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The Impact of Virtual Learning Modalities on the Academic Success of Students in One Arkansas School District

Diane F. Richards
Arkansas Tech University

THE IMPACT OF VIRTUAL LEARNING MODALITIES ON THE ACADEMIC SUCCESS OF STUDENTS IN ONE ARKANSAS SCHOOL DISTRICT

By

DIANE F. RICHARDS

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Dedication

I would like to dedicate this to all the students that are told they have learning disabilities. You are an exceptional learner that learns differently than others. The responsibility to figure out how you learn will be on your shoulders and of those who love you. If you have a dream, take one step at a time, but continue to work toward your goal. Educators, family, and friends will give you advice, listen and filter with the understanding that people mean well but don't let them limit your dream. If you don't have a dream, start dreaming.

I was in third grade when my mother was told that I would not be able to complete high school and may not be able to complete elementary school to the sixth grade due to severe dyslexia. I am now completing my fifth college degree. Fortunately for me, my mother experienced ignorance when she went to elementary because she had learning difficulties. She told me about students in the 1950s who were considered disabled if they were left-handed. A student's arm was tied behind their back until the student could learn to write right-handed. Several times she was told that she could not do things she wanted because she did not qualify according to the popular opinion of those in authority. She knew that people put limitations on others that are not necessarily true. She did not allow others to decide for me, she encouraged me to learn and continue my education without reducing my education. The school provided a pullout class for two years that helped me improve my ability to read. After I moved in the fifth grade, the new district decided that they no longer needed to offer services because I was a slow reader, but I could read. I spent many late nights completing assignments, studying, and figuring out how to learn. Several times I was told that I could not do something I wanted,

sometimes I listened to others and sometimes I went for the dream. This is a dream that came true through hard work and dedication.

Acknowledgments

I would like to express my deepest gratitude to those that have helped me accomplish this long-awaited dream. First and foremost, to God for giving me the desire to learn and teach, then equipping and leading me on this educational journey. To all my past teachers and current coworkers that are educators, thank you for sharing your knowledge and inspiring me. To my dissertation committee chair, Dr. John Freeman, thank you for your constant support and willingness to help throughout the dissertation process. I am honored to be completing this process alongside you.

To my mother, for always believing in me and encouraging me to do what others said was not possible. You helped me realize there was nothing I couldn't accomplish. Thank you for your love, patience, and unwavering support to my husband and children. To my son, David, always asking, "When will you finish this dissertation?" never "if" always when.

Abstract

THE IMPACT OF VIRTUAL LEARNING MODALITIES ON THE ACADEMIC SUCCESS OF STUDENTS IN ONE ARKANSAS SCHOOL DISTRICT

Diane F. Richards

The COVID-19 pandemic changed the way Arkansas public schools' offered students an education. While moving through this pandemic, many Arkansas schools implemented optional methods of delivery for their students. Some schools tried to maintain face-to-face classes, while others offered completely online classes. Still, others offered a hybrid format where students attended some face-to-face classes and online classes. One Arkansas school district offered all three options. School districts need guidance as to which teaching methods worked well. The long-term effects of the educational impact of COVID-19 are not known at this time. Schools could benefit from a guide with useful strategies and practices of virtual learning in public schools. The purpose of this quantitative causal-comparative study was to explore any differences between learning delivery options offered by one Arkansas school district in terms of student performance on the state-mandated ACT Aspire assessments and educators' perceptions of educating through a pandemic. The research provided data related to individual student learning gaps in mathematics that may be addressed before these students sit for their eleventh grade ACT Aspire assessments during the 2022-2023 school year. There was some evidence of mathematical learning loss as seen in the frequency change of Math Benchmark Readiness level from seventh to ninth grade, especially in Functions and Algebra for our current tenth-grade students. Educators revealed the difficult year was filled with more responsibilities and learning opportunities for all that were willing to stay the course. The educational system changed to a pandemic education with new rules

and stress which prompted learning in technology for both students and educators. The need for the increased time was seen in lessons, planning, and dividing responsibilities into the time allowed to complete tasks. Mathematical gaps existed when students were absent or not given enough time to adequately learn concepts. Collectively, the research showed that there was not a single concept or category that was lacking, but a wide scope of learning loss that only time and educational effort can reduce.

Keyterms: EDUCATION, HIGH SCHOOL, LEARNING MODALITIES, TEACHER PERCEPTIONS, COVID-19, MATHEMATICS, MIXED METHODS, ACT ASPIRE, ACCOUNTABILITY

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Chapter I: Introduction

For most Americans, the word school suggests classrooms, playgrounds, a cafeteria, and the dreaded principal's office. Brick-and-mortar buildings with their bell schedules, classroom rules, teachers of authority, lunch lines, friendships, and summer break have provided a consistent picture of public education in the United States (U.S.) since the 19th century. Despite consistent efforts to reform education, nothing has changed this basic "factory-model" system of educating children (Tyack & Cuban, 1994).

What if all that changed? Could students still learn well or perhaps even better? The world has changed with the recent COVID-19 pandemic. The 2020-2021 academic year was impacted by this pandemic, as schools throughout the U.S. and the state of Arkansas were forced to close their doors to traditional brick-and-mortar style schooling in March 2020. This drastic change caught both school leaders and policymakers by surprise with the rapid change to online delivery of instruction. It was the only option available to continue educating students.

The limited availability of technology for some students and the lack of training and expertise in online instruction among many teachers were barriers that had to be overcome in short order. Teachers and school leaders are to be commended for keeping the educational system operating under these dire circumstances, but the effects of the pandemic on the academic success of students will only be revealed by future state assessments, for better or worse.

While moving through this pandemic, many Arkansas schools implemented optional methods of delivery for their students. Some schools tried to maintain face-to-

face classes, while others offered completely online classes. Still, others offered a hybrid format where students attended some face-to-face classes and online classes.

One Arkansas school district elected to offer all three of these options. Because this district chose the option of providing three modalities (face-to-face; online; or hybrid), a research opportunity presented itself in the form of asking the question, which instructional delivery modality worked best in determining the academic success of these students? This question was the purpose of this research study.

There is a self-serving political expression, “never let a crisis go to waste.” While no one wished the pandemic on society; nevertheless, it did occur and required the world to reevaluate and rethink our approaches in the delivery of instruction to our students. As a result of the pandemic, there is an opportunity to determine if reform in U.S. education is truly possible. If so, can alternative methods of educational delivery, apart from the traditional brick-and-mortar, factory model of schooling, result in equal or greater success for students. Therefore, we may be looking at a new vision for public education in the U.S. In other words, could COVID-19 be a catalyst for change that could provide insights in improving our educational system for all?

Background of the Problem

In March 2020, COVID-19 arrived suddenly in America and appeared in Arkansas shortly thereafter. The pandemic changed the way Arkansas public schools offered and taught students an education. One might ask, what is COVID-19? According to the American Medical Association:

> Coronavirus disease 2019 (COVID-19) is a disease caused by a new coronavirus, severe acute respiratory syndrome coronavirus two (SARS-CoV-2). Symptoms

> occur on average about five days after exposure to the virus. Almost all patients develop symptoms within 12 days. The most common symptoms are cough, fever, and shortness of breath; most patients with COVID-19 have at least one of these. Other common symptoms include muscle aches, fatigue, nausea, vomiting, and diarrhea. People may also have losses or changes in their sense of taste and smell. The virus typically enters through the eyes, mouth, or nose then travels down the throat, where it may cause a cough. In some patients, the virus enters the lungs and may cause pneumonia. Pneumonia leads to fluid filling the air sacs in the lungs, which makes breathing difficult. Most patients with pneumonia must be hospitalized and treated with oxygen. Some patients become very ill and need life support such as mechanical ventilation. About one in twenty patients with COVID-19 dies. (Wiersinga & Prescott, 2020, para 3)

The sentence "one in twenty patients with COVID-19 dies," proved to be scary. According to the Arkansas Department of Health, over 5,400 people lost their lives in 12 months, and over 325,000 people tested positive for COVID-19 in Arkansas (Arkansas Department of Health, 2021).

The Arkansas Department of Health issued a directive on March 13, 2020, which prohibited visitation to nursing homes, residential care facilities, assisted living facilities, post-acute head injury retraining and residential care facilities, and any other facility that provided long-term medical or personal care (Arkansas Department of Health, 2020a). This was the first of many directives concerning the COVID-19 pandemic. On March 17, 2020, Governor Asa Hutchinson issued Executive Order 20-06, which ordered state agencies to "identify provisions of any regulatory statute, agency order or rule that in any

way prevents, hinders, or delays the agency's ability to render maximum assistance" to Arkansans during the COVID-19 health emergency (Hutchinson, 2020, para 8)

By April 6, 2020, Governor Asa Hutchinson extended the mandatory closure of all Arkansas public schools through the remainder of the 2019-2020 school year. Arkansas educators continued to provide alternative methods of instruction (AMI) for students to continue learning at home (State of Arkansas, 2020a). An Executive Order 20-37 became effective Monday, July 20, 2020, at 12:01 am: The Secretary of Health issued a public health directive requiring every person in Arkansas to wear a face-covering over their mouth and nose (State of Arkansas, 2020b). Directives and governor briefs became very common in 2020.

Schools did not begin fall 2020 the same way they had pre-pandemic. The state of Arkansas required public school districts to provide distance learning. These rules were intended to ensure that distance learning was available to every Arkansas student who wished to participate and improve content while offering different course availability to all students (Division of Elementary and Secondary Education, 2020). In the Distance and Digital Learning Rules memo requirements for future classes, it included that blended learning, online-based, or other technology-based format must be made available and tailored to meet the needs of each participating student. A public school district or open-enrollment public charter school that expelled a student should offer digital learning courses or other alternative educational courses (Division of Elementary and Secondary Education, 2020).

When the 2020-2021 school year began in August 2020, schools scrambled to develop virtual learning platforms for public school students. Unfortunately, there were

no clear directives as to how public high schools were to offer the virtual learning classes. School districts selected a method to begin the school year, and later changed or adjusted these methods after problems and concerns arose.

Problem Statement

There is a lack of research and guidance for public schools on the best practices and methods to provide virtual education to students. This lack of consensus and direction in virtual education was exacerbated by the recent COVID-19 pandemic, which caused school districts to use virtual education as a viable alternative to traditional in-class instruction. It soon became apparent that many teachers were not prepared to engage in online instruction and many schools lacked the adequate technology for this switch in modality. All educational stakeholders would benefit from an understanding of how various learning options affected student academic success, and specifically, how learning gaps in mathematics may be alleviated in Arkansas schools.

Purpose of the Study

The purpose of this quantitative causal-comparative study was to explore any differences in math scores among the three learning delivery modalities offered by one Arkansas school district during the recent COVID-19 pandemic.

The study focused on current 2021-2022 tenth graders by examining their previous ninth-grade mathematics scores on ACT Aspire (pandemic year) and their 2018-2019 seventh-grade math scores on ACT Aspire (baseline year). Not only will this study provide evidence of differences in success according to the instructional delivery modality for the students during the pandemic year, but it will also provide data related to individual student learning gaps in mathematics that may be addressed before these

students sit for their eleventh grade ACT Aspire assessments during the 2022-2023 school year. The independent variable in this study will be the learning options offered by the school district. There were three options students could choose with parental approval. These options were face-to-face, online virtual, or hybrid, which could include one or more changes between the different options. The dependent variable will be tenth graders' ACT Aspire subject scores in mathematics for their seventh and ninth grade school years.

Research Questions/Hypotheses

How does the compulsory implementation of virtual learning impact student academic success during the COVID-19 pandemic? How effective was the virtual learning implemented regarding student academic success? School districts need guidance as to which teaching methods worked well. The long-term effects of the educational impact of COVID-19 are not known at this time.

The following research questions and hypotheses guided this mixed-methods study:

RQ1: Is there a statistically significant difference in ACT Aspire Math scores between three learning delivery options one Arkansas school district offered during the pandemic 2020-21 school year?

H_o1: There is no statistically significant difference in ACT Aspire Math scores between three learning delivery options one Arkansas school district offered during the pandemic 2020-21 school year?

RQ2: Is there a statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning

delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

H_o2: There is no statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

RQ3: Is there a difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year?

H_o3: There is no difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year?

RQ4: Is there is a statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment in the five math categories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

Ho4: There is no statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment test in the five math subcategories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

RQ5: What are the teacher perceptions in one Arkansas school district of the learning gaps identified by the ninth grade ACT Aspire Math results and the math intervention program for current tenth-grade students?

Conceptual Framework - Accountability

According to Creswell (2018), a theory might appear in a research study as an argument, discussion, figure, rationale, or conceptual framework. A theory helps to explain or predict phenomena that occur in the world and education. In the present study, the conceptual framework related to accountability will be the basis to explain the concepts presented in the research study.

Schools must be accountable for successfully teaching the students who attend their school. The use of a standardized test as a measure of accountability is a common practice in the U.S. Bovens (2007) stated that accountability is one of those golden concepts that no one can be against. It is increasingly used in political discourse and policy documents because it conveys an image of transparency and trustworthiness. Society expects schools to be accountable, transparent, and trustworthy. However, evocative powers make it a very elusive concept because it can mean so many different things to various people, as anyone studying accountability will soon discover (Bovens, 2007).

Significance of the Study

There is currently little to no research focused on determining how effective the different types of public virtual school options were in educating Arkansas students. This study will provide insights into both what was done to teach students and which method of learning delivery resulted in better achievement scores.

All educational stakeholders would benefit from understanding the effects of virtual education on student education during a pandemic school year. Schools could benefit from the knowledge of how successful students were after virtual education programs were adopted. The findings from this research study could lead to the future examination of methodologies and the development of professional training to better prepare educators to teach virtual classes in Arkansas public high schools. Students will benefit directly from the identified gaps in learning to improve their mathematical understanding of the material.

The Arkansas Department of Education's Division of Elementary and Secondary Education (DESE) will be able to use the research study findings to make informed recommendations to Arkansas schools about the methods of delivering virtual education to students. In addition, school officials and educators could use this data to make informed decisions about the virtual learning platforms and the indicators of success as tied to ACT Aspire and ACT testing. School boards will be able to determine if the current method used by their schools needs to be reevaluated considering the research findings in this study.

Nature of the Study

This study will be completed as a mixed-methods research design. Both quantitative and qualitative research methods will be used to determine the outcomes of the virtual learning environment of the 2020-2021 school year. The quantitative portion of the research will assist in understanding accountability, actions, and results. The qualitative portion will highlight the process being used throughout the year and the perspectives of those who are charged with accomplishing the process.

Definition of Terms

The definitions of terms used throughout the research study are listed below:

- Achievement Growth: It refers to academic progress made over a period, as measured from the beginning to the end of the defined period. Achievement growth can be tracked and determined for individual students, schools, states, or countries, and a wide variety of variables and methodologies may be used to determine whether "growth" is being achieved (Great Schools Partnership, 2013a).
- ACT: A test to measure a high school student's readiness for college and provide colleges with one common data point that can be used to compare all applicants. It is a multiple-choice, pencil-and-paper test including English, mathematics, reading, science, and an optional essay writing exam administered by ACT, Inc. (TPR Education IP Holdings, LLC., 2021).
- ACT Aspire: It includes assessments for students from grade three through early high school in five subject areas: English, mathematics, reading, science, and writing. The system uses a standard scoring system that measures progress through each grade level and culminates with the ACT® college admissions test (United States Department of Education, 2017).
- Division of Elementary and Secondary Education (DESE): It is a division of the Arkansas Department of Education that provides leadership, support, and service to schools, districts, and communities, so every student graduate is prepared for college, career, and community engagement (Arkansas Department of Education, 2021a).

