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A Convergent Parallel Mixed Methods Study Measuring the Impact of Math-Economics Cross Curricular Intervention

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A Convergent Parallel Mixed Methods Study Measuring the Impact of Math-Economics Cross Curricular Intervention

by
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Dedication

My Dissertation is dedicated to my parents, Steve and Sherry Guest, who always encouraged and supported me throughout my educational pursuits.

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Abstract

Research studies in the past have linked math ability to success in economics courses. However, most of these studies have utilized a quantitative study design with limited studies testing the influence of math interventions on student's academic ability in economics courses. This study will use a convergent mixed-methods research design to quantitatively measure the impact of a Math intervention on High School 11th and 12th grade Economics students and qualitatively observe student engagement and motivation during the intervention. A causal-comparative research design will be utilized for the quantitative strand to compare math ability in economics courses between students who participated in the intervention (experimental group) and those who did not participate in the intervention (control group). Students will be selected for the intervention based on their algebra and/or geometry end of course test scores as well as Northwest Evaluation Association Measures of Academic Progress Math 6+ Growth scores. Participants must have earned a level of beginning or developing learner on one or both tests. This study will utilize cross-curriculum collaboration between math and economics departments to develop and refine the intervention. Two years of retrospective data will be analyzed because the intervention started in 2018-19 academic year in the targeted school. Additionally, the researcher will collect data on student's knowledge in the beginning, middle, and end of semester in the 2020-21 academic year. A dependent t-test will be utilized to measure change in student knowledge during the intervention which would assess the extent to which the intervention is successful in improving the Economics benchmark test scores. A phenomenological research design will be used for the qualitative strand to explore student engagement and motivation during math based economic interventions. Triangulation of quantitative and qualitative strands will occur through embedding and linking integration techniques.

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Chapter I: Introduction

Background of the Problem

Economics education is vital for students to prepare for future financial and business decisions. High school students usually go through economics education (Walstad, 2001). Between the 1980s and early 2000s, the number of high school students required to take economics has doubled from around 25% to 50% (Walstad, 2001). Walstad and Rebeck (2001) found that economics courses improved student performance on economics literacy tests. According to a 2012 survey, over two-thirds of high school seniors believed that economic coursework during their high school career (9^{th} to 12^{th} grade) helped them to better understand the US economy, international economy, current events, public policy, and personal finances (National Center for Education Statistics, 2013).

In the United States, the Department of Education uses the National Assessment of Educational Progress (NAEP) to measure student performance in a myriad of subjects to report the progress in the Nation's Report Card. Starting in 2006, the NAEP measured the economic literacy of twelfth grade students focusing on the areas of market economy, national economy, and international economy (National Center for Education Statistics, 2013). The NAEP assessment in Economics was given a second time in 2012 to almost 11,000 twelfth grade students. The researchers compared the overall economic literacy scores of 12^{th} grade students from 2006 to 2012 which has remained relatively the same. The reports indicated that only three percent of the student participants scored in the advanced level. Students at the advanced level could calculate real interest rates and understand the cause and effect of currency changes on import and exports. Most students fell in the Proficient (39% in 2006 and 40% in 2012) or Basic (38% in 2006 and 39% in 2012) levels. Proficient level students were able to analyze the role of competition in entrepreneurship as well as identify the economic measure of inflation to be the Consumer Price Index. Basic level students could identify key traits of different economic systems and recognize examples of the governments involvement in the economy. The percentage of Below Basic students dropped from 21% in 2006 to 18% in 2012. Students scoring in the below basic level could primarily identify key terms but struggle to recognize scenarios or examples related to those terms or analyze how one concept impacts others.

Economics can be taught as a separate class or integrated into other social studies courses. Typically, elementary and middle school integrate economic concepts into their social studies courses whereas high schools teach it as a separate course (Walstad, 2001). Saunders and Gilliard's (1995) developed the Framework for Teaching Basic Economic Concepts and established many of the core concepts taught in high school economics courses in the United States. Their framework focused on 21 core concepts divided into four domains or categories. The first domain was Fundamentals, which includes the concepts of scarcity, opportunity costs, production possibilities, and economic systems of government. The second domain was Microeconomics, which included supply, demand, businesses, consumers, as well as circular flow of money. The third domain, Macroeconomics, focused on national economic measures such as gross domestic product, unemployment, and consumer price index as well as aggregate demand, monetary policy, and fiscal policy. The fourth domain was international economics, which focused on why countries change, comparative and absolute advantage, as well as exchange rates. In Georgia, there is also a fifth domain dedicated to personal finance topics of budgeting, saving, credit, taxes, and insurance.

