were most impacted. Student progress in mathematics during the pandemic was measured by Rasch Interval Unit (RIT) scores on the NWEA MAP Growth Assessment mid-year administrations. The RIT scale ranges across all grades and across all grades equally, making it possible to compare a student's score at various points throughout his or her education. The RIT score represents the level where a student is ready to learn, also known as the Zone of Proximal Development, and measures student progress and growth over time (NWEA, 2020). The NWEA MAP Growth Assessment is a computer-adaptive test that provides each student a unique set of test questions based on their prior responses (NWEA, 2017), and assesses four Mathematical Goal Areas: Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics (NWEA, 2022).

Most schools in the country, including the ABCSD, shifted to a virtual learning model in March of 2020. The mid-year 2019-2020 administration of the NWEA MAP Growth Assessment, winter benchmark 2020, reflected student learning prior to school closures and interruptions. The mid-year 2020-2021 administration of the NWEA MAP Growth Assessment, winter benchmark 2021, reflected the amount of learning as impacted by school closures and interruptions due to the global Covid-19 pandemic. The

mean composite RIT scores in mathematics for mid-year 2019-2020 and mid-year 2020-2021 were compared to examine the extent to which there were mean differences for grades two through four combined, and for each grade level separately. The mid-year NWEA MAP Growth Assessment mean composite RIT scores in mathematics for grades two through four combined were also compared by Title I school status to examine the extent to which student learning in mathematics was impacted at Title I schools and non-Title I schools, and compared by instructional delivery model to examine the extent to which learning in mathematics was impacted for students who chose the district's Online Academy option and students who chose the in-person learning model, who experienced a combination of in-person, hybrid, and virtual instruction. Lastly, the four mathematics Goal Area mean RIT scores for winter benchmark 2020 were compared to winter benchmark 2021 Goal Area mean RIT scores for grades two through four combined to examine the extent to which there were mean differences for each of the Mathematical Goal Areas tested: Data and Statistics, Number Sense and Operations, Relationships and Algebraic Thinking, and Geometry and Measurement. Chapter 4 presents the descriptive statistics and analysis results of the hypothesis testing for the five research questions.

Descriptive Statistics

The population for this study consisted of all students in grades 2-4 during the 2019-2020 and 2020-2021 school years who completed the NWEA MAP Growth mid-year Assessment in mathematics at ABCSD in the Midwestern part of the United States. A total of 3,672 students completed the mid-year assessment during the 2019-2020 school year, and a total of 3,390 students completed the mid-year assessment during the

school year 2020-2021 for a grand total of 7,062 NWEA MAP Growth Assessment scores analyzed. Of those 7,062 scores, 2,045 scores were the same students, identified by duplicate student identification numbers over the two years. Therefore, 2,045 students are represented with scores in each year as they moved from one grade level to the next. These students with test records for each year included 2019-2020 second-grade students who took the assessment in 2020-2021 as third-graders, and third-graders who took the assessment in 2019-2020 and took the test again as fourth-graders in 2020-2021. There were 5,017 students who had only one mid-year NWEA MAP Growth Assessment record for mathematics, during either the 2019-2020 or 2020-2021, and these students included fourth-graders from 2019-2020, second-graders from 2020-2021, and any student new to the district in 2020-2021.

The Online Academy was created and presented as an enrollment option in ABCSD for the 2020-2021 school year in response to the Covid-19 pandemic. Students enrolled in the Online Academy for 2020-2021 were coded through student identification numbers as Online Academy students in the 2019-2020 data file for the purpose of comparing their NWEA MAP Growth mathematics assessment RIT scores in mathematics with their performance on the 2020-2021 mid-year assessment. The NWEA MAP Assessment generates a RIT score, which indicates the level at which students can perform with 50% accuracy, or at their proximal zone of development. The NWEA MAP Growth Assessments contained new material for each test session, so all students, even those tested in both years, took a unique test created for their grade level. The

demographics of the assessed students on the mid-year NWEA MAP Growth Assessment in mathematics for 2019-2020 and 2020-2021 are shown in Table 1.

This sample included 48.8% female students and 51.2% male students for assessment year 2019-2020, and 50.6% female and 49.4% male students for assessment year 2020-2021. The ethnic makeup of all students assessed on the NWEA MAP Growth Assessment in mathematics for the 2019-2020 year included approximately 77.2% White, 11.2% African American, 6.7% who identified as Multi-ethnic, 2.6% identified as Asian, 2.0% identified as Hispanic or Latino, and 0.1% identified as American Indian. The ethnic makeup of all students assessed on the NWEA MAP Growth Assessment in mathematics for the 2020-2021 year included 77.0% white, 11.7% African American, 7.7% who identified as Multi-ethnic, 2.3% identified as Asian, 1.5% identified as Hispanic or Latino, and 0.2% identified as American Indian.

In 2019-2020, 21.4% of students were identified as attending a Title I school and 78.6% identified as attending a non-Title I school as determined by their school of enrollment. For 2020-2021, 15.8% identified as Title I school students, and 84.2% were identified as non-Title I school students. In the 2019-2020 data sample, Title I school students represented 21.4% of the scores recorded which was approximately the same as the district average of 21%. In 2020-2021, Title I school students represented 15.8% of the scores recorded which was lower than the district average of 21% Title I school students. For the school year 2020-2021, ABCSD students had the option of in-person or online learning through the Online Academy. Of the assessed students, 17.1% chose the Online Academy, and 82.9% chose the in-person learning option for 2020-2021. The

frequencies and percentages of NWEA MAP Growth Assessment scores by demographic categories for school years 2019-2020 and 2020-2021 are summarized in Table 1.

Table 1

Frequencies and Percentages of NWEA MAP Growth Scores by Demographic Categories for 2019-2020 and 2020-2021

Demographic Category		*2019-2020*		*2020-2021*	
		Freq	*Perc*	*Freq*	*Perc*
Gender	Male	1880	51.2%	1676	49.4%
	Female	1792	48.8%	1714	50.6%
Ethnic	African Amer./Black	410	11.2%	398	11.7%
	Amer. Ind/Alaskan Nat.	2	0.1%	9	0.2%
	Asian Amer.	105	2.9%	77	2.3%
	Hispanic or Latino	73	2.0%	34	1.5%
	Multi-ethnic	247	6.7%	262	7.7%
	White	2835	77.2%	2610	77.0%
Title Status	Title I	786	21.4%	537	15.8%
	Non-Title I	2886	78.6%	2853	84.2%
Instr. Model	Online	368	10.0%	578	17.1%
	In-Person	3304	90.0%	2812	82.9%

The demographic composition of the tested students included in the data were closely aligned with the district's overall demographic data. According to data publicly

available at the Great Schools website (2019), the ABCSD demographics indicated 75.0% of students identified as white; in this sample, the numbers of students who identified as white were slightly higher with 77.2% in 2019-2020 and 77.0% in 2020-2021. ABCSD data from the Great Schools websites indicated that 13% of district students identified as black, but in the data sample analyzed for the current study there were fewer black students with 11.2% in 2019-2020 and 11.7% in 2020-2021 identifying as black. The Great Schools website does not include the Multi-ethnic category, making it more challenging to determine the difference between this sample and district demographics as a whole. In the ABCSD as a whole, female students represent 49.0% of the population, with male students representing 51.0%, according to data publicly available on the Great Schools website (2019). In the data analyzed for this study, the demographics were very similar to district demographic data, with 51.2% male and 48.8% female students in 2019-2020, and 49% male and 50.6% female in 2020-2021. However, since some students were represented more than once in the data due to the multi-year nature of NWEA MAP Growth Assessment administration cycle, these numbers can only be used to indicate that the demographic composition of the tested students included in the data for the current study were closely aligned with the district overall demographic data.

The following section contains the results of the hypothesis testing organized by the five research questions.

Hypothesis Testing

RQ1. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics for all students grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

***H1*:** There is a significant difference in the mean composite RIT scores in mathematics for all students grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment for all students in grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021 was conducted to test H_1. For all students in grades 2-4 combined, Levene's test for the equality of variances rendered a non-significant value ($p = .838$), indicating the homogeneity of variances assumption had been met for the independent-samples *t*-test of grades 2-4 combined, and the results for equal variances assumed are reported. The results indicated a statistically significant difference between the two values, $t = 8.084$, $df = 7060$, $p < .001$, and the null hypothesis was rejected. The mean composite RIT score in mathematics for grades 2-4 from mid-year 2019-2020 ($M = 198.89$ $SD = 15.375$) was significantly higher than the mean for mid-year 2020-2021 ($M = 195.94$, $SD = 15.252$). The significant decrease of 2.949 from mid-year 2019-2020 to mid-year 2020-2021 for mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment for grades 2-4 combined was of a small magnitude according to the effect size (Cohen's $d = 0.193$).