- Learning Option: There were three learning options offered for mathematics classes: online which is virtual learning all year, face-to-face, in-person all year, or a mixed hybrid where a student changed from online to face-to-face or from face-to-face to online during the school year as documented by each semester.
- Learning Gap: It is the difference between what a student has learned (i.e., the academic progress he or she has made—and what the student was expected to learn at a certain point in his or her education, such as a particular age or grade level) (Great Schools Partnership, 2013a)
- Mathematics Intervention: It is defined as an extension of the regular grade-level course that provides students who need additional focused instruction and support at the needed level of intensity.
- Pass/Fail: A grade of 60% or higher at the end of a semester is considered a passing grade, whereas anything below 60% at the end of a semester is considered a failing grade.
- Professional Development: It is used about a wide variety of specialized training, formal education, or advanced professional learning intended to help administrators, teachers, and other educators improve their professional knowledge, competence, skill, and effectiveness (Great Schools Partnership, 2013b).
- Student Achievement: It is student learning gains evidenced by the state-mandated or standardized assessment scores.

Assumptions

In this study, it is assumed that teachers understood and implemented the Arkansas State Mathematics standards and taught the mathematics content consistently. It is assumed that both the 2019 and 2021 ACT Aspire assessments were reliable and accurate measurements of student knowledge among students. It is also assumed that student effort continued at approximately the same level as previously attempted test years.

Limitations

This study only included students from one grade level that attended one large school district in Arkansas which limited the sample size and generalizability of results. The information found in this study may not be generalizable to all Arkansas schools. Outside factors such as behavior, test-taking abilities, and or technology skills may have affected the outcomes of the assessments, pass/fail rates, and student learning. There are students who either moved into or out of the school district during the three years. These students will be excluded unless all required data was found without overly identifying the student. Finally, the amount of time each student received mathematics instruction cannot be determined due to learning options, quarantines (students and/or teachers), and/or absences.

Delimitations

This study will include the graduating class of 2024 in one Arkansas school district and did not include any other classes or school districts. The summative examination was the ACT Aspire, and no additional or alternate examination scores were used in this study. The archival data was collected from current tenth-grade students who

attended the district and took the ACT Aspire in spring 2019 and spring 2021. The focus was on current tenth-grade students who attended this school during the 2021-2022 school year. A survey was given to available mathematics teachers, instructional facilitators, and mathematics support staff at both the junior and senior high schools within one Arkansas school district. The survey helped determine the perceptions of the 2020-2021 school year and possible learning gaps due to the COVID-19 pandemic.

Chapter Summary

This chapter provided the background of the problem and the purpose of this research study. This chapter continued with discussing the research questions along with the limitations, assumptions, and delimitations of this research study, while also defining the key terms within this study. The conceptual framework was identified in this chapter but will discussed further in Chapter II.

Chapter II: Literature Review

The focus of the literature review included an overview of the study's conceptual framework, along with information on six major concepts: accountability, history of distance and blended learning, teachers, students, learning management with assessment, and COVID-19.

Conceptual Framework

According to Creswell (2018), a theory might appear in a research study as an argument, discussion, figure, rationale, or a conceptual framework, and it helps to explain or predict phenomena that occurs in the world and education. This researcher believed that schools must be accountable for teaching the students who attend their school. Standardized tests are designed to show how accountability is a common practice in the United States. Bovens (2007) stated that accountability is one of those golden concepts that no one can be against. It is increasingly used in political discourse and policy documents because it conveys an image of transparency and trustworthiness. People want their schools to be accountable, transparent, and trustworthy. However, its evocative powers make it also a very elusive concept because it can mean many different things to different people, as anyone studying accountability will soon discover (Bovens, 2007).

Accountability

School-based accountability systems emerged as a standards-based reform that focused on educational outputs rather than inputs of school systems. Each state developed accountability systems designed to create incentives for schools to improve student achievement and growth. The incentive type and strengths do vary from state–to-state with 48 states adopting yearly standardized testing as the measurement tool. States are

allowed to choose the measurement levels to make adequate progress and the consequences of meeting or not meeting the goals (Goertz & Duffy, 2003).

Arkansas approved the Arkansas Educational Support and Accountability Act (AESAA) which stated that all students in grades three through twelve in which statewide assessments are administered, shall take the assessment(s) required for the student's respective grade on the date, or within the testing window established by the Department (Arkansas Department of Education, 2018). The AESAA also regulates the designation of performance levels along with how public schools shall use statewide student assessment data. Schools are to review multiple measures to identify students' strengths and needs for achievement, as well as the academic growth of students in the care of the school district. These multiple measures may include attendance, grades, classwork, demonstration of competency, formative assessment data, teacher observations, interest surveys, or other measures that are used to personalize learning for students. Through the AESAA, both public and charter schools in Arkansas are held accountable for student learning and growth. School Report Cards allow all stakeholders to see a snapshot of how each school district is performing along with the current student achievement levels, which is an average of all students who attend a public or charter school in Arkansas. Additionally, this act laid out the Arkansas Department of Education's steps to help underachieving schools improve student achievement levels (Arkansas Department of Education, 2018).

Arkansas State Board of Education regulations developed from federal and state law mandated testing for public school students in Arkansas. All students are expected to participate in state assessments with approximately 97% of Arkansas students in grades

three through ten completing summative testing in Arkansas each year. The laws and regulations require the administration of criterion-referenced tests (CRTs). Beginning in the 2015-2016 school year, Arkansas began administering ACT Aspire assessments in English, reading, writing, mathematics, and science to students in grades three through ten (Division of Elementary & Secondary Education, 2021).

History

According to an article by Archibald and Worsley (2019), the earliest form of distance learning was developed by Sir Isaac Pitman to teach shorthand. Sir Isaac Pitman developed the course and would deliver it to colleges, family members, and colleagues. In May 1840, the British postal service changed the pricing and delivery methods, which allowed for less expensive and faster delivery of correspondence and letters. Sir Isaac Pitman decided the new mail system was affordable enough to circulate his 10-lesson shorthand methods to more teachers and families. Pitman's operation began as letter writing and training through letters. Pitman began simply by responding to each letter until he was able to purchase printing equipment.

The operation expanded to 10,000 letters a year by 1845. To keep up with the demand, the Pitman's Correspondence Society was formed with over 1,000 members. The society was responsible for mailing letters and lessons across the country. The University of London was using the distance learning shorthand program to teach students through the mail to complete a requirement in some of the degree programs they offered beginning in 1858.

Lessons continued as letter writings allowed for the student-teacher relationships to develop and demonstrated bonds could form through distance learning. Students

received certificates that secretaries would list on resumes. This shorthand program eventually arrived in the United States through students and the Pitman's Correspondence Society. Despite the changes of time and technology, the heart of Pitman's Correspondence Society can still be seen in modern distance education (Archibald & Worsley, 2019).

After the development of distance learning came the concept of blended learning. The researcher at the National Institute of Education discussed the positive and negative aspects of blended learning approaches. The research proved that the development of blended programs with pedagogical approaches engaged learners. Previous distance learning was based on a lecture or reading material with tutoring. The National Institute explained the differences between lecture-style learning versus a blended learning delivery of online education. The newer technology access improved instruction by allowing a combination of face-to-face instruction and online instruction. In theory, the blend allowed for a student to learn a new concept with time to apply and/or practice before rushing to the next concept. This study found that computer-supported collaborative learning should not try to replicate face-to-face interaction using online teaching technology. The face-to-face component of education was reduced dramatically for many Arkansas students during the 2020-2021 school year. The development of learning relationships is important in supporting students' learning and growth. The communication of critical discourse could be lost without face-to-face interaction resulting in less comprehension and more frustration (So & Bonk, 2010).

Teachers

According to research in the Journal of Science Education and Technology, the professional development of teachers could be completed through online methods. There were few perceived differences between the success of meetings being held face-to-face or online. The positive factors for teachers attending meetings online were they saved time, no travel expenses, and were more accessible. Some negative aspects of meetings being held online were learning the software and tools. This created some difficulties and distractions for adult teachers during the first meeting. Some suggestions were made to improve the instruction as some teachers needed training with the software and interface, which would be helpful as they began learning online. Indications from this study suggested, if students are required to learn new programs during the beginning of a new school year, they should be given the proper time to learn and adjust to this new learning environment. Time allotment for teachers and students to learn new programs should be considered before public schools offered virtual learning options. The research showed that adults on average took 20-30 minutes learning features of one format with a facilitator assisting. The study also assumed students would require more time and training to become proficient in online meeting software and interfacing to be successful in their online courses (McConnell et al., 2013).

Another problem facing students who take online classes is the lack of training provided to teachers who are teaching online classes. The researchers who wrote the article *Learning to Teach Online* found that universities with large enrollments are not consistent inadequately preparing teachers who teach online classes (Lowenthal et al., 2019). The researchers indicated that many faculty members lack and/or need additional

training and support to develop and design their online classes. Traditional face-to-face classes do not require the same set of skills and preparation as online teaching. Each type of delivery involves different technologies, instructional strategies, communication processes, and organizational structures. The study also found there is little literature on how institutions train and develop faculty to teach online (Lowenthal et al., 2019). Training programs need to be developed that empower teachers to teach and assist students in learning new concepts through online programs. If the educators are not prepared and have not been trained properly, proper instruction to students is challenging. The key to successful online teaching is the development of training programs including technology classes offered to teachers before they are required to teach online classes (Lowenthal et al., 2019).

Another important consideration are the students with disabilities who also struggle with learning online. Students with disabilities are referred to as exceptional learners as well as those who are gifted and talented. Exceptional students are those who fall outside of the normal range of development (Columbia College, 2022). Coy (2014) explained exceptional students from various backgrounds and learning abilities can learn online with the proper support. Communication is the number one priority to successfully educate these exceptional students. Good communication skills and time to communicate are important to ensure the success of students in online classes. A learning coach is important for students, especially students with disabilities. A learning coach can be a parent, tutor, or another adult who can help students learn and advise the teacher of any difficulties the student may be facing in mastering the subject matter. For example, a teacher can schedule and assign time for communication with families during the

workday to discuss these student situations. Unfortunately, the time to communicate with families or learning coaches is something that is not always available for teachers (Coy, 2014).

The researchers studied the psychological ownership effects of cloud-based virtual learning environments on teachers. It is noted that time hinders teachers from learning how to use new cloud-based programs and platforms. The Malaysian government promoted a cloud-based learning environment to teachers six years before this study was completed in 2019. It was found that teachers averaged only three years of knowledge and use of the programs in the study (Yim et al., 2019). Teachers primarily received training in a top-down approach from personnel who received initial training through seminars. The pieces of training were organized by respective states and school districts. The Technology Acceptance Model (TAM) key components are beliefs about the utility and functional aspects of technology. Teacher decisions in technology implementations are affected by the teachers' perceived usefulness (PU) and perceived ease of use (PEU). Additionally, it is noted that this research study used an excessive number of abbreviations. These abbreviations may be very common, but they made it more difficult to read and understand the information found within the study (Yim et al., 2019).

Students

Student learning identities in a virtual classroom should be considered when designing and implementing virtual learning classrooms. Students may learn a ritualized way of learning, while others were engaged in substantial learning. This is true in face-to-face classrooms, but students have more opportunities to develop substantial learning if

scrutinized and synchronized learning is offered (Daher & Awawdeh Shahbari, 2020). Limited opportunities for interaction with the instructor could lead to negative effects on students' identities and learning in the virtual classroom could impact their attitudes and emotions towards learning. Virtual classrooms encourage independent learning, but there is a need for more interaction options to be present in the classroom. This is true for virtual classes and classes that convert to virtual as part of emergency education, such as those due to the COVID-19 pandemic (Daher & Awawdeh Shahbari, 2020).

The teacher-to-student ratio should be considered when students are virtual or online only. In Borup and Stevens's (2017) study, the teachers were given four hours a day to communicate with students and families and four hours a day to design, perform tasks, and grade assignments. These teachers were also assigned 20 students to mentor throughout the school year (Borup & Stevens, 2017). As a mentor, they developed relationships with the students and assisted them in focusing on tasks to improve their grades and communication with other teachers. As a mentor, the teacher would check in with each student to encourage and assist them to be successful online. This limited number of students allowed each teacher more time to ensure student success. The teacher still met with the students they taught, but the focus of those meetings was educational, according to the course. Students felt more valued when the praise and encouragement came from their teachers in the form of parent calls or performance praise on classroom sites. Additionally, students were rewarded with a reduction of assignments or quizzes if they completed work early and accurately (Borup & Stevens, 2017).

Alqurashi (2019) predicted that student satisfaction and perceived learning were more likely to have high student satisfaction rates if students found that online course

materials helped them to understand the class content, stimulated their interest in the course, helped relate their personal experience to new knowledge, and were easy to find and access. This study focused on college students who took at least one online course. A similar type of study could be completed to determine high school student satisfaction with online courses. The heart of the study strongly implied that satisfaction with online courses was higher when students understood what was required of them and when it was required (Alqurashi, 2019).

When schools shut down due to the COVID-19 pandemic, parents and caregivers were needed to step in and assist with student learning. When school policies provided students access to technology, such as laptop or tablet loaner programs with Wi-Fi, it allowed students to work from home without seeking public Wi-Fi access. The ability to stay at home provided more time for parents to work with their children and the technology enabled students to be more productive. When schooling was offered online-only or online with paper options, children were about 40% more likely to have worked on their own in the past week if a parent had worked with them, and 49–50% more likely to have worked on their own if both a parent and a teacher had worked with them. In contrast, teacher hours without parent hours increased the probability of children working on their own by 29.8% if their schooling was online-only, or 8.3% if it combined online and paper options. These percentages were compared to the likeliness of student learning in the situation where the school was entirely canceled (Bansak & Starr, 2021).

Management

One study surveyed online and blended learning teachers during the first year of a learning management systems (LMS) implementation process in Arizona. The school districts selected in this study adopted the use of LMSs before this study was conducted. This study only included volunteer responders which may have limited the generalizability of this study. The researchers concluded that training and continued support are needed to help teachers develop a comfort level with LMS (Lochner et al.., 2015). A minimum of one to two days was required for training on LMSs before teachers could begin to use the LMS chosen by the district. The training options available to teachers and other stakeholders were important in allowing teachers to answer questions that arose from students and parents. Teachers were also advised on how to adequately train students to use and access information at both school and home. The research study findings determined that two weeks of training time allowed teachers to be successful with integrating new technology into the classroom. The weeks included one week focused on teacher training and one additional week dedicated to after teachers began using the technology in their classrooms. The time spent in training made a better transition during the first year of implementation of the LMSs (Lochner et al., 2015).

As with several other states during the COVID-19 pandemic school year, all teachers in Arkansas were required to use a LMS. Teachers were familiar with Google classroom as they were required to use it for notes and technology integration before the COVID-19 pandemic, but they were informed that the technology platform would be changing to Schoology at the beginning of the pandemic. This information was provided to teachers during the back-to-school teacher training the week before school began in

August 2020. The district was unable to train teachers about Schoology or any related LMS before the 2020-2021 school year. The training in the researcher's school district was shorter than one day and lasted approximately four hours. Several teachers requested to use Google classroom for management purposes as they were more familiar with that platform. After much consideration, this school district restricted Google classroom use since the security and access were limited for management purposes. The new LMS requirements added learning aspects to each teachers' additional responsibilities and overall stress within the district. As the year progressed, the requirements changed and adjusted to better serve students, while changing and increasing the expectations of educators.