Several studies have examined different ways to be successful in an Economics course as well as characteristics of proficient Economic students. Some researchers have focused on teaching styles, professional development of economics teachers, high school economic courses, and collegiate economic courses (Allgood, Walstad, & Siegfried, 2015; Anderson, Benjamin, & Fuss, 1994; Singh & Bashir, 2018; Swinton, Scafidi, & Woodard, 2012). Other researchers focused on student characteristics such as gender, attendance, motivation, previous math courses, and previous math scores (Arnold & Straten, 2012; Evans, Swinton, & Thomas, 2015; Fisher, Guilfoyle, & Liedholm, 1998; McCrickard, Raymond, A., Raymond, F., & Song, 2018; Williams, Waldauer, & Duggal, 1992). Previous studies have established a strong correlation between math ability and success in Economics (Ballard & Johnson, 2004; Evans, Swinton, & Thomas, 2015; McCrickard, Raymond, A., Raymond, F., & Song, 2018). However, the criteria establishing math ability has varied from SAT scores, Grade Point Averages, Geometry end of course test scores, Algebra end of course test scores, performance in calculus course, or enrollment in remedial math course (Arnold & Straten, 2012; Ballard & Johnson, 2004; Benedict & Hoag, 2012; Brasfield, Harrison, & McCoy, 1993; Cohn, E., Cohn, S., Balch, & Bradley, 2004; Ely & Hittle, 1990; Evans, Swinton, & Thomas, 2015; Hoag & Benedict, 2010; Lagerlöf & Seltzer, 2009; McCrickard, Raymond, A., Raymond, F., & Song, 2018; Palmer, Carliner, & Romer, 1979). Within this vast body of research, there have been few studies applying this information as an intervention. Using the strong connection between math and economics, this study will develop a math intervention to help support economics students. The success of the intervention will be measured by comparing participant and non-participants scores in standardized exams.

Statement of the Problem

While taking an economics course does improve student performance on economics literacy tests, overall achievement is still very low (Walstad & Rebeck, 2001). More than half

(57%) of high school seniors performed below a proficient level on national exam of economics in 2012 (National Center for Education Statistics, 2013). In the state of this study's focus school, high school students are given an End of Course test in Economics. While not identical to the national exam, the state tests cover very similar Economics topics. During the 2018-2019 school year, 110,732 students took the Economics End of Course test statewide (Governor's Office of Student Achievement, 2020). Fifty-one percent of students scored below Proficient on the End of Course test (24% Beginning Learner level and 27.7% Developing Learner level). Thirty-five percent of students scored in the Proficient learner level and twelve percent were Advanced learners. At the school research site, 826 students took the Economics End of Course test in which 37% were beginning level, 33% developing level, 26% proficient level, and 4% advanced level.

There are several factors which contribute to low achievement in Economic courses. Previous research has studied gender differences, attendance, peer effects, and the way the courses were taught (Allgood, Walstad, & Siegfried, 2015; Lumbsden & Scott, 1987; Siegfried (1979) Singh & Bashir, 2018; Swinton, Scafidi, & Woodard, 2012; Ullmer, 2012; Williams, Waldauer, & Duggal, 1992; Zimmerman, 2003). Ballard and Johnson (2004) researched the determinants for success in college level introductory microeconomics course. They found that math ability had a significant impact on performance in microeconomics. The researchers utilized math score on the ACT, enrollment in a Calculus course, and enrollment in a remedial math course to determine math ability of students. Students who scored high on the math portion of the ACT or had taken a Calculus course tended to perform better in microeconomics than students who were required to take a remedial math course.

Academic achievement in Economics primarily impacts high school and college students because they usually take Economics courses. The research literature is limited to studies which examine the influence of math interventions to help students with remedial math skills to help them perform better in Economics. Up to date, only one study could be located that has used a math remedial course to assist Economics majors at a college in England. Lagerlöf & Seltzer (2009) found that the remedial math course did help students who traditionally do well in school. However, the remedial math course did not have much impact on students who have traditionally struggled in school. This study will contribute to the body of knowledge by creating a math-based intervention for high school Economic students as well as utilizing quantitative and qualitative measures to investigate the impact of the intervention on overall Economics performance.