RQ2. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on all students in grades 2-4 by grade level (grades 2, 3, and 4) on the mean composite RIT scores from the 2020 to 2021 mid-year NWEA MAP Growth Assessments in mathematics?

***H2*:** There is a significant difference in the mean composite RIT scores in mathematics for students in grade 2 from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores in mathematics for students in grade 2 from mid-year 2019-2020 to mid-year 2020-2021on the NWEA MAP Growth Assessment was conducted to test H_2. For grade 2 students, Levene's test for the equality of variances rendered a non-significant value (p = .687), indicating the homogeneity of variances assumption had been met for the grade 2 independent-samples *t*-test, and the results for equal variances assumed are reported. The results indicated a statistically significant difference between the two values, t= 3.332, df = 2206, p = .001, and the null hypothesis was rejected. The grade 2 mean RIT mathematics composite score for mid-year 2019-2020 (M = 186.47, SD = 12.205) was significantly higher than the mean for mid-year 2020-2021 (M = 184.71, SD = 12.610). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 2. The significant decrease of 1.761 from mid-year 2019-2020 to mid-year 2020-2021 for mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment for students in grades 2 was of a small magnitude according to the effect size (Cohen's d = 0.142).

Table 2

Grades 2-4 Mean RIT Composite Mathematics Scores on NWEA MAP Growth Assessment

Grade Level	Mid-Year 2019-2020			Mid-Year 2020-2021			Mean Dif.	Effect Size
	n	*M*	*SD*	*n*	*M*	*SD*		
Grade 2	1167	186.47	12.205	1041	184.71	12.610	-1.761	.142
Grade 3	1172	199.48	12.447	1223	197.27	13.557	-2.208	.170
Grade 4	1333	209.23	11.937	1126	204.86	12.485	-4.366	.358

***H3*:** There is a significant difference in the mean composite RIT scores in mathematics for students in grade 3 from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores in mathematics for students in grade 3 from mid-year 2019-2020 to mid-year 2020-2021on the NWEA MAP Growth Assessment was conducted to test H_3. For grade 3 students, Levene's test for the equality of variances rendered a significant value ($p = .017$), indicating the homogeneity of variances assumption had not been met for the grade 3 independent-samples *t*-test, and the results for equal variances not assumed are reported. The results indicated a statistically significant difference between the two values, $t = 4.155$, $df = 2388.644$, $p < .001$, and the null hypothesis was rejected. The grade 3 mean RIT mathematics composite score for mid-year 2019-2020 ($M = 199.48$, $SD = 12.447$) was significantly higher than the mean for mid-year 2020-2021 ($M = 197.27$, $SD = 13.557$). The descriptive statistics, mean difference, and effect sizes for the analysis are

presented in Table 2. The significant decrease of 2.208 from mid-year 2019-2020 to mid-year 2020-2021 for mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment for students in grades 3 was of a small magnitude according to the effect size (Cohen's $d = 0.170$).

***H4*:** There is a significant difference in the mean composite RIT scores in mathematics for students in grade 4 from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores in mathematics for students in grade 4 from mid-year 2019-2020 to mid-year 2020-2021on the NWEA MAP Growth Assessment was conducted to test H_2. For grade 4 students, Levene's test for the equality of variances rendered a non-significant value ($p = .105$), indicating the homogeneity of variances assumption had been met for the grade 4 independent-samples *t*-test, and the results for equal variances assumed are reported. The results indicated a statistically significant difference between the two values, $t = 8.849$, $df = 2457$, $p < .001$, and the null hypothesis was rejected. The grade 4 mean RIT mathematics composite score for mid-year 2019-2020 ($M = 209.23$, $SD = 11.937$) was significantly higher than the mean for mid-year 2020-2021 ($M = 204.86$, $SD = 12.485$). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 2. The significant decrease of 4.366 from mid-year 2019-2020 to mid-year 2020-2021 for mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment for students in grade 4 was of a medium magnitude according to the effect size (Cohen's $d = 0.358$).

RQ3. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics by Title I school status (Title I and non-Title I schools) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

***H5*:** There is a significant difference in the mean composite RIT scores in mathematics for Title I school students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment

An independent-samples *t*-test comparing mean RIT composite scores in mathematics for Title I school students in grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment was conducted to test H_5. Levene's test for the equality of variances rendered a non-significant value (p = .933), indicating the homogeneity of variances assumption had been met for the Title I schools independent-samples *t*-test of grades 2-4 combined, and the results for equal variances assumed are reported. The results indicated a statistically significant difference between the two values, $t = 4.482$, $df = 1321$, $p < .001$, and the null hypothesis was rejected. The mean RIT composite score for Title I school students in grades 2-4 combined for mid-year 2019-2020 ($M = 194.34$, $SD = 15.973$) was significantly higher than the mean for Title I school students for mid-year 2020-2021 ($M = 190.33$, $SD = 16.015$). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 3. The significant decrease of 4.012 for Title I school students grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021 in mean RIT composite

scores in mathematics on the NWEA MAP Growth Assessment was of a small magnitude according to the effect size (Cohen's $d = 0.251$).

Table 3

Mathematics Mean RIT Composite Scores on NWEA MAP Growth Assessment by Title I School Status

School Status	Mid-Year 2019-2020			Mid-Year 2020-2021			Mean Dif.	Effect Size
	n	*M*	*SD*	*n*	*M*	*SD*		
Title I	786	194.34	15.873	537	190.33	16.015	-4.012	.251
Non-Title I	2886	200.12	14.973	2853	196.99	14.873	-3.131	.210

***H6*:** There is a significant difference in the mean composite RIT scores in mathematics for non-Title I school students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores in mathematics for non-Title I school students in grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment was conducted to test H_6. Levene's test for the equality of variances rendered a non-significant value ($p = .951$), indicating the homogeneity of variances assumption had been met for the non-Title I schools independent-samples *t*-test of grades 2-4 combined, and the results for equal variances assumed are reported. The results indicated a statistically significant difference between the two values, $t = 7.947$, $df = 5737$, $p < .001$, and the null hypothesis was rejected. The mean RIT composite score for non-Title I school students in grades 2-4

combined for mid-year 2019-2020 (*M* = 200.12, *SD = 14.973*) was significantly higher than the mean for non-Title I school students for mid-year 2020-2021 (*M* = 196.99*, SD* = 14.873). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 3. The significant decrease of 3.131 for non-Title I school students grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021 in mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment was of a small magnitude according to the effect size (Cohen's *d* = 0.210).

RQ4. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean composite RIT scores in mathematics by instructional model chosen (Online Academy and in-person) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

***H7*:** There is a significant difference in the mean composite RIT scores in mathematics for students in grades 2-4 combined who chose the Online Academy instructional model from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores in mathematics on the NWEA MAP Growth Assessment in mathematics by school year, 2019-2020 and 2020-2021, for Online Academy students in grades 2-4 was conducted to test H_7. Levene's test for the equality of variances rendered a non-significant value (*p* = .520), indicating the homogeneity of variances assumption had been met for the Online Academy independent-samples *t*-test of grades 2-4 combined, and the results for equal variances assumed are reported. The results indicated a statistically significant difference

between the two values, t = -6.906, df = 944, p < .001, and the null hypothesis was rejected. The mean composite mathematics RIT score for Online Academy students grades 2-4 combined for mid-year 2019-2020 (M = 192.85, SD = 14.804) was significantly lower than the mean for Online Academy students for mid-year 2020-2021 (M = 200.03, SD = 16.049). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 4. The significant increase of 7.174 in mean composite mathematics RIT scores for Online Academy students from mid-year 2019-2020 to mid-year 2020-2021 was of a medium magnitude according to the effect size (Cohen's d = 0.461).

Table 4

Mathematics Mean RIT Composite Scores on NWEA MAP Growth Assessment by Instructional Model

Instruction Model	Mid-Year 2019-2020			Mid-Year 2020-2021			Mean Dif.	Effect Size
	n	*M*	*SD*	*n*	*M*	*SD*		
Online	368	192.85	14.804	578	200.03	16.049	+7.174	.461
In-Person	3304	199.56	15.292	2912	195.10	14.948	-4.462	.295

***H8*:** There is a significant difference in the mean composite RIT scores in mathematics for students in grades 2-4 combined who chose the in-person instructional model from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT composite scores in mathematics on the mid-year NWEA MAP Growth Assessment by school year, 2019-2020 and 2020-2021, for in-person students in grades 2-4 was conducted to test H_8. Levene's test for the equality of variances rendered a non-significant value ($p = .645$), indicating the homogeneity of variances assumption had been met for the in-person independent-samples *t*-test of grades 2-4 combined, the results for equal variances assumed are reported. The results indicated a statistically significant difference between the two values, $t = 11.490$, $df = 6114$, $p < .001$, and the null hypothesis was rejected. The mean composite mathematics RIT score for in-person students grades 2-4 combined for mid-year 2019-2020 ($M = 199.56$, $SD = 15.292$) was significantly higher than the mean for in-person students for mid-year 2020-2021 ($M = 195.10$, $SD = 14.948$). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 4. The significant decrease of 4.462 in mean composite mathematics RIT scores for in-person students from mid-year 2019-2020 to mid-year 2020-2021 was of a small magnitude according to the effect size (Cohen's $d = 0.295$).