A major concern for educators was managing student learning during this transitional time of virtual learning. A study focused on the learning outcomes and academic dishonesty indicated that the learning outcomes were similar for both face-to-face students and online distance learning students. The proper support was key in achieving the desired learning outcome of students (Lucky et al., 2019). This study suggested that teacher relationships were key in improving student engagement and learning. If the teacher-student relationship did not develop, students tended to cheat more often without concern about academic dishonesty. Academic dishonesty, also known as cheating, was found to be significantly higher among distance learners than face-to-face students. Although this study was conducted with college students, cheating at all levels is concerning for all educators (Lucky et al., 2019). A study focused on the different types of relationships teachers and students share in online/distance learning environments could shed light on a student's willingness to cheat. The researchers

suggested that academically dishonest consequences will need to be studied to determine effective methods of deterring future cheating (Lucky et al., 2019). It would be informative for teachers, students, administrators, and all major educational stakeholders to better understand the academic learning gaps developing through students cheating themselves out of an education. A campaign to educate students of the consequences and implications of unethical decisions would be advisable, especially in the virtual or non-face-to-face learning environment (Lucky et al., 2019).

The research on online proctoring, test anxiety, and student performance indicated that students with test anxiety perform at lower levels when a web-cam proctor is used during online exams (Woldeab & Brothen, 2019). Webcam proctoring is a management tool that colleges have used to prevent cheating for their online students. Educators should consider how this approach might increase student anxiety during exams and result in possibly lower grades than if the student was in a face-to-face classroom setting. As teachers and educators, we need to eliminate the effects of environmental influences when grading students' ability to learn information. This research was done with college students and should be repeated with high school students. There are teacher control programs that allow teachers to see what students have opened on their computers during testing (Woldeab & Brothen, 2019). These types of monitoring programs can be used during a window of time, but should not be used as 24-hour monitoring of a student's computer. When new programs become available to assist in preventing academic dishonesty, other factors of cheating will need to be researched before adopting a specific program (Woldeab & Brothen, 2019).

COVID-19

The research focused on the Coronavirus-induced transition to online learning provides some insight into how students transitioned during the 2020-2021 school year. These students did not have prior experience with online courses and the transition from face-to-face to distance learning was involuntary. As with many districts across the United States, schools shut their brick-and-mortar school and were only able to offer a version of online distance learning to their students. Most teachers were not prepared to teach online and required to begin teaching with very little understanding of the difficulties students would face trying to learn the material. Many students expected their free time to increase through distance learning, but found the workload and time required for online classes decreased their schedule flexibility. Regrettably, for most students, learning seemed to take more time, not less with online learning. Many students turned to outside sources to learn the information such as YouTube, Google, or they simply gave up and failed their classes. Students were forced to learn time management skills and responsible for scheduling adequate time to complete their work. The online learning process was new to all students in this survey (Brain, 2020). Students commented that the face-to-face structure motivated them to complete their assignments as compared to learning online. The lack of student-teacher relationships made students more reluctant to reach out to teachers when they were struggling to learn the material. Students believed there was more work when learning online versus how they perceived the amount of work during their in-person classes (Brain, 2020).

During the time of COVID-19, the research article *Attempts, Successes, and Failures of Distance Learning* brought out several points about the transition to online

learning during the 2020-2021 school year (Dietrich et al., 2020). The study was more of a historical account of what teachers did and how students responded in completing the spring 2020 semester. This study had many parallels to what the researcher experienced during the fall 2020 semester, and currently experiencing as a teacher. The rapid movement to online learning created a fast and necessary redesign of the educational system for all students and educators. In the case of COVID-19, educators and students were required to stay at home when many cities-imposed lockdowns; thus, inducing inequalities for both students and educators. Students did not choose online learning as it was forced upon them as they were quarantining in their own homes. Therefore, these students who were forced to transition to online learning may not have been as motivated as the students who chose distance learning. Unfortunately, many families did not have the adequate technology or internet connections in their homes for online learning. Some families did not have a computer for each child; therefore, it required sharing limited access to class meetings and video lessons. Educators were given a little more than a laptop to work from home with little to no training on how to teach students online. Educators were required to develop new ways to deliver curriculum to students who may or may not have access to computers or the internet with different and/or recently acquired technologies. Educators realized they had more to learn about technology and distance learning in a couple of months rather than years. The constant commitment and dedication of educators and families led to a better understanding of the students' learning needs during this pandemic crisis. The future of hybrid education would need to include a better understanding of students' mental well-being along with the consideration of adequate teacher training (Dietrich et al., 2020).

Chapter Summary

This chapter reviewed the conceptual framework and an understanding of the accountability of this research study. The history of distance learning has evolved from letters in the mail to the current online format we have incorporated into the classroom today. This chapter considered the educational stakeholders, specifically teachers (educators) and the students' experiences in education during the COVID-19 crisis. During the 2020-2021 school year, many concerns were raised including teacher training, technology, learning management systems, and academic dishonesty during the COVID-19 crisis in education.

Chapter III: Methodology

This chapter outlines the methodology used in the research study, including the participants, sampling style, procedures, and data analyses. The purpose of this mixed-method study was to explore the relationship between learning options, mathematics grades, and the ACT Aspire scores of ninth-grade students in one Arkansas school district during the COVID-19 pandemic school year (2020-2021). This study attempted to identify the learning gaps in mathematics education for current tenth-grade students who were ninth-graders in one Arkansas public school during the 2020-2021 school year.

This study collected both quantitative (test scores) and qualitative (survey and follow-up interviews) data to explore the relationships between test scores from state-mandated testing and mathematics curriculum teaching delivery methods during the affected school year by one Arkansas school district. The test scores were from the ACT Aspire testing years in 2019 and 2021. Specifically, this study used the individual student mathematics composite scores for both testing years, along with the sub-scores of the 2021 ACT Aspire test in the five mathematic categories and three mathematical practices: number and quantity, functions, algebra, geometry, statistics and probability, foundation, justification and explanation, and modeling. These test scores were archival data from students who were in the district taking the ACT Aspire assessment in both the seventh and ninth grades. The survey was sent to mathematic teachers, mathematic support staff, and mathematic instructional facilitators in this one school district. After the test scores and survey results were reviewed, four follow-up interviews were conducted with survey respondents who indicated a willingness to participate in this part of the data collection process. It was a goal that the interviews were conducted with one mathematics

instructional facilitator, one special education mathematics support teacher, and two current tenth-grade mathematics teachers to determine their perspectives of mathematics education during and after the 2020-2021 school year.

Research Design

This research study utilized a mixed-methods design based on the assumption that collecting quantitative and qualitative data would provide a more complete understanding of the research problem investigated in this study (Creswell, 2018). This study used the convergent-parallel approach. The convergent-parallel approach is sometimes referred to as concurrent triangulation design, which is a concurrent approach and involves the simultaneous collection of qualitative and quantitative data (both QUAL and QUAN are the emphasis), followed by the combination and comparisons of these multiple data sources (Edmonds & Kennedy, 2013).

> The parallel-databases design is structured so the QUAN and QUAL data are collected separately but at the same time. The analyses of data are also analyzed concurrently. The results are then converged by comparing the data to one overall interpretive framework. This design allows researchers to validate data by converging the QUAN results with the QUAL findings. (Edmonds & Kennedy, 2013, p. 150)

According to Patton (2015), triangulation is ideal in employing multiple methods, measures, and perspectives. Triangulation can be defined as a process of combining different data sources or methods to strengthen a study of a particular social phenomenon. The two types used in this study were data and methodological triangulation. Data triangulation is the use of multiple data sources to make conclusions, while

methodological triangulation is the use of multiple methods in the study. Triangulation has proved to strengthen the credibility of the evidence for reviewing and corroborating findings in surveys and assessments (Patton, 2015).

The purpose of the study was to determine what, if any approach to delivering the education to students resulted in statistically different test scores, and if there were any that resulted in mathematical learning gaps. This study collected both test scores (ACT Aspire) and survey data to examine the relationships between the state-mandated ACT Aspire scores and the teaching-delivery methods used to deliver mathematics curriculum during the COVID-19 pandemic used by one school district in Arkansas.

The quantitative phase utilized a causal-comparative research method to examine the relationships between past and current ACT Aspire scores of one Arkansas school district's current tenth-grade students. Causal comparative is a form of non-experimental research called *ex post facto* (after the fact) (Edmonds & Kennedy, 2013). The researcher used individual student testing score data from spring 2019 and spring 2021 to compare the composite score differences in testing scores before and after the pandemic for current tenth-grade students during the 2020-2021 school year. The ACT Aspire has four categories for ACT Readiness Benchmarks which allows students to know if they are on target for college readiness as determined by the student's predicted test score on the future ACT including the need for support, close, ready, and exceeding. The overall percentages of each benchmark score were compared from the district's scores when students were seventh graders in 2019 to the district scores when students were ninth graders in 2021 to see if the readiness levels decreased from before the pandemic to after the pandemic school year. Additionally, the researcher compared the 2021 ACT Aspire

sub-scores in the five mathematical categories and three mathematical practices of the district's current tenth-grade students to see if any sub-score mean was significantly lower, which indicated any learning gaps for the current ten graders. The researcher believed the test scores would be lower across the state of Arkansas due to the pandemic. It was unclear how much or to what extent the scores would or would not fall. This study attempted to compare the differences in the data and determine if the change revealed learning gaps or areas of concern. This study also compared the mathematics class passing rate to the type of learning option, online versus face-to-face versus hybrid for the students in the ninth grade during the 2020-2021 school year.

The qualitative portion utilized an email survey to gather information about mathematics teachers, mathematics support staff, and mathematics instructional facilitators' perceptions of the 2020-2021 school year and the learning gaps among current mathematic students. Surveys were utilized to observe trends, attitudes, or opinions of the population of interest. Although multiple participants were selected to discover the relative incidence, distribution, and interrelations of educational, sociological, behavioral, or psychological variables, this survey was restricted to mathematics teachers, mathematics support staff, and mathematics instructional facilitators in one Arkansas school district (Edmonds & Kennedy, 2013). The researcher surveyed participants from two schools including the junior high which educates eighth through ninth-grade students and the high school which educates tenth through twelfth-grade students. Data collection concluded with four follow-up interviews conducted with survey respondents who indicated a willingness to participate. It was desired that the interviews be conducted with one mathematics instructional facilitator, one special

education mathematics support teacher, and two current tenth-grade mathematics teachers to determine their perspectives of mathematics education during and after the 2020-2021 school year. The interviews completed the triangulation of research information.

Research Questions/Hypotheses

The following research questions will be explored in this study:

RQ1: Is there a statistically significant difference in ACT Aspire Math scores between three learning delivery options one Arkansas school district offered during the pandemic 2020-21 school year?

H_o1: There is no statistically significant difference in ACT Aspire Math scores between three learning delivery options one Arkansas school district offered during the pandemic 2020-21 school year?

RQ2: Is there a statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

H_o2: There is no statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

RQ3: Is there a difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year?

H_o3: There is no difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year?

RQ4: Is there is a statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment in the five math categories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

Ho4: There is no statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment test in the five math subcategories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

RQ5: What are the teacher perceptions in one Arkansas school district of the learning gaps identified by the ninth grade ACT Aspire Math results and the math intervention program for current tenth-grade students?

Population and Sample Selection

The setting for this study was a county with over 100,000 residents whose median annual income is $50,000. According to the most recent census, approximately 90% of households have at least one computer and 80% of households have a broadband subscription for internet services (United States Census Bureau, 2020). The school district is responsible for educating approximately 10,000 students from Pre-Kindergarten to twelfth grade. The demographics for the county are approximately 50%

White/Caucasian, 30% Black/African American, and 20% all other or mixed races. Less than 10% of the student body are English learners (English is not the primary home language), and less than 15% of the student body qualifies for special education services (Arkansas Department of Education, 2021a)

The student population for this study was the school's current tenth graders who were ninth-grade students during the 2020-2021 school year and completed both the 2019 and 2021 ACT Aspire Math assessments administered by the participating school district. The test results came from the *Arkansas Department of Education My School Info* school report card data and the administrators of the Arkansas school district where the students of this study attend school. This study used a convenience sampling of archival data to compare the cumulative and sub-scores of the mathematics portions of the ACT Aspire test to the composite mathematics scores of these current tenth graders from their seventh and ninth-grade test scores. The individual scores were used to determine if students improved, stayed about the same, or lowered their overall understanding of mathematics. Sub-scores were analyzed to determine if any learning gaps appeared in the data. The individual student sub-scores of the 2021 ACT Aspire test in the five mathematical categories number and quantity, functions, algebra, geometry, and statistics and probability were analyzed to determine if one or more scores were significantly lower, which would indicate a possible learning gap for the tenth-grade student body. The overall three sub-scores of students' mathematical practices foundation, justification, and explanation and modeling were ranked from lowest to highest from the district results of the ACT Aspire 2021. When applying restrictions, only tenth-grade students from this one Arkansas school district were the focus of this study. Any tenth-grade students who

did not take the ACT Aspire during their seventh and ninth-grade years were excluded from the study. The results of this study were informative to similar public and charter schools in Arkansas, which offered the same learning options since all tenth-grade students shared the same testing pattern used in this study.

The educator population was a convenience sampling of mathematic teachers, mathematic support staff, and mathematic instructional facilitators from the participating school district who voluntarily completed an emailed survey. Survey participants were employed at one of two schools within the school district including the junior high which educates eighth through ninth grade and the high school which educates tenth through twelfth grade. The focus of the survey was the perceptions of the 2020-2021 school year and the perceptions of possible learning loss that were observed or determined by survey participants. Data collection concluded with four follow-up interviews conducted with survey respondents who indicated a willingness to participate in the research study. It was desired that the interviews were conducted with one mathematics instructional facilitator, one special education mathematics support teacher, and two current tenth-grade mathematics teachers to share their perspectives of mathematics education during and after the 2020-2021 school year, and what possible learning gaps/loss were experienced by current tenth-grade students within the school district.

Instrumentation and Sources of Data

The independent variables in this study were the learning options offered by the school district. The learning options were face-to-face, online, or hybrid which included students changing between the different options throughout the school year. The dependent variables for current tenth graders were the 2019 and 2021 ACT Aspire exam

subject scores in mathematics for their seventh and ninth grade school years. The individual student data from spring 2019 and spring 2021 testing scores were used to compare the composite score differences before and after the pandemic for current tenth-grade students during the 2020-2021 school year. The overall percentages of each benchmark score were compared from the district's scores from 2019 with the then seventh-graders to the district scores from 2021 with the then ninth graders to see if the readiness levels decreased from before the pandemic to after the pandemic school year. This study compared the 2021 ACT Aspire sub-scores in the five mathematical categories and three mathematical practices of the district's current tenth-grade students to see if any sub-score mean was significantly lower and showed any learning gaps for the current ten graders.

The ACT Aspire end-of-year summative assessment was used to assess all Arkansas public school students in grades three through twelfth grade unless they qualified for an alternate assessment. Each student participated in English, reading, writing, mathematics, and science tests (State of Arkansas, 2021a).

ACT Aspire Fast Facts adopted from the ACT website (ACT Inc, 2021):

- Vertically articulated, a standards-based system of summative assessments
- Aligned to ACT College Readiness Benchmarks and Common Core State Standards
- Anchored by the capstone college readiness assessment, the ACT
- Multiple question types: constructed response, selected response, and technology-enhanced
- subject areas: English, math, reading, science, and writing for grades 3–10

- Online delivery of assessments with traditional paper-and-pencil option
- Accurately predicts students' future scores on Aspire Summative and the ACT
- Periodic testing administration offered.

The ACT Aspire has four performance-level descriptors which include in need of support, close, proficient, and exceeding. The cut score for the proficient level is based on the ACT Readiness Benchmark at that grade level (ACT, Inc., 2019). If the student's score falls well below the benchmark of the readiness score, they are considered "in need of support." If the score falls below but close to the readiness mean score the student is "close" to being ready for the next level of education. If on or slightly above the readiness score the student is considered "ready" for the next level. If the readiness score is above the ready benchmark score, the student is "exceeding" the expectations of students in their grade level (ACT, Inc., 2019).

Performance level descriptors (PLD) outline the knowledge, skills, and practices that students perform at any given level and what they achieve in each content area at each grade level. PLD indicates if the students are academically prepared to engage successfully in further studies in each content area, the next grade's material, and eventually at the high school level to prove that they are college and career ready (State of Arkansas, 2021a).

The mathematics assessment subject scale score or composite score is the sum of the skill scores from each subcategory assessed using the ACT Aspire exam. The skill scores for seventh and ninth grade included grade-level progress, foundation (sometimes referred to as integrating essential skills), justification and explanation, and modeling.

These scores are a snapshot of how the individual student progressed in their math education.

The researcher gathered basic information about the educational options students were given, the passing rates of mathematics classes of individual students paired with their ACT Aspire results, and the percentages of students opting to participate in online virtual learning, face-to-face, and hybrid learning during the 2020-2021 school year. The researcher requested information from one school district's current tenth-grade student body. As the research was conducted, the researcher requested any available information that would help increase the informational understanding of how the 2020-2021 school year proceeded during the COVID-19 pandemic. A survey asked teachers about the perceptions and observations of learning loss among current tenth-grade students. A follow-up interview was conducted to enhance the understanding of perceptions with four survey participants.

Data Collection

Archival data was accessed after spring 2019 and spring 2021 with testing information being released on the Arkansas Department of Education website and to each school district in Arkansas. The researcher collected data from one Arkansas school district which tested current tenth graders during two testing years in both 2019 and 2021.

The researcher sent a request to the Arkansas district asking for assistance in collecting data from the 2020-2021 school year. The researcher requested testing results from 2019 and 2021 for the current tenth-grade class (class of 2024), along with the pass/fail results of the mathematics classes of current tenth grades during their ninth grade 2020-2021 school year. Data collected included the types of educational delivery

options given to students, percentages of students participating in virtual options, the success rate of those students, decisions to continue or discontinue virtual options, how virtual options were carried out, and documentation distributed to parents/stakeholders about choices and options for students during the 2020-2021 school year.

The data and identities of students and faculty were well protected during and after this study. The Arkansas Tech University Institutional Review Board approved the methods and data collection procedures before the research data was collected. Permission to use student data was requested and approved by the superintendent of the one Arkansas district used in this study. Numerical codes were used to represent students and no student names were used in this study. The researcher received coded data without student names. All data collected from students, the survey, and interviews were secured in a locked file cabinet by the researcher.

Data Analysis Procedures

Statistical Package for the Social Sciences (SPSS) software was used to conduct all data testing for this study. The ACT Aspire scores were analyzed to determine descriptive statistics, such as frequencies, means, and standard deviations for each year. To answer each research question, specific statistical analyses were applied to the data, such as dependent *t*-tests, independent *t*-tests, and Analysis of Variance (ANOVA) tests.

RQ1 sought to determine if there was a statistically significant difference between the ACT Aspire Mathematics scores among the three learning options offered by the participating school district (face-to-face; online; hybrid). The 2021 assessment data was coded by learning option, followed by computing the means and standard deviations for each option. To determine if there was a statistically significant difference, the researcher

ran an ANOVA test, which identified whether there was a difference among the learning options. A Scheffe post hoc test was run to determine which combination of options had a statistically significant difference. The results determine if the null hypothesis would be rejected or failed to be rejected.

RQ2 sought to categorize the ACT Aspire data by the learning delivery option for each ninth-grade student in 2020-2021 who is now in the tenth grade. In each category, the ACT Aspire Mathematics scores from when they were in seventh grade were analyzed with their ninth-grade scores to determine if the students improved or declined in their academic mathematics performance. A dependent *t*-test was run to determine if the ninth-grade mean scores were statistically different from their seventh-grade scores. This analysis determined whether the null hypothesis was rejected or failed to be rejected.

RQ3 sought to determine if there was a statistically significant difference in the passing rates for mathematics classes and the three learning delivery options offered by the school district during the 2020-2021 school year. A frequency of course grades was compiled and labeled passing and non-passing for students in each of the three categories. Chi-Square analysis was run to determine if there was a difference in the frequencies of those passing the course among the three learning categories. This determined if the null hypothesis was rejected or failed to be rejected.

RQ4 sought to determine if there was a statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Mathematics assessment in the five mathematic categories (number and quantity, functions, algebra, geometry, statistics, and probability) and between the three learning delivery options offered by one Arkansas school district during the pandemic 2020-2021 school year. To determine if there was a

statistically significant difference, the researcher ran an ANOVA which identified whether there was a difference among the three learning delivery options. This analysis determined whether the null hypothesis was rejected or failed to be rejected.

RQ5 is a qualitative question that sought to collect survey and interview data to determine the perceptions of various educational stakeholders who are privy to mathematics instruction in the school district. These perceptions helped to explain any achievement gaps in the mathematical data that can be used to better prepare students for upcoming assessments. In addition, the perceptions of these stakeholders helped to describe the effects of the pandemic on their teaching in these learning delivery options, and how they perceived the student responses to these options.

The survey was analyzed for teachers' perceptions of the 2020-2021 school year including teacher demographics, access to technology, and perceived learning loss or gaps in mathematical understanding. The interview asked open-ended questions about the procedures and elements of the curriculum delivery of the 2020-2021 school year. The researcher reviewed the data for trends and methods used by high schools during the pandemic.

Interview Instrument

Each interview was conducted using a Sony PX370 recorder and transcribed into a word document. The transcription was transcribed through a paid transcription service called TEMI. The researcher utilized the following open-ended, systemized, interview format, and the prepared questions are as follows:

1. During the pandemic 20-21 school year, are there any procedures or elements of the curriculum delivery that you felt stood out to you as either beneficial or difficult to do?
2. In the survey that I gave to teachers, they indicated that they were required to learn between three and five new technologies. What did you think about the technologies that teachers and students were required to learn?
3. At the start of this school year, did you think it was going to be any different when we first began?
4. Do you believe families still had the same concerns stemming from the pandemic this year as last?
5. Would you say that at the beginning of the year there was a change in the normal level of math abilities as compared with prior years?
6. Now that we are ending the mask mandates, contact tracing, and quarantining of A-symptomatic students and staff, do you believe things will improve?
7. The survey showed that teachers perceived that there is some learning loss across math skills. Do you believe the programs we have put in place are helping to reduce learning loss?
8. Is there better programs or ways to improve math skills?
9. If you could say just a few words about teaching during the pandemic and current year, what would they be?
10. Do you see any inspiring moments going forward?

Chapter IV: Data Analysis and Results

The purpose of this quantitative causal-comparative study was to explore any differences between learning delivery options offered by one Arkansas school district in terms of student performance on the state-mandated ACT Aspire assessments. The researcher investigated how various learning options affected student learning; specifically, what learning gaps in mathematics do schools in Arkansas need to address in continuing the successful education of students. The following research questions and hypotheses analyzed in this mixed-methods study were:

RQ1: Is there a statistically significant difference in ACT Aspire Math scores between three learning delivery options one Arkansas school district offered during the pandemic 2020-21 school year?

H_o1: There is no statistically significant difference in ACT Aspire Math scores between three learning delivery options one Arkansas school district offered during the pandemic 2020-21 school year?

RQ2: Is there a statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

H_o2: There is no statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

RQ3: Is there a difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year?

H_o3: There is no difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year?

RQ4: Is there is a statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment in the five math categories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

Ho4: There is no statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment test in the five math subcategories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

RQ5: What are the teacher perceptions in one Arkansas school district of the learning gaps identified by the ninth grade ACT Aspire Math results and the math intervention program for current tenth-grade students?

This chapter is divided into four sections. The first section, Descriptive Findings, provides a summary of sample characteristics and demographics of the participants in this study. The second section, Quantitative Data, is an explanation of the quantitative data and helping answer the first four research questions and analyses of the four hypotheses.

The third section, Qualitative Data, is an explanation of the qualitative data and helping answer research question number five by analyzing the survey and interview responses. The fourth sections, Chapter Summary, summarizes the results of this study.

Descriptive Findings

The sample population for this research study was one Arkansas school district's class of 2024. The class of 2024 had 695 students classified as tenth graders with ACT Aspire scores for the 2021 spring test in this district. The researcher removed district students from the sample who did not have ACT Aspire test scores from both spring 2019 and spring 2021. The sample consisted of 539 students who took the ACT Aspire examination in both seventh and ninth grades at the same public school district. The student sample was comprised of 264 females (49%) and 275 males (51%) of the research population. Student learning modalities of the group included 303 - Face-to-Face (56%), 91 - Online (17%), and 135 - Hybrid (27%).

The sample population for the surveys and interviews came from two different schools within the school district. The junior high includes both eighth- and ninth-grade students and the high school includes tenth- through twelfth-grade students. The survey was sent to 26 mathematic teachers, mathematic support staff, and mathematic instructional facilitators with 13 individuals responding (50%). The thirteen individuals who responded to the survey consisted of ten mathematic teachers, one mathematic support staff, and two special education teachers. The respondents consisted of educators with varied years [zero to twenty or more years] of professional experience. The twenty or more years as an educator was the mode with six of the thirteen respondents falling in that range. Initially, requests were sent through emails asking for interview volunteers,

which was followed up by in-person requests from the researcher. The six who agreed to be interviewed were comprised of three high school mathematics teachers, one special education teacher, one mathematics supervisor, and one assistant principal. Interviewees number one, two, and four are high school math teachers. Interviewee number three is a high school special education math teacher with a classroom and roster as a stand-alone teacher. Interviewee number five is an assistant principal for the high school that supervises some of the math teachers. Interviewee number six has a math teacher background that is supervising much of the math department among other things. All these individuals were employed in a position at the high school during and after the start of the pandemic. The interviewees consisted of four females (67%) and two males (33%) who have been employed for more than three years in their current district position.

Quantitative Data Analysis

Research question number one (RQ1) was: *Is there a statistically significant difference in ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year*? The null hypotheses were accepted as shown in Table 1. There was no statistically significant difference in ACT Aspire Math scores between the three learning delivery options one Arkansas school district offered during the 2020-2021 pandemic school year.

Table 1

ACT Aspire Math Composite Score Compared by Modality

(I) Modality	(J) Modality	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Face-to-Face	Online	-1.659	1.005	.256	-4.13	.81
	Hybrid	-1.789	.849	.109	-3.87	.29
Online	Face-to-Face	1.659	1.005	.256	-.81	4.13
	Hybrid	-.129	1.124	.993	-2.89	2.63
Hybrid	Face-to-Face	1.789	.849	.109	-.29	3.87
	Online	.129	1.124	.993	-2.63	2.89

Note. Dependent Variable: ACT Aspire Math Composite Score

Research question number two (RQ2) was: *Is there a statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year*? This question was analyzed in two parts. First, an ANOVA test was run to compare if there was a significant difference between seventh and ninth grade ACT Aspire Math composite scores as seen in Table 2. The dependent *t*-test showed a significant value of 0.001, which is less than a 0.05 difference between the seventh and nine grade tests.

Table 2

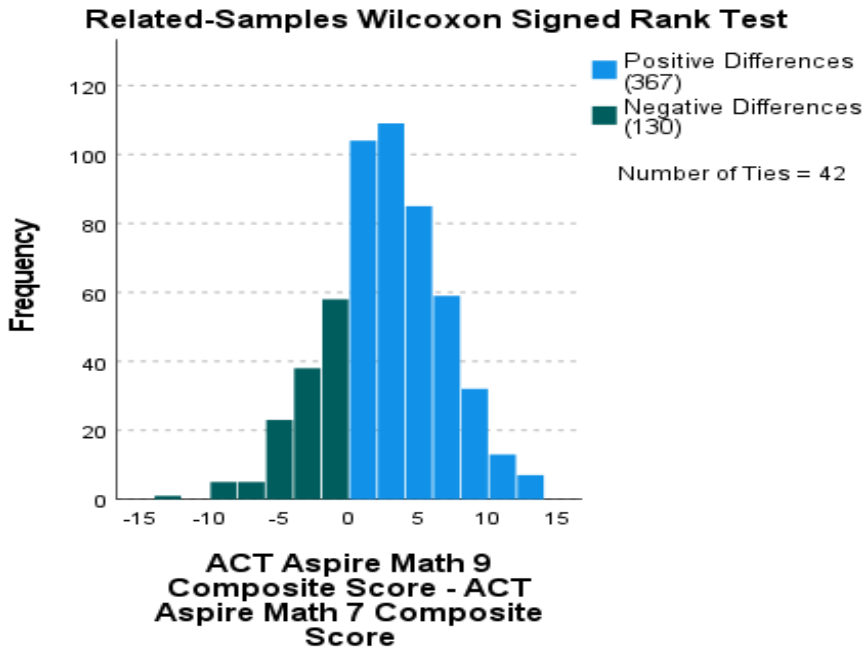
ACT Aspire Math Composite Score Compared by Testing Year

			Sum of Squares	df	Mean Square	*F*	Sig.
ACT Aspire Math 9 Composite Score * ACT Aspire Math 7 Composite Score	Between Groups	(Combined)	30026.226	37	811.520	49.411	<.001
		Linearity	29258.554	1	29258.554	1781.474	<.001
		Deviation from Linearity	767.673	36	21.324	1.298	.119
	Within Groups		8228.319	501	16.424		
	Total		38254.545	538			

An analysis of the groups was run to determine the extent of the statistical difference from seventh grade to ninth grade using a Related-Samples Wilcoxon Signed Rank test as seen in Figure 1

Figure 1

ACT Aspire Math Composite Differences from Seventh to Ninth Grade



The analysis of Math Readiness or on a Grade Level Math Benchmark comparison used a Chi-Square analysis which showed the shift from the seventh grade to the ninth grade in overall math readiness as seen in Table 3.

Table 3

Grade Level Progress Readiness Benchmark

Grade		Math Readiness Benchmark	
		Ready	Not Ready
Seventh Grade	Count	359	180
	Expected Count	288.0	251.0
	% within Math Readiness Benchmark	62.3%	35.9%
Ninth Grade	Count	217	322
	Expected Count	288.0	251.0
	% within Math Readiness Benchmark	37.7%	64.1%

Further analysis was competed to determine if there was a statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between the three learning delivery options offered by one Arkansas school district during the 2020-2021 pandemic school year. In Table 4, an ANOVA test showed no statistically significant differences among the three delivery options. Therefore, the null hypotheses were accepted. There was no statistically significant differences in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between the three learning delivery options offered by one Arkansas school district during the 2020-2021 pandemic school year.

Table 4

ACT Aspire Math Composite Score Compared by Modality

(I) Modality	(J) Modality	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Face-to-Face	Online	.1683	.49927	.945	-1.0572	1.3938
	Hybrid	-.0179	.42176	.999	-1.0531	1.0174
Online	Face-to-Face	-.1683	.49927	.945	-1.3938	1.0572
	Hybrid	-.1862	.55858	.946	-1.5573	1.1849
Hybrid	Face-to-Face	.0179	.42176	.999	-1.0174	1.0531
	Online	.1862	.55858	.946	-1.1849	1.5573

Note. Based on observed means. Dependent Variable: Difference. The error term is Mean Square (Error) = 17.445.