RQ5. To what extent have widespread school closures due to the Covid-19 pandemic had an impact on mean RIT scores in mathematics for students in grades 2-4 combined by Mathematical Goal Areas (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics) from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment?

***H9*:** There is a significant difference in mean RIT scores for Mathematical Goal Area 1 (Number Sense and Operations) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT Goal Area 1 scores on the mid-year NWEA MAP Growth mid-year Assessment in mathematics by school year, 2019-2020 and 2020-2021, for students in grades 2-4 combined was conducted to test H_9. Levene's test for the equality of variances rendered a significant value ($p = .039$), indicating the homogeneity of variances assumption had not been met for the Goal Area 1 independent-samples *t*-test of grades 2-4 combined, and the results not assuming equal variances are reported. The results indicated a statistically significant difference between the two values, $t = 5.195$, $df = 6915.195$, $p < .001$, and the null hypothesis was rejected. The mean mathematics Goal Area 1 RIT score with grades 2-4 combined for mid-year 2019-2020 ($M = 197.74$, $SD = 14.755$) was significantly higher than the mean RIT score for Goal Area 1 mid-year 2020-2021 ($M = 195.85$, $SD = 15.747$). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 5. The significant decrease of 1.891 in mean mathematics Goal Area 1 RIT scores from mid-year 2019-2020 to mid-year 2020-2021 was of a small magnitude according to the effect size (Cohen's $d = 0.124$).

Table 5

NWEA Map Growth Assessment Mean RIT Scores by Mathematical Goal Areas 1-4

Goal Area	Mid-Year 2019-2020			Mid-Year 2020-2021			Mean Dif.	Effect Size
	n	*M*	*SD*	*n*	*M*	*SD*		
Goal Area 1	3672	197.74	14.755	3390	195.85	15.747	-1.891	.124
Goal Area 2	3672	192.85	14.804	3390	200.03	16.049	-3.825	.220
Goal Area 3	3672	198.03	16.224	3390	193.13	15.683	-4.907	.306
Goal Area 4	3672	200.04	17.965	3390	198.83	17.551	-1.213	.068

***H10*:** There is a significant difference in mean RIT scores for Mathematical Goal Area 2 (Relationships and Algebraic Thinking) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT Goal Area 2 scores on the mid-year NWEA MAP Growth Assessment in mathematics by school year, 2019-2020 and 2020-2021, for students in grades 2-4 combined was conducted to test H_{10}. Levene's test for the equality of variances rendered a significant value ($p = .001$), indicating the homogeneity of variances assumption had not been met for the Goal Area 2 independent-samples *t*-test of grades 2-4 combined, and the results not assuming equal variances are reported. The results indicated a statistically significant difference between the two values, $t = 9.197$, $df = 6908.960$, $p < .001$, and the null hypothesis was rejected. The mean mathematics Goal Area 2 RIT score with grades 2-4 combined for mid-year 2019-2020 ($M = 199.69$, $SD = 16.833$) was significantly higher than the mean RIT score for

Goal Area 2 for mid-year 2020-2021 (M = 195.86, SD = 18.022). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 5. The significant decrease of 3.825 in mean mathematics Goal Area 2 RIT scores from mid-year 2019-2020 to mid-year 2020-2021 was of a small magnitude according to the effect size (Cohen's d = 0.220).

H11: There is a significant difference in mean RIT scores for Mathematical Goal Area 3 (Geometry and Measurement) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples t-test comparing mean RIT Goal Area 3 scores on the mid-year NWEA MAP Growth Assessment in mathematics by school year, 2019-2020 and 2020-2021, for students in grades 2-4 combined was conducted to test H_{11}. Levene's test for the equality of variances rendered a non-significant value (p = .271), indicating the homogeneity of variances assumption had been met for the Goal Area 3 independent-samples t-test of grades 2-4 combined, and the results for equal variances assumed are reported. The results indicated a statistically significant difference between the two values, t = 12.860, df = 7060, p < .001, and the null hypothesis was rejected. The mean mathematics Goal Area 3 RIT score with grades 2-4 combined for mid-year 2019-2020 (M = 198.03, SD = *16.324*) was significantly higher than the mean RIT Score for Goal Area 3 mid-year 2020-2021 (M = 193.13, SD = 15.683). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 5. The significant decrease of 4.907 in mean mathematics Goal Area 3 RIT scores from mid-year 2019-

2020 to mid-year 2020-2021 was of a medium magnitude according to the effect size (Cohen's $d = 0.306$).

H12: There is a significant difference in mean RIT scores for Mathematical Goal Area 4 (Data and Statistics) for students in grades 2-4 combined from the mid-year 2019-2020 to the mid-year 2020-2021 NWEA MAP Growth Assessment.

An independent-samples *t*-test comparing mean RIT Goal Area 4 scores on the mid-year NWEA MAP Growth Assessment in mathematics by school year, 2019-2020 and 2020-2021, for students in grades 2-4 combined was conducted to test H_{12}. Levene's test for the equality of variances rendered a non-significant value ($p = .246$), indicating the homogeneity of variances assumption had been met for the Goal Area 4 independent-samples *t*-test of grades 2-4 combined, the results for equal variances assumed are reported. The results indicated a statistically significant difference between the two values, $t = 2.867$, $df = 7060$, $p = .004$, and the null hypothesis was rejected. The mean mathematics Goal Area 4 RIT score with grades 2-4 combined for mid-year 2019-2020 ($M = 200.04$, $SD = 17.965$) was significantly higher than the mean for Goal Area 4 for mid-year 2020-2021 ($M = 198.83$, $SD = 17.551$). The descriptive statistics, mean difference, and effect sizes for the analysis are presented in Table 5. The significant decrease of 1.213 in mean NWEA mathematics Goal Area 4 RIT scores from mid-year 2019-2020 to mid-year 2020-2021 was of a very small magnitude according to the effect size (Cohen's $d = 0.068$).

Summary

Chapter 4 included the data analysis and the hypothesis testing results for the research questions related to the current study of the extent to which student mathematics learning was affected by school closures and interrupted learning due to Covid-19 during the 2019-2020 and 2020-2021 school years. The results for a series of independent-samples *t*-tests were provided to address twelve separate hypotheses under five research questions. All tests rendered significant decreases from mid-year 2019-2020 to mid-year 2020-2021, except Online Academy which showed a significant increase with medium effect size (.461). Of the significant decreases from mid-year 2019-2020 to mid-year 2020-2021,

the largest effect sizes for groups from mid-year 2019-2020 to mid-year 2020-2021 were grade 4 (Cohen's $d = 0.358$) and Goal Area 3 (Cohen's $d = 0.306$) with medium magnitude. Chapter 5 contains a study summary, an overview of the problem, review of the methodology, and a summary of major findings derived from the study. In chapter 5, findings related to literature and implications for action applying the current findings for instructional use at the district level for curriculum development and professional development are outlined. Also included in Chapter 5 are limitations of the study, recommendations for future research, and conclusions.

Chapter 5

Interpretation and Recommendations

Children attending school during the global Covid-19 pandemic had experiences unlike any other educational cohort in the history of public school in America. These students had their experience in school irrevocably changed, interrupted, and altered due to the pandemic-related school closures. Whether it was high school seniors who had a virtual graduation ceremony, no prom, and no final exams or the elementary students who had the thrill of a drive-by parade of teachers, a virtual field day, an end-of-year movie party via Google Meets, or the joy of show-and-tell with live animals; these students participated in an unprecedented period in American history that "changed education forever" (Li, 2020, p. 1). The current study was conducted to examine to what extent elementary student learning in mathematics was impacted by pandemic-related school closures and interrupted instruction. Chapter 5 includes a summary of the study by providing an overview of the problem, the purpose statement and research questions, the methodology, and the major findings. The chapter also includes a discussion of the findings related to the literature. Chapter 5 concludes with the implications for action for the ABCSD curriculum specialists and professional development planners, as well as recommendations for future research designed to extend or complement the research completed for this study.

Background Study Summary

Overview of the Problem. The Covid-19 pandemic led to "an unprecedented and sweeping shift in the landscape of K-12 public schooling" as schools throughout the

United States were forced to close and adopt “distance learning supports that varied in degree and type” (Hamilton et al., 2020, p. 6). Approximately 55 million students across the nation were affected by abrupt school closures that moved almost all students into some form of online learning in March of 2020 (von Hippel, 2020). Given the unprecedented nationwide shift from in-person to virtual learning due to the Covid-19 pandemic, students, teachers, and families were widely affected. The American educational system and American families made the single most substantive shift since the one-room schoolhouses became school buildings with multiple classrooms (Education Week, 2020c).