To better analyze the results for research question number three, the tests were run for the fall and spring semesters. Each high school mathematics class received a passing or non-passing grade at the termination of each semester. Research question number three (RQ3) was: *Is there a difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year*? Chi-Square analysis was run for the fall semester to determine if there was a difference in the frequencies of those passing the mathematics course among the three categories as observed in Table 5. The Pearson Chi-Square significance value was 0.056, which was above the 0.05 or below value for statistical significance. The analysis for the fall pass/non-passing resulted in an acceptance of the null hypotheses for the fall semester. There was no difference in the frequency of students passing ninth-grade mathematics class between the three learning delivery options offered by one Arkansas school district during the fall 2020-2021 school year as observed in Table 6.

Table 5

Chi-Square Test for Significance of Passing Rate Fall 2020

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.749[a]	2	.056
Likelihood Ratio	5.169	2	.075
Linear-by-Linear Association	.654	1	.419
N of Valid Cases	539		

Note. a. 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 10.47.

Table 6

Frequency Rates of Pass and Non-Passing Grades by Modality Fall 2020

Modality		Pass/Non-Passing Fall		Total
		Pass	Non-Passing	
Face-to-Face	Count	274_a	29_a	303
	Expected Count	268.1	34.9	303.0
	% within Modality	90.4%	9.6%	100.0%
	% within Pass/Non-Passing Fall	57.4%	46.8%	56.2%
	% of Total	50.8%	5.4%	56.2%
	Standardized Residual	.4	-1.0	
Online	Count	74_a	17_b	91
	Expected Count	80.5	10.5	91.0
	% within Modality	81.3%	18.7%	100.0%
	% within Pass/Non-Passing Fall	15.5%	27.4%	16.9%
	% of Total	13.7%	3.2%	16.9%
	Standardized Residual	-.7	2.0	
Hybrid	Count	129_a	16_a	145
	Expected Count	128.3	16.7	145.0
	% within Modality	89.0%	11.0%	100.0%
	% within Pass/Non-Passing Fall	27.0%	25.8%	26.9%
	% of Total	23.9%	3.0%	26.9%
	Standardized Residual	.1	-.2	
Total	Count	477	62	539
	% within Modality	88.5%	11.5%	100.0%
	% of Total	88.5%	11.5%	100.0%

Note. Each subscript letter denotes a subset of Pass/Non-Passing Fall categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square analysis was run for the spring semester to determine if there was a difference in the frequencies of those passing the mathematics course among the three categories. The Pearson Chi-Square significance value was 0.075, which was above the 0.05 or below value for statistical significance as observed in Table 7.

Table 7

Chi-Square Test for Significance of Passing Rate Spring 2021

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.184[a]	2	.075
Likelihood Ratio	4.672	2	.097
Linear-by-Linear Association	.053	1	.817
N of Valid Cases	539		

Note. a. 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 8.44.

The analysis for the spring pass/non-passing resulted in an acceptance of the null hypotheses for the spring. There was no difference in the frequency of students passing ninth-grade mathematics classes between the three learning delivery options offered by one Arkansas school district during the spring 2020-2021 school year as described in Table 8.

Table 8

Frequency Rates of Pass and Non-Passing Grades by Modality Spring 2021

Modality		Pass/Non-Passing Spring		Total
		Pass	Non-Passing	
Face-to-Face	Count	277_a	26_a	303
	Expected Count	274.9	28.1	303.0
	% within Modality	91.4%	8.6%	100.0%
	% within Pass/Non-Passing Spring	56.6%	52.0%	56.2%
	% of Total	51.4%	4.8%	56.2%
	Standardized Residual	.1	-.4	
Online	Count	77_a	14_b	91
	Expected Count	82.6	8.4	91.0
	% within Modality	84.6%	15.4%	100.0%
	% within Pass/Non-Passing Spring	15.7%	28.0%	16.9%
	% of Total	14.3%	2.6%	16.9%
	Standardized Residual	-.6	1.9	
Hybrid	Count	135_a	10_a	145
	Expected Count	131.5	13.5	145.0
	% within Modality	93.1%	6.9%	100.0%
	% within Pass/Non-Passing Spring	27.6%	20.0%	26.9%
	% of Total	25.0%	1.9%	26.9%
	Standardized Residual	.3	-.9	
Total	Count	489	50	539
	% within Modality	90.7%	9.3%	100.0%
	% of Total	90.7%	9.3%	100.0%

Note. Each subscript letter denotes a subset of Pass/Non-Passing Spring categories whose column proportions do not differ significantly from each other at the .05 level.

Research question number four (RQ4) was*: Is there is a statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment in the five math categories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year*? An ANOVA test was run to identify whether there was a difference among the three delivery options. There was not a statistically different score among the delivery options and test percentages as observed in Table 9.

Table 9

ACT Aspire Math Benchmark Readiness Means Compared by Modality

Reporting Category	(I) Modality	(J) Modality	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number and Quantity	Face-to-Face	Online	1.150	3.403	.945	-7.20	9.50
		Hybrid	-.513	2.875	.984	-7.57	6.54
	Online	Face-to-Face	-1.150	3.403	.945	-9.50	7.20
		Hybrid	-1.663	3.808	.909	-11.01	7.68
	Hybrid	Face-to-Face	.513	2.875	.984	-6.54	7.57
		Online	1.663	3.808	.909	-7.68	11.01
Algebra	Face-to-Face	Online	3.001	2.664	.531	-3.54	9.54
		Hybrid	-1.714	2.251	.748	-7.24	3.81
	Online	Face-to-Face	-3.001	2.664	.531	-9.54	3.54
		Hybrid	-4.715	2.981	.287	-12.03	2.60
	Hybrid	Face-to-Face	1.714	2.251	.748	-3.81	7.24
		Online	4.715	2.981	.287	-2.60	12.03

continued

Table 9 Continued

ACT Aspire Math Benchmark Readiness Means Compared by Modality

Reporting Category	(I) Modality	(J) Modality	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Functions	Face-to-Face	Online	5.207	2.962	.214	-2.06	12.48
		Hybrid	-2.609	2.502	.581	-8.75	3.53
	Online	Face-to-Face	-5.207	2.962	.214	-12.48	2.06
		Hybrid	-7.816	3.314	.063	-15.95	.32
	Hybrid	Face-to-Face	2.609	2.502	.581	-3.53	8.75
		Online	7.816	3.314	.063	-.32	15.95
Geometry	Face-to-Face	Online	-2.638	2.656	.611	-9.16	3.88
		Hybrid	-2.584	2.244	.516	-8.09	2.92
	Online	Face-to-Face	2.638	2.656	.611	-3.88	9.16
		Hybrid	.054	2.972	1.000	-7.24	7.35
	Hybrid	Face-to-Face	2.584	2.244	.516	-2.92	8.09
		Online	-.054	2.972	1.000	-7.35	7.24
Statistics and Probability	Face-to-Face	Online	-1.694	3.481	.888	-10.24	6.85
		Hybrid	-3.323	2.941	.528	-10.54	3.89
	Online	Face-to-Face	1.694	3.481	.888	-6.85	10.24
		Hybrid	-1.629	3.895	.916	-11.19	7.93
	Hybrid	Face-to-Face	3.323	2.941	.528	-3.89	10.54
		Online	1.629	3.895	.916	-7.93	11.19

Qualitative Data Analysis

Two instruments were used to collect qualitative data to answer research question number five. Research question number five (RQ5) was: *What are the teacher perceptions in one Arkansas school district of the learning gaps identified by the ninth grade ACT Aspire Math results and the math intervention program for current tenth-grade students*? A survey followed by interviews was used to collect data information.

The interview questions were designed as emergent from the archival data and survey questions.

Survey

The survey assisted in the development of the interview questions. Three parts were used to prod deeper into the participants' perceptions of mathematical student learning. Tables 10, 11, and 12 include frequencies from the survey to help clarify the 2020-2021 pandemic school year.

Table 10

Number of Technology Question Responses

How many different technologies related to school did you begin using within the last 18 months?		
Options	Selected	Percentage
None (Zero)	0	0.00%
1 to 2	4	30.77%
3 to 4	8	61.54%
5 to 6	1	7.69%
7 or More	0	0.00%

Table 11

Learning Technology Question Responses

How many months did it take to become comfortable with the technology needed to teach students online and in-person?		
Options	Selected	Percentage
0 to 2 Months	3	23.08%
3 to 5 Months	5	38.46%
6 to 8 Months	3	23.08%
9 or More Months	1	7.69%
Still not comfortable.	1	7.69%

Table 12

Teacher Perceptions from Survey

Scale	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Students had difficulties using technology for classroom assignments.	7.69%	0.00%	30.77%	46.15%	15.38%
2. My in-person students received more help learning technology than online students.	0.00%	0.00%	7.69%	46.15%	46.15%
3. During online meetings fewer than ten students on average attended.	0.00%	0.00%	7.69%	7.69%	84.62%
4. Having two types of students, in-class and online, in one class period decreased the amount of time spent with either set.	0.00%	7.69%	0.00%	53.85%	38.46%
5. As an educator, do you perceive that online students learned well?	38.46%	30.77%	15.38%	15.38%	0.00%
6. As an educator, do you perceive that face-to-face students learned well?	0.00%	0.00%	0.00%	69.23%	30.77%
7. It is difficult to build relationships with in-person students wearing masks.	15.38%	15.38%	7.69%	23.08%	38.46%
8. It is difficult to build relationships with online students.	0.00%	7.69%	0.00%	7.69%	84.62%

Note. These questions used a five-point Likert Scale.

Comments

Do you have any additional comments about math education, as you experienced it in 20-21?

- "*I felt overwhelmed most of the year. It was difficult to handle all the responsibilities required of teachers. The new technologies with the two classes in one roster made it more difficult to build relationships with students*."
- "*Very challenging.... videos of the lesson did help, but in-person is the best*."

- "*The online students that sought out help and interacted with me online had the opportunity to be successful. However, the ones that did not almost universally severely struggled and I think there was little to no perseverance because I had no relationship with them and could not push them to not give up*."
- "*It seemed like two full-time jobs*."
- "*Some students successfully learned regardless of the modality of education (face-to-face v online). It seemed that some students performed well in each category. The determining factor of student learning was student characteristics and motivation. I find this to be the case in any given year*."

Interview Findings

The researcher's theme and data analysis listed five recurring themes with 12 supporting subthemes from interview transcripts. The first major theme was *Pandemic Education* with two supporting subthemes *Students* and *Teaching*. The second major theme was *Technology* with three supporting subthemes *Learning*, *Benefits*, and *Educating with Technology*. The third major theme was *Time* with three supporting subthemes *Pandemic*, *Quarantining*, and *Whatever It Takes*. The fourth major theme was *Mental Health* with two supporting themes *Negative* and *Positive*. The fifth major theme was *Math Gaps* with two supporting themes *Education* and *Programs*. These themes and subthemes with coding frequencies are shown in Table 13.

Table 13

Emerging Themes and Subthemes from Data Analysis

Major Themes	Subthemes	Count	% Codes	Cases	%Cases
Pandemic Education	Students	14	6.5%	5	83.3%
	Teachers	26	12.0%	6	100.0%
Technology	Learning	14	6.5%	5	83.3%
	Benefits	9	4.2%	5	83.3%
	Educating w/Technology	12	5.6%	5	83.3%
Time	Quarantining	7	3.2%	5	83.3&
	Pandemic	22	10.2%	6	100.0%
	Whatever It Takes	13	6.0%	6	100.0%
Mental Health	Positive	23	10.6%	6	100.0%
	Negative	26	12.0%	6	100.0%
Mathematical Gaps	Education	38	17.6%	6	100.0%
	Programs	12	5.6%	4	66.7%

Pandemic Education

The theme, *Pandemic Education*, emerged from all participants. The dialogue regarding the theme Pandemic Education varied between the two subthemes: *Students* and *Teaching*. Five participants shared perceptions about students during and after the 2020-2021 school year. The most impactful comments for subtheme, *Students* came from interviewee number six who said:

- "*The resource was there, but we're talking about extrinsic learners who are, we're talking about young, young teenagers who don't understand the ramifications for them, it's not as serious as you would've had an older student who has been paying money out of their pockets at college and needs to close this gap. And so that's a discrepancy right there."*

- *"I don't feel students utilized the resources that were prepared to, to the full potential that they could have been used. So, we were basically out there on our own and you know, that really put some students in tremendous hindrance. You know I know my lower-income specifically since I work with English language learners, you know, first generations in-country, you know, some of those students struggled and were asked to help support families*."

Interviewees number one, three, and four shared similar comments about perceived behaviors including:

- "*I feel like they aren't holding themselves accountable and they think no one else will. I could kind of tell the ones that were here because they at least acted like students. I think we just, they had to learn how to be students again. Them interacting with each other and them learning how to be around other people that they don't like*."

Interviewees two and three shared similar comments about students being in school:

- "*I'm so glad that we, that the district took that stand because I think that got a lot of students to come that were maybe on the fence about coming. I think for a lot of families that stress is easing on the flip side, there's still the struggle with my student getting the education last year. If ever everybody can stay healthy and stay in school, it's going to be good for students' education.*"

While all participants shared perceptions of teaching during the COVID-19 pandemic. The most impactful comments for the subtheme, *Teaching* came from interviewees number one and four who said:

- "*I felt like we were two teachers because we had students that were here, and we also had virtual students. I couldn't give either my full attention because I was constantly divided between what to do for these kids and trying to figure out what to do for the kids that were not face to face. The teachers had to overcome it*."
- "*It was difficult feeling like, or it was difficult approaching teaching without knowing them, like, if it was a kid I'd never had, I had no rapport. I felt like I was tutoring more when they had the virtual, like, I felt limited on how I taught to keep it the same. My students were out of my class so much. It just became difficult. I think us being constant and it, attendance being expected that they, they come to school, and they learn. I think that is the consistency is more important and time in front of a teacher would be more productive*."

Interviewees number two and three shared similar comments about teaching:

- "*I knew that the students would be in the classroom, and I thought that, I guess I thought that I'd be able to do more with them than at the beginning, we still couldn't do the collaborative pieces as well because we were still trying to keep our distances*."
- "*I feel better about teaching now than I did even last August, because I feel like I can be more one on one and work with students and have a better relationship with them because we're not distanced because of the pandemic*."
- "*What we all discovered was just, I think the virtual learning went even worse than we all expected. Our students, it really illuminated to me just how much we get done with our kids just by having them in the room for 50 minutes, five days a week. Because when we lost that, for a lot of them, we lost everything, and I didn't*

expect it to be that bad. I would've just preferred more time to just work on specific skills with my students than use programs. I think more classroom time, I just want more time with my kids."

Interviewees number five and six shared similar comments about teaching:

- "*I think the most difficult piece of it was trying to balance some form of virtual. Teaching both virtual and onsite having to use technology on the fly teachers having to learn how to zoom you know, trying to switch an entire curriculum from, in-person face to face to virtual obviously presented significant challenges*."
- "*I felt a tremendous burden on my teachers when my teachers were running both an onsite school and a virtual school, you know, trying to divvy that responsibility both ways. I know in my department, which happened to be the math department, my teachers were giving full fledge lessons in class in addition to doing the virtual." Students were quarantined without teachers knowing if they were ill or not. "As an educator, you don't know the circumstances of this child's living situation or why this child was quarantined, and you want to provide the same services*."

Technology

The theme, *Technology*, emerged from all participants. The dialogue regarding the theme *Technology* varied between three subthemes: *Learning*, *Benefits*, and *Educating with Technology*. Five participants shared perceptions about each of the three subthemes. The most impactful comments for the subtheme, *Learning* came from interviewees number one and two who said:

- "*That was the first time using the new platform, last year. You know, we at least had a 30-minute training on our LMS. I mean, then we had to learn loom and zoom. So, making all the videos and lessons was time-consuming. I think kids and just people, in general, were suffering so much through loss of job and not being able to feed the kids and the kids being home, that it wasn't a priority. And so, since it wasn't a priority to learn all these five or whatever new technologies but trying to get the students to learn it's, I mean, it's just bad*."
- "*I think training the students with the new technology would've helped a whole lot, but since they were virtual and started virtual, I don't know how we would've delivered that training. I spent a lot of time please submit pictures, take a better-quality picture. Please submit a format that I can open. It was, it was a mess trying to get that work in. We did turn in things online, I think the hardest part of it was Ig good quality work turned in, in math, particularly because you can't type math, you must write it out. And by the time students took pictures and uploaded, a lot of the quality was gone*."

Interviewees three, five, and six made similar comments:

- "*I thought it was it was beneficial. We needed some medium by which to get this out. It was the only sad part was a very short turnaround. When we reported to school, they gave us an extra week that wasn't enough*."
- "*I don't know it was, it was super hard to learn that on top of everything else, but I'm not sure I have a better solution. And so, I don't want to be too critical of the people that made that decision when we had to have something right away."*
- *"I think the learning curve, it was kind of steep*."

The most impactful comments for subtheme, *Benefits* came from interviewees number three and five who said:

- "*We do need online communication and so we needed something. I kind of came as we developed that new technology. So, I did use Google classroom in the past at, at other schools and, and that seemed effective but wasn't approved over grade security issues." Referring to the Schoology, "the learning curve of it, of where, when you create the assignment difficult, I've got the organization aspect of it down now. And I, I like it to a large extent now*."
- "*I think there are some features with Schoology that have made it a more suitable platform form if they want to use it for all, all the bells and whistles that it comes with. New technologies that the teachers and students were required to learn improved communications. I'm a fan of zoom. I think it's made things a lot simpler*."

Other comments from interviewees one, two, and six:

- "*I had to make lesson videos last year, and this year it has made it so much easier for students to make up lessons because I, I had the videos on hand*."
- "*You know families trying to find hot spots because we did pull back, you know, for the first year we were able to have hot spots for the students, the government gave us all those devices to give students to have internet access*."
- "*I felt like we were kind of thrown into that because we changed our whole learning platform, which needed to be done, now it is better when a student is absent, they have the work at home*."

The most impactful comments for subtheme, *Educating with Technology* came from interviewee number four who said:

- "*I don't think the difficulty was out of anyone's realm, but the technology all working at the same time, there were a lot of glitches. My Internet stunk; I think they had the same Internet. There were internet problems and using zoom and I mean, where I live, I wouldn't have been able to zoom if I were a student, the internet was subpar. I understand kids not having the quality of internet they needed for zoom sessions. When there's good technology, they just have technology, they can Google and I think, you know, being able to find what they need is important. I just don't think it's real being alone and interacting via technology to learn and prepare for the future*."

Interviewees one and six shared these thoughts:

- "*I felt like we were two teachers because we had students that were here, and we also had students that were virtual. This year was better having had done that stuff last year, it was already in place. So, we at least didn't have to recreate all that stuff. We'd already created last year digitally*."
- "*All the recording I thought was a tremendous burden on teachers. Now the recordings are a resource*."

Interviewees two and three shared these thoughts:

- "*Last year during the pandemic, we offered zoom sessions and I didn't have very many students come, but there were a couple of times I was able to work one on one with a student and offer some encouragement and we were able to get through a topic*."

- "*I think the lack of rapport with a teacher and the lack of having a teacher available as they learned to immediately reinforce or immediately clear up misconceptions is difficult. I think for a lot of them, it just turned into a, this is too hard*."

Time

The theme, *Time*, emerged from all participants. The dialogue regarding the theme *Time* varied between three subthemes: *Pandemic*, *Quarantining*, and *Whatever It Takes.* Six participants shared perceptions about the subtheme, *Pandemic*. The most impactful comments for the subtheme, *Pandemic* came from interviewees number five and six who said:

- "*Teamwork, teamwork, teamwork. I have seen my administrative staff that we still did everything. We had to do it as administrators did all the quarantine did everything we had to do, but I think even greater than was because I was so confined in that area, that every department depended on teamwork. Quarantining that's hard to, you know, a parent would say, well, I've sent my child, my child's been masked. I've vaccinated. My child, they were vaccinated. Why is my child being denied the right to be educated?"*
- *"Then I think too, being concerned about getting back into a groove had a lot of parents talk about, you know, they're not wanting their kid to miss school or be out of school worried about what they were going to miss. Then having to dismiss school when, you know, numbers got high. How long will this, this pandemic effect be in place? That's a question in itself*."

- "*Whereas a lot of the daily COVID things we were having to take care took so much time. Those things mitigated what else we were able to do, essential tasks only. I think that's one of the byproducts of going through the pandemic is it's really taught us what's important and, and what to focus on. Using video conferencing allowed us to conference much easier, especially in the special ed world. We've gotten a lot more parental involvement versus having people come to the school. We have a lot more parents who are participating by phone or by zoom. So, I've enjoyed being able to use that. Technology kind of helped us stay safe as we've continued to navigate through the pandemic in terms of an LMS and Schoology*"

Some other comments about the subtheme, *Pandemic* from the other interviewees was:

- "*The pandemic year seems to have become two years and maybe continuing*."
- "*They tested positive was a common phrase heard from students and staff."*
- *"I think we are all at the point of like knowing the health concerns*. *I felt like when people started getting that shot, they were like, they tried to act like everything was normal and then the numbers went up."*
- *"I didn't feel like I was teaching well because there wasn't the one-on-one work with students as much because of the pandemic*."

Five participants shared perceptions about the subtheme, *Quarantining*. The most impactful comments for subtheme, *Quarantining* came from the summation of what three interviewees said:

- "*We were still having to try to keep everyone distanced and trying to be mindful of quarantines."*

- *"The constant quarantines of students, the pulling in and out students being out for 10 days, being out for five days, it was just a nightmare for my teachers to try to continue to move forward with a curriculum."*
- *"I think them being out of school, you know, either on quarantine or being sick has contributed to them, struggling with a lot of anxiety coming back and feeling like they're behind they don't know how to catch up or just choosing not to come at all*."

Six participants shared perceptions about the subtheme, *Whatever It Takes*. The most impactful comments for subtheme, *Whatever It Takes* came from interviewees number one and three who said:

- "*I'm proud of my students. I think, I think they overcame that quite well over time."*
- *"I don't know that I would've been in favor returning to completely onsite instruction at the time, before going through that virtual teaching experience, just because I know the health concerns are real and I'm not trying to, to make people endanger their health, but it did not work."*
- *"We tried recoupment programs, but I felt like it took time out of the regular classroom. I think nothing replaces classroom time in front of the teacher*."
- "*Whereas, you know, after a year and a half of this, my kids need to go to school. I think in that sense, there's been a real shift, maybe a little bit in that regard. I think that's where I've been able to bond with students. We have a mutual appreciation for each other because they, they understand that I care about that*

more than I care about their geometry knowledge, and I teach and manage my class in a way that reflects that."

Some other comments about the subtheme, *Whatever It Takes* from the other interviewee was:

- "*I think that we, as a district did the best that we could do given the circumstances but know that it's not the same as before the pandemic. It's not ideal of course, we know with COVID, it's always kind of a toss-up if students or staff will be able to come to school."*
- *"I think one of the was trying times in the 32 years, I've been in education*."

Mental Health

The theme, *Mental Health*, emerged from all participants. The dialogue regarding the theme, *Mental Health* varied between the two subthemes: *Positive* and *Negative*. All participants shared perceptions about each of the two subthemes. The most impactful comments for subtheme, *Positive* came from interviewee number five who said:

- "*Resiliency comes to mind with our teachers and their ability to overcome obstacles and challenges resiliency of our students to be able to transition back and forth from onsite to virtual school. To be able to come to school masked and then not masked and the mask again and just all the ups and downs that have come, you know, in so many different intervals really over the past three years since we've been dealing with this."*
- *"I think the word that comes to mind there is just resiliency and overcoming all those things. I think we're going in the right direction in terms of getting back to what normal school looks like with roles and responsibilities."*

- *"The beneficial piece of it, I would say is I think it did raise some awareness and importance for the value of education and how hard teachers worked."*
- *"I think moving forward, we're going to see some, some amazing curriculum and instruction from our teachers and just overwhelming knowledge from our kids. I think as we've continued to navigate the pandemic, there's been a significant shift towards students, mental health*."

Interviewee number five comments related to subtheme, *Positive* was:

- "*My teachers got together and said, okay, we need to hold this together. I could watch them from a distance and know that they were holding it together moving forward to the best of their ability, helping children learn, even though I wasn't there to be their instructional leader, they were leaders within themselves."*
- *"If it wasn't for the strength of members in the team, the education of students wouldn't have been possible."*
- *"Impressed by what the faculty have done, I'm very impressed that they held on through these difficult times*."

Some additional comments from the other interviewee about the subtheme, *Positive* from the other interviewee was:

- "*I was really encouraged. I think just the more you can be there for your students, mental health, the better. I do think for the most part, my students have gone through that learning curve like in a good way. I think a lot of families are getting there too we just need time; we're going to be just fine*."
- "*I'm glad we're on this side of the pandemic. I think we're headed in a right direction. Since we've been back this year, I've been able to sit down with students*

and we've been able to go through things. I feel like there's been more visible learning."

- "*I think it will be less fearful. It's been more rewarding as a teacher this year, but so there have been some good moments in the last couple of years*."
- "*I see some of them beginning to work again, felt good! Yeah, There's always hope*."

The most impactful comments for subtheme, *Negative* came from interviewees number one and three who said:

- "*I think kids and just people in general were suffering so much through loss of job and, you know, not being able to feed the kids and the kids being home, that it wasn't a priority. Their education suffered because they couldn't add all that on top of trying to survive for some of them, it just went downhill from there. So, I don't think that it's really going to be better if people are testing positive. When the students go virtual, they don't feel like they're responsible for doing any of the stuff on the computer."*
- *"If I try to sum up in a few words the time since the pandemic began, I say chaos inconsistency brokenness, broken curriculum, broken kids, broken teachers, just lots of holes and chaos and inconsistency*."
- "*We knew it was going to be hard and we knew it was going to be a challenge. I mean, I know personally it's a challenge to work from home at the same degree that I work at work. I think that mental health was a growing issue before this pandemic. My students say it's just too much; this is asking too much of me. I'm going to shut down and I'm going to avoid as opposed to tackling this."*

- *"I think this is just exacerbated the mental health problem surfacing in students. Students need to be in school, but I worry about changing the guidelines, it depends how many people get sick. I guess that's the answer. If we can all stay healthy, I think it will probably be a good thing. I'm not a health expert. I don't know what it's going to mean, that we're not going to send people home preemptively before we think they might get sick*."

Some additional comments from the other interviewees about the subtheme, *Negative* were:

- "*The pandemic did was it created distance between me and the students because I was wary about getting too close to anybody for any length of time. And it felt distant. I think the fear of COVID itself is great*."
- "*I didn't feel like I could convince them that they could trust me enough to learn from me. I think them being shut up behind a computer with even less accountability it's just not real. I just don't know, just don't. I think if I summed up this past year, I would say anxious and lack of accountability*."
- "*The question was, where were we? Yeah, it still is, it is a sad situation. That's the reality of what was happening. I guess I'm skeptical, if we don't have another rise in another strand, you know, I think we should have some a new level of stability that we haven't had*."
- "*And so, it's just crazy to think about that we're still trying to balance all those things to do with COVID and kind of see a more normal or traditional style of education*."

Mathematical Gaps

The theme, *Mathematical Gaps,* was the theme that emerged most often from all participants. Overall, the theme meant most of the participants expressed concern about students having gaps in their understanding of mathematical concepts. The dialogue regarding the theme, *Mathematical Gaps* varied between the two subthemes: *Programs* and *Education.* All participants shared perceptions about the subtheme, *Education*. Each interviewee had insightful comments about their perception of the subtheme, *Education*, they said:

- "*I felt like they did Pythagorean theorem in eighth grade, but then I have 10th graders and even seniors now that act like they've never seen that. I mean, which is different than in years past before the pandemic, I felt like everybody at least knew the word, you know, and knew it had something to do with triangles. But a lot of little things like that, I felt like they should have picked up were lost."*
- *"The ones that weren't here, I didn't feel even had any of those skills that students just normally have. I just feel like we're sticking them in saying, hey, here's this try these. If they didn't know the concept, they can't do the problem. So, they're just kind of stuck in a loop of until we go and say, oh, this is what it's asking*."
- "*We've talked about, study habits, we've talked about skills that they're missing and working on improving skills. Students were able to do even more at the beginning of the last year, I think, than they were this year because of missing math knowledge."*
- *"During the pandemic last year teaching, I couldn't do any group activities. Students couldn't work together. They collaborate without that collaborative*

piece; I don't feel like they had the opportunity to gain perspective and deeper understanding of mathematics."

- "*I know that's always going to be an issue in geometry and us, we have plans to reinforce that and reteach math, but I mean, it maybe even a little lower than normal. I'm talking 10 plus instances of talking with parents of students who had always been a or B students in the past who were getting grades of 8%, 10%, just because the combination of the lack of self-discipline and virtual learning. I really truly believe the classroom time is what is closing the gaps and the using the technologies in the classroom, as opposed to programs during classroom time."*
- *"We just need time with our kids to help them recover math skills, learn things and move forward*."
- "*I think there was math concepts missing there. I think they had missed out on instruction. So, I think they were set back. I think they weren't used to learning new stuff. I think it was an issue."*
- *"We keep changing how we measure success in the classroom to allow students to succeed leaving gaps in understanding*."
- "*Obviously, we had students during the pandemic who just did nothing. They didn't do any online school, any anything. So those students are kind of starting from scratch in terms of credit. My hope is, is that as we continue to focus on our learning loss, recruitment it and focus on good curriculum and instruction that we will see our students perform better and that they will, will start working on bridging those gaps."*

- *"I think we've gotten to a place where we've realized that we must teach less better and make sure that we really dial in on what our students need to know*."
- "*We've increased the gaps that we once tried to close. We have this problem in the end and the solution is not going to be an overnight solution. I'm fearful that students still have tremendous gaps. We were behind, there's no question about it. I think one of the biggest issues besides being behind is the student who remained virtual, how much did they really know?"*
- *"I don't think the students utilized what was provided to them to their full potential. We should go to year-round learning to improve the learning gaps. Even just a couple of years, until we can get this thing settled back down or extended years*."

While only four participants shared perceptions about the subtheme, *Programs*. The interviewee's comments were:

- "*The kids that did not do well with virtual learning or programs, it was obvious from their skills and their study habits and they lost a lot of the organization and the skills that they needed just to be able to be a good student."*
- *"I don't see a reflection in the classroom per se of math computer programs directly impacting students' math levels. Even when I go back and look two or three days later, I'm not real sure what they did and what, how they're doing in the program. I think a program that I can assign a specific skill, see how a student is doing and then go back and, and lower that skill as needed to get the remedial skills. Being able to assign missing skills that directly correlates with what I'm*

doing in class with real-time data so that I can look it up as they're working would be very beneficial. What we have now, I can't tell what a student's doing."