These massive shifts in learning models and heroic actions by school districts and teachers, coupled with varying amounts of family support, created a unique school experience for almost all students across the United States (Education Week, 2020a). Faced with these unprecedented challenges, teachers and school administrators had many concerns regarding the effectiveness of unfamiliar instructional models for student learning at all levels, and specifically how effective educators were at meeting the needs of at-risk student populations. The pandemic shifted the American education system into an experiment of enormous proportions.

On March 23, 2020, the Department of Elementary and Secondary Education in Missouri ordered schools to close for the remainder of the 2019-2020 school year. School closures impacted 2,424 schools and 915,040 students across the state of Missouri (Education Week, 2020a). All students in the ABC School District (Bergen, 2020a) began a virtual learning model on March 30, 2020, which continued for most students

until February 2021. The learning model was fluid and often changing based on local and national guidelines from the CDC and county mandates related to Covid-19 infection rates. When elementary classrooms in the ABCSD shifted to a fully virtual learning model, teachers provided instruction remotely to students through an online learning management system that was previously seldom used at the elementary level. Over the duration of the school closures, students experienced a combination of learning models that included virtual, hybrid, synchronous, asynchronous, and in-person learning models (Bergen, 2020b; Buck, 2020).

Purpose Statement and Research Questions. The purpose of this causal-comparative study was to examine to what extent student learning in mathematics for grades two through four in ABCSD was impacted by school closures due to Covid-19, and to determine which student subgroups and Mathematical Goal Areas were most impacted. Student progress in mathematics during the pandemic was measured by Rasch Interval Unit (RIT) scores on the NWEA MAP Growth Assessment mid-year administrations. The RIT scale ranges across all grades and across all grades equally, making it possible to compare a student's score at various points throughout his or her education. The RIT score represents the level where a student is ready to learn, also known as the Zone of Proximal Development, and measures student progress and growth over time (NWEA, 2020). The NWEA MAP Growth Assessment is a computer-adaptive test that provides each student a unique set of test questions based on their prior responses (NWEA, 2017), and assesses four Mathematical Goal Areas: Number Sense

and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics (NWEA, 2022).

Most schools in the country, including the ABCSD, shifted to a virtual learning model in March of 2020. The mid-year 2019-2020 administration of the NWEA MAP Growth Assessment, winter benchmark 2020, reflected student learning prior to school closures and interruptions. The mid-year 2020-2021 administration of the NWEA MAP Growth Assessment, winter benchmark 2021, reflected the amount of learning as impacted by school closures and interruptions due to the global Covid-19 pandemic. The mean composite RIT scores in mathematics for mid-year 2019-2020 and mid-year 2020-2021 were compared to examine the extent to which there were mean differences for grades two through four combined, and for each grade level separately. The mid-year NWEA MAP Growth Assessment mean composite RIT scores in mathematics for grades two through four combined were also compared by Title I school status to examine the extent to which student learning in mathematics was impacted at Title I schools and non-Title I schools, and compared by instructional delivery model to examine the extent to which learning in mathematics was impacted for students who chose the district's Online Academy option and students who chose the in-person learning model, who experienced a combination of in-person, hybrid, and virtual instruction. Lastly, the four mathematics Goal Area mean RIT scores for winter benchmark 2020 were compared to winter benchmark 2021 Goal Area mean RIT scores for grades two through four combined to examine the extent to which there were mean differences for each of the Mathematical Goal Areas tested: Data and Statistics, Number Sense and Operations, Relationships and

Algebraic Thinking, and Geometry and Measurement. Five research questions guided this study with 12 hypotheses tested to address these questions.

Review of the Methodology. The current study included all 18 elementary schools in the ABCSD and those students that chose the Online Academy in 2020-2021. The archival data analyzed was comprised of all elementary-aged students in the ABCSD attending grades 2-4 during the 2019-2020 and 2020-2021 school years and completed the mid-year NWEA MAP Growth Assessments both years. Deidentified individual test scores and demographic variables were used in the analysis and students' information was not personally identifiable.

The dependent variable, for four of the five research questions, mean RIT composite scores, was measured by mid-year mathematics NWEA MAP Growth Assessments from the 2019-2020 and the 2020-2021 school years. The dependent variable for the final research question, Mathematical Goal Area subscale RIT scores, were measured by mid-year NWEA MAP Growth Assessment subscale RIT scores from the 2019-2020 school year and the 2020-2021 school year. The independent variable for the current study was school year in which the assessment was administered. Demographic variables were used to create student groupings for comparisons by grade level, Title I and non-Title I school status, and chosen instructional model: Online Academy learning model versus students who chose the in-person learning model who experienced a combination of in-person, hybrid, and virtual learning. Mid-year NWEA MAP Growth Assessment mean composite RIT scores in mathematics for mid-year 2019-2020 and mid-year 2020-2021 were compared using a series of independent-

samples *t*-tests for various demographic groupings to examine to what extent there was a significant difference for all students in grades 2-4 combined, by each separate grade level, and by Title I school status. Mid-year NWEA MAP Growth Assessment mean composite RIT scores in mathematics for each year were also compared for groups of students who chose the district's Online Academy option and students who chose the in-person learning model and experienced a combination of in-person, hybrid, and virtual learning. NWEA MAP Growth mid-year mean RIT scores of the four Mathematical Goal Areas for 2019-2020 and 2020-2021 subtests were compared for all grade 2-4 learners combined to examine potential differences for each of the Mathematical Goal Areas (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics).

Major Findings. School closures and interruptions in instruction during the pandemic had a significant negative impact on mean composite RIT scores for the mid-year NWEA MAP Growth Assessment in mathematics from 2019-2020 to 2020-2021 for all ABCSD students in grades 2-4 combined, and for each grade level separately. Student mid-year mean composite RIT scores in mathematics for grades 2-4 combined at both Title I and non-Title I schools were also significantly negatively impacted. Students who opted for the district in-person learning model and experienced a combination of in-person, hybrid, and virtual instruction showed a significant decrease from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment, but students who opted for the district Online Academy showed the only significant increase in mathematics mean RIT composite scores. School closures and interruptions in

instruction also had a significant negative impact on mean RIT scores in mathematics for all four Mathematical Goal Areas tested on the mid-year NWEA MAP Growth Assessment (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics) for ABCSD students in grades 2-4 combined from mid-year 2019-2020 to mid-year 2020-2021. A complete description of the results from testing the twelve hypotheses associated with the five research questions guiding the current study was presented in Chapter 4. The statistical analysis of the data revealed the following key findings regarding mathematics learning trends in ABCSD elementary schools.

- Students in grade levels 2-4 combined showed a significant small decrease (-2.949) in mean composite RIT scores on the mid-year NWEA MAP Growth Assessment in mathematics from before pandemic-related school closures to the year following school closures.
- Students in grade levels 2, 3, and 4 separately each showed a significant decrease in mean composite RIT scores on the mid-year NWEA MAP Growth Assessment in mathematics from before pandemic-related school closures to the year following school closures. For grades 2 and 3, this decrease was of small magnitude (-1.761 and -2.208, respectively), but grade 4 showed the greatest amount of learning loss at a medium magnitude (-4.366).
- Students at both Title I and non-Title I schools in grade levels 2-4 combined showed significant decreases of medium magnitude in mean composite RIT scores for the mid-year NWEA MAP Growth Assessment in mathematics from

before pandemic-related school closures to the year following school closures. Students at Title I schools showed a greater amount of learning loss (-4.012) than did students at non-Title I schools (-3.313).

- Students who opted for the district in-person learning model and experienced a combination of in-person, hybrid, and virtual instruction showed a significant decrease of medium magnitude (-4.462) for mean composite RIT scores in mathematics of grades 2-4 combined.
- Students who opted for the ABCSD Online Academy showed the only significant gains in mathematics learning during pandemic-related school closures (+7.174).
- Students in grade levels 2-4 combined showed significant decreases in mean RIT scores for all four Mathematical Goal Areas (Number Sense and Operations, Relationships and Algebraic Thinking, Geometry and Measurement, and Data and Statistics) from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment. Goal Area 3 (Geometry and Measurement) showed the greatest amount of learning loss at a medium magnitude (-4.907), followed by Goal Area 2 (Relationships and Algebraic Thinking) at a smaller magnitude (-3.825). Goal Areas 1 (Number Sense and Operations) and 4 (Data and Statistics) both showed decreases of small magnitude (-1.891 and -1.213, respectively) from before pandemic-related school closures to the year following school closures.

Findings Related to the Literature

The literature reviewed for this study identified an array of reasons that may have factored into the observed results. School closures during the pandemic had a significant

negative impact on mathematics scores for all ABCSD students in grades 2-4 combined, and for each grade level separately during the period of the current study. The Education Research Alliance described school closures due to the pandemic as the "gravest crisis the country has seen in a century" and that "few institutions have been as affected as schools" (Harris et al., 2020, p. 2). Therefore, it is not surprising that results from the current study indicated that students did not learn at the same levels during pandemic-related changes to the learning model as they would have learned without instructional interruptions. The abrupt shift to virtual learning was not a scenario for which public schooling had prepared students, teachers, or families. There are many findings in the literature that explain why learning loss was a result of what has been described as "an unprecedented and sweeping shift in the landscape of K-12 public schooling" (Hamilton et al., 2020, p. 1).

Prior to pandemic-related school closings, most K-12 students in the United States participated in an in-class educational experience (Dorn et al., 2020b). Almost all students experienced a change in their learning model from in-person learning in traditional classrooms to some form of remote or virtual learning environments due to widespread school closures (Kuhfeld, 2021). Newton (2020) stated that K-12 schooling was "blindsided by the jarring transition to online schooling" (para. 3). The education system nationwide, and in ABCSD, was unprepared for this shift and virtual learning for all elementary students had never occurred on this large of scale (Dorn et al., 2020a).

ABCSD student learning in mathematics for grades 2-4 was impacted by the school closures and changes to the learning model. Research indicated that prior to the

widespread school closings and shift to virtual learning that occurred in March 2020, most virtual learning occurred in isolated and unique settings to meet the needs of specific learners (Watson & Ryan, 2007). Studies of existing virtual learning prior to the pandemic indicated that a virtual learning setting was not ideal for all learners; rather, best suited for students who exhibited qualities such as high levels of independence and motivation, strong time management skills, and advanced technology skills- asserting that the ideal candidates for success in an online learning environment were adults (Barbour & Reeves, 2009). Based on virtual learning models at the time of the Barbour and Reeves' 2009 study, it was declared that the need for improving virtual learning was urgent and while the availability of virtual schooling grows, to be successful, improvement was needed.

None of the pre-pandemic research on virtual schooling suggested that online school would be successful on a large scale for all ages of learners. Therefore, the fact that results from the current study indicated that elementary students were not learning at the same levels as they were prior to school closings related to the pandemic was not a surprising outcome. Elementary students, for the most part, do not fit the description of the ideal virtual learner as described by Barbour and Reeves (2009). Children in second through fourth grades most likely did not have the levels of independence and motivation, nor strong time management, literacy, and technology skills that were identified as necessary for success in virtual learning as described in the research of Barbour and Reeves (2009). Students in the ABCSD during the period of pandemic-related school interruptions and changes to the learning model not only experienced virtual learning,

they also experienced hybrid learning models, asynchronous learning, and intermittent in-person learning. Barbour and Reeves (2009) presented the characteristics for a virtual learner in a predictable, stable, remote learning environment. The students affected by pandemic-related school closings experienced multiple models that changed throughout the period of the current study. In addition to the challenges of being an online learner, these children were undergoing virtual learning at a time in American history in which there were health and safety issues that were stressful for society as a whole. Families were adapting to stay-at-home orders in response to emerging information about the global pandemic while shifting to learning from home.

A report from McKinsey and Company in the fall of 2020, stated that the "first priority of every school system must be to reduce virus transmission rates and protect the health and safety of staff" (Dorn et al., 2020b, p. 1) which indicated that health and safety took precedence over teaching and learning in American schools. There was little mention in the literature of how teachers were prepared to teach well during a pandemic with their students learning from home or in a continually changing learning model. Students and teachers of all grades were faced with a learning model that operated unlike previous school experiences with little notice, training, or preparation (Gross & Opalka, 2020). With the shift to online learning, brick-and-mortar classrooms were duplicated in a digital version. Most teachers had little to no training on best practices in an online learning environment to meet the needs of learners in a virtual environment. ABCSD leaders scrambled to provide the hardware and connectivity for nearly all students to have the capability to connect with the classroom in preparation for the shift, but there wasn't

time to adequately train teachers how to best instruct young learners across a computer screen effectively. The ABCSD school district mobilized district instructional technology specialists to assist teachers with the shift, but the task was immense considering all the changes experienced in education and communities at this time. Teachers heroically created online content to reach learners, recreated classrooms in their homes, replicated lessons in video format for asynchronous delivery, but as Malkus described, educators were "trying to build the plane as it went down the runway" (Malkus, 2020a, para. 4).

Elementary teachers had an even greater challenge due to the age and lack of technology experience of their virtual learners. Students with emerging technology skills were expected to navigate online learning environments using unfamiliar learning management systems. Students shifted from a familiar classroom environment with a trusted adult guiding them in their learning to a home without guided instruction on how to do so. In the case of the youngest students who shifted to online instruction, they were using a learning management tool, Schoology, that was utilized prior to the pandemic very little, if at all, in the elementary schools. In the earliest days of the shift to virtual schooling when all students were learning at home, these young students were exclusively using a tool that was mostly unfamiliar to them. Elementary teachers were dependent on this same unfamiliar platform to connect with students, deliver instruction, provide and score assignments, and, ironically, to teach students the functionality of the Schoology platform itself.

There were great differences in the accountability for student learning during pandemic-related school closures as reported in the literature (Harris et al., 2020; Malkus, 2020b; Gross & Opalka, 2020; Hamilton et al., 2020). There was no national model, platform, curriculum, or accountability system for what students learning remotely should receive (Harris et al., 2020). Each school district created independent policies, which resulted in a wide range of experiences for students across each state and across the nation (Gross & Opalka, 2020). Expectations varied widely by school district for attendance, grading, assessment, and when students were expected to access the learning management system. National research results confirmed that for many districts, virtual learning grades were not kept, and students were, for the most part, presented primarily review material and not assessed on their comprehension of material presented (Gross & Opalka, 2020).

For the ABCSD, students in the spring of 2020 were not graded for their work or participation from the date of school closures, March 13, 2020, until the end of the year. In communication from ABCSD to the school community including parents, no student would be penalized for pandemic-related school closures and the grade on record at the time of school closures would be the grade for the semester (Bergen, 2020a). Grades could improve, but not decline from the grade on March 13, 2020. At the elementary level in ABCSD, grades were standards-based, meaning that students were assessed based on their level of mastery on a learning target. Teachers continued to address learning targets, but because of the grading policy, many families chose to opt out of participation in virtual learning for the remainder of the 2019-2020 school year.

Lack of accountability resulted in a two-fold problem for ABCSD student learning in mathematics as revealed by the current study. First, students were simply not present online to learn mathematical content and there was not a penalty for non-participation. Second, students who were participating in online learning were not assessed on their mastery toward the learning targets. Math instruction is very sequential in elementary school and while instruction was presented, there was very little feedback given to students regarding their progress or capabilities toward the learning target. The CPRE study revealed that approximately half of the districts surveyed nationwide did not expect teachers to assess students' progress or work samples, to return graded work to students, or to provide parents with progress reports (Gross & Opalka, 2020). The district grading policy made it challenging for teachers to assess student progress, provide remediation, identify gaps in student understanding, or address missing foundational skills. As students returned to school in their chosen instructional model in the fall of school year 2020-2021, teachers did not have information about what these students had learned during the period of school closures or their gaps in mathematical understanding.

According to the findings of the current study, students in Title I schools experienced learning loss in mathematics to a greater extent than students in non-Title I schools. Emerging literature has provided evidence of the disparate effects of the pandemic on lower-income students. In a report published by the American Enterprise Institute entitled *Too Little, Too Late: A Hard Look at Spring 2020 Remote Learning,* Malkus (2020b) examined the effects of the Covid-19 pandemic using descriptive statistics from districts across the country to quantify lost instructional time, differences

in remote offerings across districts, and variety of learning models offered. While studies measuring learning loss due to the Covid-19 pandemic continue to emerge, students in low-income schools, students of color, and English language learners tend to have been falling farther behind in math than white students or students in schools with higher socioeconomic levels (Martin, 2021). Hawkins (2020b) warned that the pandemic-related interruptions to the instructional model would increase the gaps already apparent for students from lower socioeconomic areas and for students of color.