- "*I'm getting older myself and it's hard for me not to compare them to how I was at their age, and they need a different skill set than I had. When we dismissed at the end of the school year, 2020, when we shut it down in March and we let the ones slide without working, like when we graded them based on the first semester, I think that sort of set a tone that made them feel like they didn't need to do anything. I felt like we were fighting with that last year. Students don't take computer programs seriously with no real accountability*."
- "*Well, I could tell all the kids that didn't come last year because they had lost just the habits you develop as being a student, like bringing your materials and taking notes. And it was like, everything was brand new to them. No program was going to help them learn these skills. A program doesn't teach them like a teacher, worked through a unit or so, and it expects that, you know that and then has you practice. So, if you don't know it doesn't ever really say, hey, this is what you're missing, or this is what you're doing wrong, or this is the concept you don't have. So, in that way, no, it's not helping*."
- "*I don't know that it was really a lot different than I expected, but I knew we were in for more of a learning curve than normal. The program hasn't been as useful as I hoped*."

Chapter Summary

The purpose of this chapter was to share the analyses of both the quantitative and qualitative data collected during this research study. The archival data involved the class of 2024's ACT Aspire scores in both the seventh and ninth grades and the passing/non-passing rates of mathematical classes. The student learning modalities were also analyzed to compare the results of these findings. An analysis was included to determine if mathematical gaps exist and provide any insight on those gaps. This chapter provided relevant data gathered from a survey to educators along with follow-up interviews. Based on the dialogue from the interviewees, five major themes and twelve subthemes were determined to discuss the perspectives from current educators during the 2020-2021 and 2021-2022 school years. The research conclusions will be summarized in Chapter V.

Chapter V: Conclusions

The purpose of this mixed-method study was to explore the relationship between learning options, mathematic grades, and the ACT Aspire scores of ninth-grade students in one Arkansas school district during the COVID-19 pandemic school year (2020-2021). This study attempted to identify the learning gaps in mathematics education for current tenth-grade students who were ninth graders in one Arkansas public school during the 2020-2021 pandemic school year. The researcher conducted both quantitative and qualitative analyses to evaluate the mathematics level of current tenth graders and educators' perceptions of teaching through the pandemic. A goal of this research study was to provide the district with data that could be used to help improve the mathematical understanding of current tenth grader students.

Additionally, the researcher desired to share the perceptions of educators to provide insight into the positive and negative effects of educating students during the COVID-19 pandemic. In Chapter IV, the researcher summarized the findings from both the quantitative and qualitative data collection and analysis. Chapter V examined the research findings, identified any study limitations, and provided recommendations on how to improve the mathematics education process within the district of this study. The researcher used archival data from the ACT Aspire scores from 2019 and 2021 along with mathematic grades, attendance records, and other demographics to assist in categorizing the data. The researcher identified common perception themes in the delivery of mathematics education and ways to improve the process through surveys and interviews. This study evaluated the learning loss suffered by the class of 2024 and

provided suggestions for future studies to improve the mathematics education for future students in one Arkansas school district.

Limitations

This study had some limitations. The researcher focused on one convenient group of students from the class of 2024 within one Arkansas school district. It cannot be assumed that the findings and perceptions from this one Arkansas school represent the findings of all public high schools. The study is not necessarily applicable to other research settings; it simply means that the reader must determine what is relevant within other applications.

The student data was limited to students who attended the same school district in both seventh and ninth grades and continued to attend during the data collection process. The researcher attempted to limit additional environmental factors that could affect student learning. There are currently 695 tenth grade students of those only 539 students have ACT Aspire scores for seventh grade in our district and all data points analyzed in this study. Limiting the analysis to students who had continued from seventh grade in the district, allowed for 78% of the class of 2024 to be included in the study.

There were two types of Hybrid categories in this study including Students who returned to Face-to-Face for the spring semester and those who changed from Face-to-Face to Online for the spring semester. Without knowing the reasons behind the switch of Hybrid students at semester, the researcher could not rule out the outside factors that could have skewed the data.

Approximately 50% of the eligible educator participants responded to the survey with only 23% volunteering to be interviewed, which limited the data collection to the

selected participants. By expanding data collection and gathering additional responses from the chosen Arkansas school district, it would have added greater depth to the study. Additionally, by including other students and educators from other public schools, it would have provided a basis for comparing multiple public schools in the state to further determine the mathematical gaps and educator perceptions of teaching and learning during the COVID-19 pandemic.

Questions and Hypotheses

Research Question One

Is there a statistically significant difference in ACT Aspire Math scores between three learning delivery options one Arkansas school district offered during the pandemic 2020-21 school year?

Research Question Two

Is there a statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

Research Question Three

Is there a difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year?

Research Question Four

Is there is a statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment in the five math categories number and

quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

Research Question Five

What are the teacher perceptions in one Arkansas school district of the learning gaps identified by the ninth grade ACT Aspire Math results and the math intervention program for current tenth-grade students?

Null Hypothesis 1

There is no statistically significant difference in ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year.

Null Hypothesis 2

There is no statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year.

Null Hypothesis 3

There is no difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year.

Null Hypothesis 4

There is no statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment test in the five math subcategories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

Implications

Research Question One

Is there a statistically significant difference in ACT Aspire Math scores between three learning delivery options one Arkansas school district offered during the pandemic 2020-21 school year?

Through the analysis of the ninth grade ACT Aspire Math scores using the ANOVA results, the researcher identified that there was not a significant difference among the learning options. This implied that the learning modality choice did not lead to either positive or negative outcome effects.

Research Question Two

Is there a statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

By comparing the ACT Aspire scores from seventh and ninth grade, it showed a significant difference that needed to be analyzed further. The Related-Samples Wilcoxon Signed Rank test revealed that 130 (24%) of the students lowered their mean score with a

negative difference of mathematical understanding from seventh to ninth grade, while 367 (68%) of the students raised their mean score with a positive difference of mathematical understanding from seventh to the ninth grade. The remaining 42 (8%) of the students had no change to their mean score of mathematical understanding from seventh to the ninth grade. The researcher used a Chi-Square analysis which indicated a shift in Math Readiness Benchmark from 62.3% ready in seventh grade to 37.7% when they tested in ninth grade for that same student. This resulted in an understanding that there were mathematical learning losses, or gaps present in this group of students.

Research Question Three

Is there a difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year?

Chi-Square analysis was run for both the fall and spring semesters to determine if there was a difference in the frequencies of those passing the mathematics course among the three learning modality categories. Although the data did not show significant differences among passing rates, there were some interesting results. The passing rates for all learning modalities went up from fall to spring, but the passing rate for Hybrid students increased the most during the spring grade report. The Face-to-Face fall passing rate was 90.4% and the spring was 91.4%. The Online passing rate in the fall was 81.3% and the spring was 84.6%. The Hybrid fall passing rate was 89.0% and the spring was 93.1%. Students were improving in their ability to accomplish the requirements to pass the class. Learning the expectations and new technologies may have been a factor in non-passing rates for the fall semester.

Research Question Four

Is there is a statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment in the five math categories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year?

Through the analysis of the ninth grade, ACT Aspire Math scores using the ANOVA results with multiple comparisons, the researcher identified that there was not a significant difference among the five mathematic categories and between the three learning options. The highest mean differences were found in Functions and Algebra, respectfully.

Null Hypothesis 1

There is no statistically significant difference in ACT Aspire Math scores between the three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year. Therefore, the null hypothesis was rejected.

The ANOVA test results showed there was no statistically significant differences between the mean ACT Aspire Math scores of students who choose one of three different learning modalities. Therefore, there was no evidence that the learning delivery option affected the mean score of the ninth graders' 2021 mathematic scores.

Null Hypothesis 2

There is a statistically significant difference in ninth grade ACT Aspire Math scores compared to seventh grade ACT Aspire Math scores, but not between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year. Therefore, the null hypothesis was rejected.

The results of the Independent *t*-test of the seventh and ninth grade ACT Aspire Mathematic scores showed a significance value of $p < 0.001$, which was below the 0.05 value for statistical significance. By using the Related-Samples Wilcoxon Signed Rant Test, it revealed that 367 (68%) of students showed some mathematical growth, while the other 172 (32%) of students showed no growth or loss of mathematical understanding. The analysis of the cross-tabulation showed a shift from 359 (62.3%) of the students meeting the on-Grade Level Benchmark in the seventh grade to only 217 (37.7%) meeting the benchmark in the ninth grade. Not ready in the seventh grade had 180 (35.9%) shifting to 322 (64.1%) not ready in the ninth grade. This was an indication of a loss of mathematical understanding during the pandemic disruption of 2019 through 2021 testing years. The final analysis for this hypothesis was multiple comparisons that showed no significant difference between learning modalities and ACT Aspire Math mean scores.

Null Hypothesis 3

There is no statistically significant difference in the frequency of students passing ninth-grade math class between three learning delivery options offered by one Arkansas school district during the 2020-21 school year. Therefore, the null hypothesis was rejected.

The Chi-Square test showed a statistical significance of $p = 0.056$ in the fall and $p = 0.075$ in the spring, which was above the 0.05 value for statistical significance. Although, there were some points of interest such as the non-passing rate was the highest among Online students in both semesters. The non-passing rate within the modality of online was 18.7% in the fall and 15.4% in the spring, which was over 6% higher than either of the other two types of modality.

Null Hypothesis 4

There is no statistically significant difference in students' sub-score percentages on the 2021 ACT Aspire Math assessment test in the five math subcategories number and quantity, functions, algebra, geometry, statistics, and probability, between three learning delivery options offered by one Arkansas school district during the pandemic 2020-21 school year.

The ANOVA test was used to determine there was no statistically significant difference between categories. The lowest *p*-value was 0.063, which was above the 0.05 value for statistical significance. An interesting point was the mean differences were higher in Functions and Algebra which indicated a possible gap in understanding in those categories. Therefore, the null hypothesis was rejected.

Research Question Five

What are the teacher perceptions in one Arkansas school district of the learning gaps identified by the ninth grade ACT Aspire Math results and the math intervention program for current tenth-grade students?

Pandemic Education

It was difficult for students and educators to continue schooling during the pandemic. The dramatic change caused a shift in responsibilities for students to be more accountable for their education. The resources were available for students. However, as young learners, these students did not utilize the resources that were prepared to their fullest potential. The relationships that teachers developed in the classroom to understand the learning styles of their students changed or did not exist during the 2020-2021 school year. Teachers felt that they were completing two jobs while teaching two sets of students per class period. Educators discovered that virtual teaching and in-person teaching spread the teacher much too thin. The shift away from both options to Face-to-face only helped teachers and students reconnect and increase student learning.

Technology

A Learning Management Systems (LMS) was introduced to teachers the week before school started for the 2020-2021 school year. The training was limited to a portion of a professional development day, which left many attendees with more questions than answers. Teachers were allowed to use the LMS platforms of Schoology, Loom, or Zoom, but were not allowed to use Google Classroom. Educators were asked to make video lessons and meet with virtual and quarantined students twice a week, while completing all the normal classroom responsibilities. The survey indicated that the teachers were required to learn three to five new programs at the beginning of the school year. On average, it took about five months to get comfortable with using the new programs. During those months, teachers were responsible for training students to use the same technology. The survey indicated that fewer than ten students on average attended

the bi-weekly Zoom sessions, which made it more difficult for the teacher to connect with those students. Although students and parents were able to select the preferred learning modality, many students without proper internet services chose to go virtual. Eventually, the district received government-issued hot-spots for students that were later returned at the end of the 2020-2021 school year. Internet service is still an issue for students learning from home during medical absence and quarantines. As the interviews pointed out, it was extremely hard to learn on top of everything else, but a learning curve was allowed because of the new requirements.

The educational system needed to improve and this worldwide pandemic was a catalyst to begin that change. Students now have computers as tools for learning that they can use to access classroom material from home, even when they are unable to be in school. Teachers now have video lessons to help absent, or distracted students learn what they may have missed in the classroom. Conferences with students, parents, and colleagues have become more mainstream by using platforms such as Zoom, WebEx, or Loom.

Time

The daily COVID procedures took significant time. Fear, illness, quarantines, and masks were constant concerns in the school buildings. The pandemic year began in March 2020 and has continued through 2022. Educators are exhausted, but highly concerned about what students lost educationally during this period, and how to make up for lost time. By trying to keep everyone socially distanced and remembering who has been out over illness and quarantining, educators were always adjusting to meet those needs. The constant feeling there was not enough time to educate and catch up on skill

loss for students who have been out of class was a daily concern. Many educators and students realized that face-to-face interaction with a teacher is very valuable in the learning process. Teachers, parents, students, and all stakeholders found out who was willing to do whatever it took to educate our young people. The reoccurring theme was students need time with their teachers.

Mental Health

There were both positive and negative concerns about the mental health of students and educators. The resiliency and overcoming of difficulties during these trying times seem to shift awareness towards mental health for both teachers and students. The raised awareness of mental health and the importance of the value of education is leading people to a renewed understanding. Teachers worked as teams to educate, improve curriculum, and instruction to improve student interaction and mental health. Students worked through difficult mathematical concepts and improved their problem-solving skills.

The stress, change, and unknowns made it very difficult due to the pandemic. Many lives were lost to the pandemic including school employees, family members of students, and educators. Several individuals were ill or hospitalized due to COVID-19. The concern over being vaccinated, or not being vaccinated weighed heavy in many conversations. Should you wear a mask, why are not some concerned about the same precautions as others?

Some returning students needed to relearn the skills of being a student, while some simply needed to realize their teachers were there to help them learn. There was a lot of suffering and loss which increased the mental health concerns. One interview

comment summed the year up as, “chaos, inconsistency, brokenness, broken curriculum, broken teachers, broken kids, just lots of holes and chaos.” It was the most difficult time in education for many of those involved in the learning modality transitions.

Math Gaps

There were noticeable mathematical gaps in understanding as compared to prior years. The current tenth-grade students were missing many of the basic algebra skills teachers have seen in the past. Most students struggled with mathematical function skills in on-level math classes. A common theme was the lack of collaborative learning due to distancing rules which weakened the learning experience for mathematic students. Teachers were looking for ways to help students develop missing math skills in full classes without having students work together. The school district purchased a well-known mathematics program to assist teachers in helping to close those gaps. At the high school level, the consensus was the program was not helping in a constructive way for the students who were struggling with basic mathematic skills. At the beginning of the semester, benchmark tests were taken by students who they thought that the program would help find learning gaps and assist students in learning how to improve their understanding of those concepts. Unfortunately, the benchmark tests did not adjust the level or the work for individual students. The program continued with a preset Algebra path which was difficult for some and easy for others. Teachers would like the ability to assign concepts that would directly relate to lessons in class and noticeable gaps in understanding. The most concerning were the mathematical gaps spread out over the entire curriculum and could not be pinpointed easily. Time, effort, and consistency in the classroom would help these students to improve their mathematical understanding.

Summary of Findings

The research found no statistical significance between ACT Mathematic scores, grades, and learning modalities. This led the researcher to believe that the learning modality was not the factor that led to mathematical gaps in understanding and learning loss. There was some evidence of mathematical learning loss as seen in the frequency change of Math Benchmark Readiness level from seventh to ninth grade, especially in Functions and Algebra for the current tenth-grade students. Educators revealed the pandemic year that was filled with more responsibilities and learning opportunities for all who were willing to stay the course. The educational system changed to a pandemic education with new rules and stress that prompted new learning in technology for both students and educators. The need for increased time was seen in lessons, planning, and dividing responsibilities into the time allowed to complete the necessary tasks. The curriculum taught in the mathematics classroom was adjusted to allow time for teachers to prepare and students to learn during the rising of COVID-19 infections. The educators and students became more aware of the mental health issues related to education, illnesses, fear, and stress. During the participant interviews, emotionally difficult reflections included comments about chaos, inconsistency, and fear, but also inspiring examples of resiliency, teamwork, and pride in a job well done. Mathematical gaps existed when students were absent or not given adequate time to learn concepts. Collectively, the research showed there was not a single concept or category that was lacking, but a wide scope of learning loss that only time and educational effort can reduce.