There seem to be many factors that may have contributed to greater learning loss for students in Title I schools; however, previous research has indicated that students from lower-socioeconomic settings may have experienced greater learning loss due to the pandemic-related school closures (Kuhfeld et al., 2020; Li & Lalani, 2020; Malkus, 2020b; Strauss, 2020). The nationwide CRPE study found that only one-third of districts surveyed expected teachers to engage and interact with students in a whole-class setting; but instead counting live video lessons, recorded lessons and lectures, phone support, email, and online feedback as instructional time (Gross & Opalka, 2020). Teachers were providing content and lessons, but the findings of the current study show this may not have been effective mathematics instruction given the virtual learning model in spring 2020 and the continually changing instructional model fall of 2020. In a remote school environment, it was more challenging for teachers to engage in effective mathematics instruction, which could have decreased the efficacy of student mathematics learning (Sawchuk & Sparks, 2020). During in-person learning, especially at the elementary level, math instruction had traditionally benefitted from the use of manipulatives,

concrete visuals, inquiry-based learning, and problem-based learning to help students understand more complex concepts (Smith, 2009; Sawchuk & Sparks, 2020). Teachers in the ABCSD employed any number of virtual activities attempting to approximate the experience of using manipulatives as if students were in the classroom, but the results of the current study suggest that these experiences were not as productive for student learning as the in-person instructional setting. Jon Star, a professor at Harvard School of Education, warned that elementary students would have fewer mathematics experiences resulting in less conceptual understanding, and could lose the deep understanding of math due to learning remotely (Sawchuk & Sparks, 2020). The results of the current study indicate that Star's prediction came true, especially for learners in Title I schools.

All students in grade levels 2-4 combined and in grade levels 2, 3, and 4 separately showed a significant decrease in mean composite RIT scores in mathematics on the mid-year NWEA MAP Growth Assessment in mathematics from before pandemic-related school closures to the year following school closures. For grades 2 and 3, this decrease was of small magnitude, but grade 4 showed the greatest amount of learning loss. There are myriad reasons fourth grade was affected to a greater extent, and could be attributed to the increased academic rigor of concepts tested at this level. Additionally, per the NWEA MAP Growth Assessment, students would have been expected to have progressed through the curriculum at a rate commensurate with an uninterrupted or 'normal' school year. Students in grades 2-3 may have been tested on foundational math skills acquired prior to school closures, while students in fourth grade would have been expected to show learning on new content and cumulative learning

encompassing mathematical skills that built on prior learning. Very little new content was presented during the period of school closures and remote learning, for the most part, students were presented review and enrichment concepts. Fourth-grade students may have been tested on a greater number of items for which the content had not been taught in a setting in which a student could work with an educator because of school closures and the interrupted learning model. Missing from the learning model in many cases was the feedback loop in which students working with an educator trained in math instruction could have their misunderstandings corrected or their learning gaps in mathematics addressed while working which has been shown to have the greatest effect on student learning (Hattie, 2012).

Students who opted for the district in-person learning model and experienced a combination of in-person, hybrid, and virtual instruction showed a significant decrease in mathematics mean RIT composite scores from mid-year 2019-2020 to mid-year 2020-2021 on the NWEA MAP Growth Assessment, but students who opted for the district Online Academy showed the only significant increase in scores. Students in ABCSD who chose the in-person model experienced a combination of in-person, hybrid, and virtual instruction. From March of 2020 through February of 2021 these students had to continually change where, when, and how they were learning. The district planned to open in-person for the fall of the 2020-2021 school year, but this model experienced numerous changes and interruptions due to pandemic-related guidelines from local and national directives. Following the Missouri statewide school closures in the spring of 2020 when all students were learning remotely, kindergarten through third-grade students

in the ABCSD were able to return to the school building in the fall of 2020. Fourth grade students started the 2020-2021 school year remotely, and later moved to a hybrid schedule until a full return to in-person school four days a week in February of 2021. During the 2020-2021 school year, all students had periods when learning moved to remote and asynchronous models due to local mandates based on infection rates, quarantines due to potential Covid-19 exposure, and AMI days for weather-related closings and staff vaccinations. As a result, students and families were continually adjusting to a changing instructional model. The hybrid learning model allowed for social distancing by reducing class size, but also required that half of the class learn the same content from home. In this hybrid model, half of the students completed assignments or supplemental learning experiences outside of the classroom independently, while half of the students in-person learned the content from a teacher in school (Tophat, 2020b). Results of from the current study would indicate that the changing instructional model negatively affected mathematical achievement during the period analyzed.

Unlike ABCSD students who chose an in-person learning model that experienced an ever-changing learning model and schedule, Online Academy students had the same mode of learning throughout the period examined for the study. Even though their learning mode was virtual for the duration, these students experienced consistency. For the most part, these students had the same virtual teacher, same classmates, predictable daily schedule, and consistency of the Schoology platform for completing assignments and accessing coursework. Data analysis results for the current study indicated that for

these students, mathematics learning was positively impacted by the consistency and predictable nature of the Online Academy program even though this model was different than their prior in-person experiences. The results of the current study suggest the unpredictability of the changing in-person model did not serve students as well as the consistency of the entirely virtual Online Academy model.

Results of the current study indicated that the greatest amount of learning loss occurred in Mathematical Goal Area 3 (Geometry and Measurement) followed by Goal Area 2 (Relationships and Algebraic Thinking). The lower scores in Goal Areas 2 and 3 suggest that these mathematical concepts were more challenging to teach in a virtual learning environment. These results could also suggest that the instruction presented was not effective for student learning or that changes to the instructional model impacted the mathematical learning levels in these Goal Areas. As with all other areas of learning loss, teacher lack of preparation to effectively teach these skills in a virtual environment, lack of accountability for student learning, and student non-participation could be factors affecting lower assessment scores in these areas. Research has suggested that geometry and measurement may be subjects best taught in person with hands-on learning using math manipulatives (McAnelly, 2020). Covid slide predictions issued by NWEA in the early days of the pandemic-related school closures indicated that learning loss in math would be greater than other content areas; and results from the current study support this claim (Hawkins, 2020a).

We may not ever know the full extent of the effects of pandemic-related school closures. The current study provided evidence to support that learning loss had occurred,

and all students in grades 2-4 at ABCSD may have deficits in mathematics knowledge as a result of the change to various learning models during this unprecedented time. There was no national model, platform, curriculum, or accountability system for what virtual learning should have been or how districts should respond (Harris et al., 2020).

During the time of pandemic-related school closures, the ABCSD met the needs of students and families in tremendous ways. There were many advantages that ABCSD had that may not have been present in other districts; yet, the learning loss was evident in nearly all learners even with such provisions. This district may have represented best-case scenario in terms of responsive actions supported by emerging research about what worked well during pandemic-related school closures. At the first opportunity to safely bring students back into the classroom, the ABCSD brought the youngest and highest-needs learners back to an in-person learning environment. Students with special education needs plus pre-K, kindergarten, and grades 1-3 returned to school in-person in the fall of 2020 at ABCSD. The district also offered the choice of in-person instruction or Online Academy learning models starting in the fall of 2020. Any student in kindergarten through grade 12 could enroll in a fully online option or choose to attend in-person, with the understanding that the in-person model would be subject to changing guidelines from the CDC and local mandates. The ABCSD had a learning management system in place for all students in kindergarten through grade 12 prior to the pandemic. All students had a district-issued Chromebook prior to the pandemic-related school closures, and in the wake of school closures, the district quickly assessed internet access needs for all students in the district. Students in homes without broadband access were

provided mobile hotspots for use for the duration of virtual learning. These devices were delivered by the district, as well as, meal delivery services offered for any student, regardless of family income. In hindsight, there were many ways in which the pivot to online learning, although hasty, the ABCSD response to unforeseen school closures was successful. Results from the current study would indicate that in other school districts without the plans that were in place in the ABCSD, student learning could likely be affected to an even greater extent.

Conclusions

This section provides conclusions from the current study of pandemic-related school closures on mathematics learning. Implications for action and recommendations for further research are included. This section ends with concluding remarks.

Implications for Action. The results of the current study have implications for the ABCSD pertaining to the implementation of teacher professional development, evaluation of curriculum materials, and improvement of a remote learning plan. The causal-comparative research method allows researchers to "determine cause-and-effect relationships between variables" (Lunenburg & Irby, 2008, p. 45). Findings from the current study could be used to make modifications to professional development plans, address learning loss in mathematics for students affected by pandemic-related school closures, and inform future decision making for unforeseen interrupted learning. Based on the data analysis results from the current study, the researcher would like to focus on the following implications for action.

To facilitate more successful virtual learning at ABCSD in the future, there are a number of recommendations related to the emerging body of research surrounding this unprecedented time in American educational history. Foremost, schools should implement and practice procedures for a remote learning plan much like a tornado, fire, or intruder safety plan. Schools should also create procedures for remote instruction, student technology, learning management systems, communication plans, and staff preparedness. In the event of unforeseen future interruptions to the learning model, a comprehensive plan in place prior to the event could reduce learning loss and decrease the amount of lost instructional time for preparation at the time of the crisis.

If not implemented already, districts should have a learning management system in place for teachers and students to connect remotely in the event of school closures. This learning management system can be utilized during in-person learning at all levels so that, in the event of school closures, all students are familiar and comfortable with the functionality of the platform. Embedded experiences using the learning management platform for staff professional development would enable teachers greater opportunities to understand functionality of the system.