Recommendations

A recommendation for this one Arkansas school district is to allow teachers to select the mathematical concepts in the current mathematics recovery program that would help the group of students in each class based on need. A blanket program with preset objectives distracts from the classroom time and the ability to close noticeable mathematical gaps. Any program can be useful if the teachers are well trained and can facilitate learning that enhances classroom learning. An additional recommendation is allowing more time to learn concepts well by examining the requirements of each mathematical framework. This researcher would recommend that the State of Arkansas reexamine the reason and level of mathematical concepts and classes to graduate to better prepare students for the future.

This researcher would recommend opening an online structure for public schools with minimum requirements for students to proceed in online classes. Some students did successfully complete the requirements of classes evidenced by the passing rate of mathematical classes. If passing requirements are in place and dedicated teachers are available for online class options, online learning can be a valuable option for students and parents.

Recommendations for Future Research

This research study found that learning modalities did not significantly impact ACT Aspire math scores for ninth-grade students in one Arkansas school district. However, there are questions beyond this study that have not been answered. The researcher recommends that further research is completed in the following areas:

1. A replication study focusing on how each learning modality was delivered in multiple school districts in Arkansas with similar student-teacher ratios. This would allow researchers to possibly learn what other districts did to provide students with access to mathematical education. The research could develop future policies on education during a crisis that would advise school districts on recommendations of how to proceed collectively and consistently when educating students.

2. A replication study to compare other grade levels and subject matters focusing on similar learning options and what can be learned about educating students in the future. Educational needs are changing, research into both the success and failures would clarify new opportunities and methods which could lead to a better system of educating students.

3. A study involving time in the classroom and time to understand new concepts. For example, research different school day structures at other school districts, Many comments referred to the time teachers and students were able to work together on improving the understanding of mathematic concepts. Are five days a week the best for students, or is there a better structure for the education of students?

Conclusions

This research began to determine if learning modalities had any effect on students learning mathematics and if any mathematical gaps existed from the pandemic school year. When excluding as much outside interference as possible, it became clear that the learning modalities were not the issue. The struggles to learn and change were felt by all

involved in the educational process. Teachers rushed to learn three to five new technologies to begin a school year full of difficulties and double-duty classrooms. Educators including administrators attempted to strip away any unnecessary hindrance to education, while a pandemic infected the world. Students began taking on more responsibility for their education, and were accountable to schedule time to complete assignments to pass their classes. Although the ACT Aspire Mathematic composite scores showed a difference with more growth than loss, students' overall Math Readiness Benchmark scores changed from 62.3% ready to 35.9% ready in the two years focused in this research study. The two categories most concerning were Functions and Algebra skills. Students will need help and practice to improve those skills if they are to prepare for the ACT testing during their junior year. Time in front of the teacher and the ability to tailor supplemental programs to the student needs are the first steps to improve these underdeveloped mathematical skills.

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Appendix A

Survey – Educators' Perceptions

1. How many years have you been an educator?
    a. 0 to 4 years
    b. 5 to 9 years
    c. 10 to 14 years
    d. 15 to 19 years
    e. 20 or more years

2. Which is your position as an educator?
    a. Classroom teacher that teaches math
    b. Classroom support teacher that helps in a math classroom
    c. Instructional Facilitator that assists math educators
    d. Special Education Teacher that teaches math
    e. An administration that assists math educators

3. Which grades did you teach or support during the 2020-2021 school year? Check all that apply:
    a. 8^{th}
    b. 9^{th}
    c. 10^{th}
    d. 11^{th}
    e. 12^{th}
    f. Did not teach any of these grades.

4. Which grades do you teach or support during the 2021-2022 school year? Check all that apply:
    a. 8th
    b. 9th
    c. 10th
    d. 11th
    e. 12th
    f. Did not teach any of these grades.

5. How different technologies did you begin using within the last 18 months due to the change to the pandemic school year?
    a. 0
    b. 1 to 2
    c. 3 to 4
    d. 5 to 6

e. More than 7

6. How many months did it take to become comfortable with the technology needed to teach online students?
    a. 0 to 2
    b. 3 to 4
    c. 5 to 6
    d. 7 to 8
    e. 9 or more
    f. Still not comfortable

7. Please rank these six areas from hardest to easiest for students to learn. One is the hardest to learn and six is the easiest math concept to learn.
    a. number and quantity,
    b. functions,
    c. algebra,
    d. geometry,
    e. statistics,
    f. probability

8. Please rank these in order from least understood to easiest for students this year. One is the most difficult for students and six is the easiest task for students.
    a. Solving for a variable
    b. Solving a multi-step equation
    c. Finding area
    d. Functions
    e. Linear equations
    f. Inequalities

9. This year have you observed students struggling with any of these concepts: (Check all that apply)
    a. Solving for a variable
    b. Solving a multi-step equation
    c. Finding area
    d. Finding volume
    e. 2-dimensional shapes
    f. 3-dimensional shapes
    g. Functions
    h. Inequalities
    i. Linear equations
    j. Understanding real number system
    k. Multiplying
    l. Negative numbers

m. Order of operation
n. Fractions
o. How to use a calculator

The next problems will use a Five-point Likert Scale

(1=Strongly Disagree 2 = Disagree 3=No Opinion 4=Agree 5=Strongly Agree)

10. Students had difficulties using technology for classroom assignments.
    a. 1 2 3 4 5

11. My in-person students received more help learning technology than online students.
    a. 1 2 3 4 5

12. During online meetings fewer than ten students on average attended.
    a. 1 2 3 4 5

13. Having two types of students, in-class and online, in one class period decreased the amount of time spent with either set.
    a. 1 2 3 4 5

14. As an educator, do you perceive that online students learned well?
    a. 1 2 3 4 5

15. As an educator, do you perceive that face-to-face students learned well?
    a. 1 2 3 4 5

16. It is difficult to build relationships with in-person students wearing masks.
    a. 1 2 3 4 5

17. It is difficult to build relationships with online students.
    a. 1 2 3 4 5

Appendix B

Proposed Interview Questions

1. Is there evidence to support major learning gaps in mathematical concepts?
2. What are the gaps in learning that can be corrected through classroom intervention?
3. What are the gaps in learning that will need additional support or classes to correct?
4. Is the math intervention program identifying and assisting in closing learning gaps?
5. What are teacher perceptions about learning gaps?

More questions will be developed from the results of the data and survey. The interview will be emergent throughout the research study.

Emergent Interview Questions

1. During the pandemic 20-21 school year, are there any procedures or elements of the curriculum delivery that you felt stood out to you as either beneficial or difficult to do?

2. In the survey that I gave to teachers, they indicated that they were required to learn between three and five new technologies. What did you think about the technologies that teachers and students were required to learn?

3. At the start of this school year, did you think it was going to be any different when we first began?

4. Do you believe families still had the same concerns stemming from the pandemic this year as last?

5. Would you say that at the beginning of the year there was a change in the normal level of math abilities as compared with prior years?

6. Now that we are ending the mask mandates, contact tracing, and quarantining of A-symptomatic students and staff, do you believe things will improve?

7. The survey showed that teachers perceived that there is some learning loss across math skills. Do you believe the programs we have put in place are helping to reduce learning loss?

8. Is there better programs or ways to improve math skills?

9. If you could say just a few words about teaching during the pandemic and current year, what would they be?

10. Do you see any inspiring moments going forward?

Appendix C

IRB Approval Letter

ARKANSAS TECH UNIVERSITY

OFFICE OF RESEARCH AND SPONSORED PROGRAMS

1509 North Boulder Avenue
Administration, Room 207
Russellville, AR 72801

479-880-4327
www.atu.edu

November 10, 2021

To Whom It May Concern:

The Arkansas Tech University Institutional Review Board has approved the IRB application for Diane Richards' proposed research, entitled "The Impact of Virtual Learning Modalities on the Academic Success of Students in one Arkansas School District" The Institutional Review Board used an expedited review procedure under 45 CFR 46.110 (7).

Please note that in the event that any of the parameters of the study change, the researcher may be required to submit an amended application.

Please proceed with your research. We wish you success with this endeavor.

Sincerely,

Tennille Lasker-Scott, Ph.D.
Institutional Review Board
Arkansas Tech University

Appendix D

Informed Consent Form

Arkansas Tech University

Title of Project: **THE IMPACT OF VIRTUAL LEARNING MODALITIES ON THE ACADEMIC SUCCESS OF STUDENTS IN ONE ARKANSAS SCHOOL DISTRICT**

Principal Investigator: Diane F. Richards

Participant's Printed Name: _____

We invite you to take part in a research study entitled *THE IMPACT OF VIRTUAL LEARNING MODALITIES ON THE ACADEMIC SUCCESS OF STUDENTS IN ONE ARKANSAS SCHOOL DISTRICT.* This study seeks to identify any potential differences in math acquisition across three instructional delivery methods during the pandemic. Taking part in this study is entirely voluntary. We urge you discuss any questions about this study with me, Diane Richards. Also, we encourage you to talk to your family and friends about it and take your time to make your decision. If you decide to participate, you must sign this form to show that you want to take part.

The purpose of this mixed method study is to explore any differences between learning delivery options offered by one Arkansas school district in terms of student performance on the state-mandated ACT Aspire assessments. Not only will this study provide evidence of differences in success according to the instructional delivery modality for the students during the pandemic year, but it will also provide data related to individual student learning gaps in math that may be addressed before these students sit for their eleventh grade ACT Aspire assessments in the 2022-23 school year. You are being invited to participate because you were involved in math instruction in the school during the 2020-21 school year amid the COVID-19 pandemic and can provide insight into what you and the students endured during that academic year. We are hoping to have 30-35 total participants from your school district.

You are being invited to participate in an interview, having recently completed an online survey on this topic, to add to the understanding of events during that school year. If you choose to participate in this study a time that works for you will be set up to complete the interview. The interviewer will ask questions and audio record your responses. At the end of the interview, you will be asked once again if you would like to participate and can your interview answers be used in this study. If you agree to take part in this study, your involvement will last approximately 45 minutes.

There are no known risks associated with the research and there will be no personal benefits or remuneration for participating in the study. However, the results of this research may guide the future education of math students within your district.

Your interview will be audio recorded to guarantee accuracy of the data. The researcher will transcribe TEMI from the recordings. All digital files containing these data will be secured in a locked filing cabinet in the researcher's home for three years and then deleted after that time. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared. We will keep your participation in this research study confidential to the extent permitted by law. However, it is possible that other people may become aware of your participation in this study. For example, the following people/groups may inspect and copy records pertaining to this research.

- The Office of Human Research Protections in the U. S. Department of Health and Human Services *(for drug/device studies, add the U.S. Food and Drug Administration)*
- The Arkansas Tech University Institutional Review Board (IRB)
- The Arkansas Tech University *IRB* Office•

Some of these records could contain information that personally identifies you. Reasonable efforts will be made to keep the personal information in your research record private and confidential but absolute confidentiality cannot be guaranteed.

Taking part in this research study is voluntary. If you choose to take part in this research, your major responsibilities will include participation in an interview. You do not have to participate in this research. If you choose to take part, you have the right to stop at any time. If you decide not to participate or if you decide to stop taking part in the research at a later date, there will be no penalty or loss of benefits to which you are otherwise entitled.

If you have questions regarding your rights as a research participant or have concerns or general questions about the research, contact the research participants protection advocate in the Arkansas Tech University IRB Office at *irb@atu.edu*.

For more information about participation in a research study and about the Institutional Review Board (IRB), a group of people who review the research to protect your rights, please visit Arkansas Tech University's *IRB* web site at *https://www.atu.edu/ospui/human_subjects.php*. Included on this web site, under the heading "Participant Info", you can access federal regulations and information about the protection of human research participants. If you do not have access to the internet, copies of these federal regulations are available by calling the *Arkansas Tech University* at *844-804-2628.*

Before making the decision regarding enrollment in this research you should have:

- Discussed this study with an investigator,
- Reviewed the information in this form, and

- Had the opportunity to ask any questions you may have.

Your signature below means that you have received this information, have asked the questions you currently have about the research and those questions have been answered. You will receive a copy of the signed and dated form to keep for future reference.

By signing this consent form, you indicate that you are voluntarily choosing to take part in this research.

_____	_____	_____	_____
Signature of Participant	Date	Time	Printed Name

Your signature below means that you have explained the research to the participant and have answered any questions he/she has about the research.

_____	_____	_____	_____
Signature of person who explained this research	Date	Time	Printed Name

Appendix E

Recruitment Letter

Email Recruitment Letter for Survey to Math Teachers, Math Support Personnel, Administrators, or Instructional facilitators.

Dear Educator,

Your participation in this brief survey will be GREATLY appreciated!

My name is Diane Richards, and I am a math teacher at the high school. Currently, I am beginning the dissertation portion of my doctoral program at Arkansas Tech University. My title is: The Impact of Virtual Learning Modalities on the Academic Success of Students in one Arkansas School District.

The purpose of this mixed-methods study will be to determine information about the 2020-2021 school year. You may have heard that students have learning gaps from the Covid-19 school year, are they different for the students if they chose online classes, in-person classes, or going back and forth in a hybrid form? Are there real gaps or a lack of education? What can be done about it to help our students? What do educators that worked with these students think? These questions are some that will be researched in this study.

The survey will be anonymous and no personal information will be collected. No one, including the researcher, will be able to associate any information gained from the survey back to any one individual or school. The survey will be open for four weeks. It will consist of 18 questions and the estimated time for completion is between five to ten minutes.

Thank you for all that you do every day to help our students do the best they can do. Thank you very much for your time. Without your participation, I would not be able to complete this dissertation process.

Please click the link below to complete the survey:

If you are willing to participate in an interview to further the understanding of the perceptions of educators and the gaps in mathematical understanding, please email me at richardsd@conwayschools.info

Sincerely,

Diane Richards

[redacted] Tue, Oct 26, 2021 at 7:23 AM
To: "Richards, Diane" <richardsd@[redacted]>

This is approved.

Thanks,

[redacted] Schools Superintendent
[Quoted text hidden]

Richards, Diane <richardsd@[redacted] Fri, Oct 22, 2021 at 1:44 PM
To: [redacted]

Good Afternoon,
I am working on my doctorate degree from Arkansas Tech University. In order to continue my research I will need persimmon to complete my research.
The name of my research is: THE IMPACT OF VIRTUAL LEARNING MODALITIES ON THE ACADEMIC SUCCESS OF STUDENTS IN ONE ARKANSAS SCHOOL DISTRICT.
In this research I will need to survey math teachers and interview some educators to determine their perceptions. I will also be using some historical data to examine scores for the possible learning gaps in mathematics for our students. At no time will any student or faculty names be used or released beyond my own name as a researcher.
If this sounds acceptable and I am able to continue please email me stating I may do my research. If you have any questions or would like to meet, just let me know.
Thank you,

--
Diane Richards, Ed.S
Math Department
Sr. Beta Club Sponsor
NBCT - AYA Mathematics 2010-2020
Ed.S Education Specialist

[redacted]

This communication is for exclusive use by the person(s) to whom it is addressed and may contain information that is confidential or privileged and exempt from disclosure under applicable law. If you are not the intended recipient, please be aware that any disclosure, dissemination, distribution or copying of the communication, or the use of its contents is prohibited. If you received this message in error, please immediately notify me of your inadvertent receipt and delete this message from all the data storage systems.

[redacted] Tue, Oct 26, 2021 at 7:23 AM
To: "Richards, Diane" <richardsd@[redacted]>

This is approved.

Thanks,

[redacted] Schools Superintendent