Additionally, teachers need professional development centered on best practices in virtual instruction. A remote learning environment should not be a digital duplicate of an in-person learning space. Teacher training that includes strategies to maximize student learning in a virtual learning scenario will benefit student learning. There is an emerging body of research about what worked and what did not work for virtual learning during the pandemic that can be used to build professional development modules. Going

forward, professional development and curriculum resources for teachers should include strategies for both in-person and virtual learning environments.

Students also need training prior to possible school closures on how to access and effectively use any learning management system in place in the district. School districts could develop protocols for a virtual learning model that represents research-based, best practices in remote learning. For future online learning, whether it is due to an unforeseen and widespread pandemic or a local weather-related closure, there should be a seamless transition from an in-person to a virtual learning model because students have had training with an educator on how to navigate and successfully engage with content in a virtual setting.

Elementary students in ABCSD who experienced learning loss in mathematics because of the pandemic-related school closures will need continued support and remediation in the classroom. Second through fourth grade, the grade levels examined in the current study, represent a time in which students learn mathematical concepts that are the building blocks of future mathematical understanding. Many students may have missed foundational skills in mathematics that were prerequisite skills for furthering math progress. This developmental level of mathematics skills is a critical undertaking and students cannot be expected to simply jump back in at a fourth-grade level, for example, when they are missing skills covered at an earlier grade level. Therefore, strategic instruction to address missing and deficient skills in mathematics is essential for this cohort of students to address learning loss and for future mathematics achievement. It may be necessary for school districts to adjust curriculum mapping for the students

affected during pandemic-related school closures at all levels to account for the instructional time that was lost due to the changes in the learning model. It may be that the new learning plan for students doesn't include the breadth of learning standards that were taught in a classroom pre-pandemic, rather, an adjusted curriculum map addressing essential learning standards. This group of students may need specific mathematical instruction to address their areas of greatest learning loss. Students need the opportunity to develop their mathematical understanding through classroom instruction with a teacher trained to address their level of conceptual understandings or misunderstandings. For example, the ABCSD might benefit from altering the grade-level expectations at the elementary level to allow instructors to teach missing skills and foundational mathematical concepts, especially in NWEA MAP Growth Assessment Goal Area 2 (Relationships and Algebraic Thinking) and Goal Area 3 (Geometry and Measurement), the Mathematical Goal Areas that showed the greatest amounts of learning loss. Additional instruction could be delivered through tiered support systems to catch up students in specific mathematical goal areas.

Covid-19 has changed the nature of most aspects of life in America and schools might not be able to begin anew and operate in the exact same manner as prior to the pandemic. As an education system, it must be recognized that students experienced an interruption in their learning. Despite the best efforts of the educational systems, individual school districts, and hard-working teachers in these systems, students did not have the same number of instructional minutes they would have had in a non-pandemic school year. It cannot be expected that students enter back into school at the same level

or without a lasting impact due to the changes to their instructional model. There will be gaps in student learning and, as the current study shows, the learning loss for elementary mathematics in ABCSD seems widespread. The learning challenges for this cohort of students may take years to overcome. In all, as an educational community, there needs to be an understanding that these students and the dedicated teachers who worked with them during the time of extended school closures and interrupted learning models did the best that could be done under the circumstances at the time. There will be long-ranging consequences for lost instructional time and missing foundational skills, and the learning loss may take years for these students and the educators working with them to overcome.

However, there may be some ancillary benefits the pandemic-related school closures afforded students in other areas. No other cohort of students in the history of American education has experienced the autonomy of online learning and the associated skills students gained as a result. Students who experienced virtual learning acquired a different set of skills in order to access school from home through an online platform, communicate with teachers through an internet-connected device such as email, video-conferencing, message boards, and learning management systems. Students also learned to troubleshoot technical issues on their devices, connect with technical support when needed, and advocate for themselves when connectivity or technical difficulties interfered with their learning. It is unprecedented in American educational history that elementary students had such a degree of autonomy and self-efficacy. The level of adaptability and resilience required by students to navigate virtual learning at this time may be a huge gain

for these students in terms of life skills. These gains may be more difficult to quantify than their learning loss in mathematics.

Recommendations for Future Research. While results from the current study provided evidence of widespread learning loss in mathematics for most students in grades 2-4 at ABCSD as impacted by the pandemic-related school closures, there are many possible directions for future research into the effects of the Covid-19 pandemic on students and educational systems. This period in American educational history will provide countless opportunities for researchers to assess what worked, what did not work, and how students fared during and after this unprecedented period.

The first recommendation for future research would be to replicate the current study comparing future years' mid-year data on NWEA MAP Growth Assessment in mathematics for subsequent years and analyze mean RIT scores using the same demographic grouping variables. The current study only analyzed two years of scores, (2019-2020 and 2020-2021) and future studies could assess NWEA MAP Growth Assessment mean composite RIT scores in mathematics by grade level to examine changes in learning.

The second recommendation for future research would be to replicate the current study in the subject area of reading. Research should be conducted comparing mid-year data on NWEA MAP Growth Assessment RIT scores in reading for the same or subsequent years using the same demographic groupings. The current study only analyzed two years of scores, (2019-2020 and 2020-2021), and future studies could

assess NWEA MAP Growth Assessment scores in reading by grade level to examine amounts of learning loss in reading.

The third recommendation for future research would be to follow this cohort of students as they progress through school and assess the long-term impacts of pandemic-related school closures at the elementary level for future learning in mathematics. A fourth recommendation would be to study the long-term effects of pandemic-related school closures on student subgroups, including students in Title I schools, students of color, students of essential workers, students who experienced only online education post-pandemic, and by ages or grade level of students during school closures.

A fifth recommendation for future researchers is to study student achievement regarding Mathematical Goal Areas, specifically, Goal Area 2 (Relationships and Algebraic Thinking) and Goal Area 3 (Geometry and Measurement). A sixth, and final, recommendation is to assess the social and emotional impacts of pandemic-related school closures on student mental health. Students experienced isolation, routine changes, and a substantial disruption to their school experience. They experienced this during a time in American history that is widely regarded as stressful for most people. The long-term effects of this period for people of all ages, but especially these students who were part of an unprecedented school experience, will provide rich research opportunities for studies in the field of social sciences.

The ABCSD has committed to a continuation of the Online Academy and there are multitudes of studies that could emerge from researching this new learning model for K-12 learners. Any number of additional studies could focus on district preparation plans

for school closures, virtual learning models, or best practices in virtual instruction. Studies could also be conducted to assess how curriculum resources could be revised to adapt to future changes to the learning model and provide resources for teachers to navigate shifts between virtual and in-person models.

Concluding Remarks. The Covid-19 pandemic will forever be etched in the memory of people worldwide for the myriad effects this event imposed on the way of life for everyone. From the tragic loss of life to the political divisions over vaccines and masking, this time was life-changing for most people. Of course, the effects on the field of education have been substantial and wide-ranging. The current study focused on the learning loss experienced for one school district in one content area due to the ongoing changes to the learning model during this period.

Learning loss in overall mathematics for students was evident in almost all groups and Mathematical Goal Areas studied, which should not be surprising when considering all the difficulties that students and families experienced due to pandemic-related school closures and interrupted instruction. Students in the 2021-2022 school year returned to the classroom with an instructional delivery model that appears to be very similar to pre-pandemic learning modalities; however, the student body and the education community are far from the same as pre-pandemic times. Educators continue to be faced with heightened pressure to meet the needs of a wide range of learners in the classroom and challenged to manage classrooms of students who have experienced a variety of learning models and may have associated trauma because of the Covid-19 pandemic.

School leadership has experienced changes to their roles as they have navigated protocols for the safety of staff and students in a time of great division in American society. While the school building may appear the same on the outside, the impact of the pandemic has had widespread effects from the classroom to the health room, and from the principal's office to the district office. The term 'school building' may in fact be an antiquated term now that all schools have some capability to connect with students in an online learning environment.

Students during this time were disconnected from peers and the social setting school provides. Research is emerging regarding the implications of the social and emotional effects of this isolation. All public-school students affected by pandemic-related school closures, an estimated 55 million, navigated public school from home via the internet and pivoted between learning models and changing schedules. The long-term effects of social isolation and the associated emotional effects may never be fully known.

There have been some positive outcomes to the world of education as a result of the Covid-19 pandemic. Protocols have been established to provide educational opportunities for students who are unable to attend in-person school. There have been exponential increases in the resources available for teachers to provide online instruction and experiences for students. Incredible new platforms exist to engage learners through virtual environments and students have greater opportunities to experience the world through these interactive digital experiences. For example, museums and cultural experiences, closed due to the pandemic, were able to open online. Authors, artists, and scientists have provided content for educators to incorporate into lessons providing rich

experiences never before available in the classroom with students having more equity in accessing historical and cultural experiences.

There are increased demands on educators to address the high needs of students affected by pandemic related school closures and 'catch them up' academically, and in response, many educators are leaving the profession. In the wake of unprecedented circumstances, the education world made a fundamental shift. At the time that schools moved to virtual learning, the world of education was unprepared for these changes. The response to the Covid-19 pandemic with related school closures and interrupted instruction has taken a substantial toll almost all individuals involved, families, educators, and students. The metrics used to measure learning loss, the extent to which students experienced Covid-slide, and the achievement gap for students doesn't take into account the human story of school closures, educational isolation, or trauma experienced individuals during this abrupt and seismic shift in the American educational model. Hopefully, lessons learned from the response of the education community to the Covid-19 pandemic, plus information from studies of this time could add to the greater body of knowledge, while actionable results could transform education for the betterment of all students in the future as the world of education continues to evolve.

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Appendices

Appendix A: Baker University Institutional Review Board Approval

Baker University Institutional Review Board

July 15th, 2021

Dear Kerrie Creemer and Denis Yoder,

The Baker University IRB has reviewed your project application and approved this project under Exempt Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.
6. If this project is not completed within a year, you must renew IRB approval.

If you have any questions, please contact me at npoell@bakeru.edu or 785.594.4582.

Sincerely,

Nathan Poell, MLS
Chair, Baker University IRB

Baker University IRB Committee
Sara Crump, PhD

Appendix B: Application to conduct research in ABCSD

SCHOOL OF EDUCATION
Baldwin City, Overland Park, Wichita, Topeka
Kansas City and Lee's Summit

BAKER UNIVERSITY
Own Confidence

To: [redacted]

Re: Kerrie Creemer

Date: April 14, 2021

From: Denis Yoder Ed.D.

This letter is written as confirmation that, as Kerrie Creemer's major advisor at Baker University, I have reviewed and approved her study, Elementary Learning Loss in Mathematics During School Closings and Interrupted School Models due to Covid-19. Additionally, I can confirm that her study has been reviewed and approved by Baker University School of Education Research Analyst, Dr. Kayla Supon-Carter. If you have any questions, please contact me.

Respectfully,

Denis Yoder

Denis Yoder Ed.D.
Associate Professor
Graduate School of Education
Baker University
913-344-1231
dyoder@bakeru.edu

Application to Conduct Research at [redacted]

Identifying Information

Name: Kerrie Creemer	Home Address: [redacted]	Phone Number: [redacted]
Grade/Subject: Grades 2-4	Building: [redacted]	Email: kerrie.creemer@[redacted]

Title of Project:

Learning Loss in Mathematics for Elementary Students Grades 2-4 During School Closures and Interrupted Learning Due to Covid-19 Pandemic Based on NWEA Map Growth Data Analysis

Why are you conducting the study?

- Independent Research
- Masters Thesis/Paper
- Graduate Class Requirement
- **Dissertation Research/Project**
- Other (Please Describe)

University/College Affiliation:

Faculty Advisor:
Denis Yoder, Ed.D.
Associate Professor
Graduate School of Education
Baker University
913-344-1231
dyoder@bakeru.edu

Proposed Participants
Researcher will analyze midyear NWEA MAP Growth scores pre-pandemic (Winter, SY 2019-2020) and post school closures (Winter, SY 2020-2021) NWEA Math scores of elementary students in all grades 2-4. Test scores will further be analyzed for subgroups and for math goal area achievement. All data will be anonymously evaluated with the use of student numbers with no identifying student information viewed or used in the course of research. Test data will be analyzed using subgroup analysis and reports available through NWEA.

Demands on Participants
There will be no demands on participants. Scores have been reported by NWEA and collected by the district. Researcher will be using archival data.

Privacy Protection

All identifying data will be removed including student name and school identification. Students, schools, or district will not be identified by name in analysis, research, or publication. Student numbers will be utilized as well as data sorting tools available through the NWEA online portal for test administrators.

Benefits

Information gained from the research will seek to identify to what extent interrupted learning impacted student achievement as measured on NWEA MidYear SY 2019-2020 and MidYear SY 2020-2021 NWEA math scores. The researcher will look for change (positive and negative) in achievement data based on NWEA goal reporting in math goal areas for each grade level: number sense and operations, relationships and algebraic thinking, geometry and measurement, and data and statistics, to identify specific areas that were impacted at a greater extent than others. Additionally, the researcher will look for differential achievement trends across student subgroups: white/nonwhite; title/non-title; in-person and virtual students, and male/female. Data will be used to inform future instruction to determine how best to offset learning loss in students and identify subgroups affected to a greater degree by learning loss. As a result of the research, the researcher will be able to identify to what extent each subgroup/groups and which goal areas in math were most impacted by school closures. Additionally, information collected will assist in informing the elementary superintendent team for allocation of future resources to address deficit areas.

The following research questions will be addressed:

RQ1. To what extent was student achievement in math for all students enrolled in grades 2-4 impacted during the time of school closures and across the period of interrupted learning based on NWEA MAP Growth midyear assessment data prior to and after widespread school closures caused by the pandemic?

RQ2. Did interrupted learning have a greater impact on math scores of all students enrolled in grades 2-4 based on midyear NWEA MAP Growth assessments prior to and after widespread school closures caused by the pandemic?

RQ3. Did interrupted learning have a greater impact on math scores of white versus non-white students enrolled in grades 2-4 on NWEA MAP Growth midyear assessments prior to and after widespread school closures caused by the pandemic?

RQ4. Did interrupted learning have a greater impact on math scores of Title 1 versus non-Title I students enrolled in grades 2-4 on NWEA MAP Growth midyear assessments prior to and after widespread school closures caused by the pandemic?

RQ5. Did interrupted learning have a greater impact on math scores of male versus female students enrolled in grades 2-4 on NWEA MAP Growth midyear assessments prior to and after widespread school closures caused by the pandemic?

RQ6. Did interrupted learning have a greater impact on math scores of [redacted] students versus the same students in-person on NWEA MAP Growth midyear assessments in 2019-2020, prior to shutdowns, and after widespread school closures caused by the pandemic, mid-year 2020-2021?

RQ7. Which math goal area (number-sense and operations, relationships and algebraic thinking, geometry and measurement, data and statistics) showed the greatest change (positive and negative) at each grade level all students enrolled in grades 2-4 for the sample group studied?

Timeline

.

The researcher will begin assessing data in conjunction with Dr. [redacted] and the office of Assessment and Data Analysis as soon as the research application is approved. Data will be analyzed with cooperation from the Assessment and Data Analysis office as well as Dr. [redacted] research analyst for Baker University Graduate School of Education. Research will commence following the assessment window for midyear assessments for NWEA Map Growth tests in February, 2021.

Research Proposal

NOTE: Approval Letter If you are a doctoral degree candidate or pursuing a master's degree, enclose with your application: (1) a letter of authorization from your major advisor or committee chair; (2) an approval form or letter from your university's human subjects committee, if appropriate.

Please read each of the following statements and place a checkmark in the box indicating that you have read and agreed to each of the statements:

x I understand that acceptance of this request in no way obligates [redacted] Schools to participate in this research. I also understand that approval does not constitute commitment of resources or endorsement of the study or its findings by the school system or by the School Board.

x I understand that participation in this research by students, parents, and school staff is voluntary. I will preserve the anonymity of all participants in all reporting of this study. I will not reveal the identity or include identifiable characteristics of the schools or the school system.

x If approval is granted, I will abide by all the policies and regulations of [redacted] Schools and will conduct the research within the stipulations accompanying any letter of approval.

At the completion of this study, I will provide [redacted] Schools with a copy of the results.

Applicant's Signature: [signature]
Date: 4/19/2021

Advisor's Signature: Denis Yoder
Date: 4/14/2021

PLEASE EMAIL OR FAX ALL REQUESTED TO:
[redacted]

Appendix C: Agreement from Dr. K., Associate Superintendent Academic Services

[redacted]

[redacted]

Associate Superintendent
Academic Services

April 29, 2021

Kerrie Creemer
kerrie.creemer[redacted]

Dear Ms. Kerrie Creemer,

Thank you for submitting your research application: Learning Loss in Mathematics for Elementary Students Grades 2-4 During School Closures and Interrupted Learning Due to Covid-19 Pandemic Based on NWEA Map Growth Data Analysis. It is my privilege to inform you that the [redacted] Instructional Operations Team has read your research proposal and approved your request for [redacted] to participate in your research. Any person who participates will do so voluntarily and they should clearly understand the time commitment associated with this project.

I support this effort and will provide any assistance necessary for the successful implementation of this study. Remember you must maintain the confidentiality of all student and staff information. If you have any questions, please do not hesitate to contact my Administrative Assistant, [redacted], by phone at [redacted] or email [redacted] and she will be happy to address any questions or concerns.

Sincerely,

[redacted]

cc: [redacted]