Purpose of the Study

The purpose of this convergent parallel mixed methods study is to better understand student performance in Economics with math supports by converging quantitative and qualitative data. In this study, state assessments (End of Course tests) will be used to measure the relationship between economic performance and math ability of 11th and 12th grade high school students at an online school in Georgia. At the same time, the central phenomenon of student engagement will be explored using observations on intervention sessions, and pre-test, mid-test, and post-test scores using Likert-based survey questions. Data will be analyzed separately, and the results will be then integrated using triangulation. The reason for collecting both quantitative and qualitative is to converge the two forms of data to bring greater insight and information about the influence of a math-based intervention on student performance in economics (Creswell & Plano Clark, 2018).

Research Questions and Hypotheses

- Quantitative Question 1: What is the difference in Economics End of Course scores (Cohort 2018 and Cohort 2019) OR Economics benchmark assessment scores (Cohort 2020) between 11th and 12th grade high school students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention?
    - *Null Hypothesis (H_o) for RQ1* There is no statistically significant difference between students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention on the Economics End of Course test (Cohort 2018 and Cohort 2019) or Economics Benchmark Assessments (Cohort 2020) for high school Economics students.
    - *Alternative Hypothesis (H_a) for RQ1* There is a statistically significant difference between students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention on the Economics End of Course test (Cohort 2018 and Cohort 2019) or Economics Benchmark Assessments (Cohort 2020) for high school Economics students.
- Quantitative Question 2: What change can be seen in Cohort 2020 11th and 12th grade high school students' knowledge between pre-test and post-test scores who participated in the math skills support intervention?
    - *Null Hypothesis (H_o) for Quantitative Question 2* There is no statistically significant difference in knowledge between pre-test and post-test scores of 11th and 12th grade students' who participated in the math skills support intervention.

- *Alternative Hypothesis (H_a) for Quantitative Question 2* There is a statistically significant difference in knowledge between pre-test and post-test scores of 11th and 12th grade students' who participated in the math skills support intervention.

- Qualitative Research Question: What forms of student engagement and teaching strategies can be observed during the math intervention for 11th and 12th grade high school economics students?
- Mixed Methods Research Question: To what extent did student engagement during the math intervention for Cohort 2020 11th, and 12th grade students improve performance on Economic Benchmark Assessments?

Theoretical Framework

This study will utilize cross-curricula approach to support the math intervention for Economics. A cross- curriculum approach has a long history stemming from Ancient Greek to Enlightenment philosophers as well as 20th century progressive educators, and governmental reforms (Barnes, 2015). Progressive educators such as Montessori, Freinet, Petersen, and Steiner encouraged freedom as well as choice in education to fulfill student development, while encouraging making connections between subject matter and the real-world (Beckmann, 2009). Dannels and Gaffney (2009) pinpointed the 1970s as the start of the cross-curriculum approach, but suggested the theory gained more momentum in the 1980s and 1990s. Several researchers have found that the process of connecting ideas across multiple content areas can help students solidify ideas in their minds (Barnes, 2015; Ward-Penny 2011; Savage, 2011).

Barnes (2015) stated "lasting, transferable learning in both pure subject and cross-curricular contexts is generated by emotional relevance, engagement in fulfilling activity, and working on shared challenges with others" (p. 265). Barnes (2015) identified six different cross-curricular approaches – tokenistic, hierarchical, multidisciplinary, interdisciplinary, opportunistic, and double focused. Tokenistic cross curriculum approach is not really a cross cultural approach except in name. Barnes gave the example of using a song to introduce a topic. While the song may be engaging and the lyrics may focus on the content, this only teaches you about the content, and not about song writing or music theory. Hierarchical cross-curricular approach places the focus of learning on one main subject, and then the second subject helps students to understand the main subject better. Through this process, students learn more about both subjects even though one subject holds more of the focus. Multidisciplinary refers to two or more topics being taught at one time to help shed light on a single experience or event. For example, students in history class reading survivor journals from the Holocaust. The students learn about history, first person accounts, primary documents, and journaling. On the other hand, interdisciplinary has the goal of connecting, or combining two or more multiple subjects to generate something new. Opportunistic cross curriculum learning is typically lead by the students in response to an event, visitor, or stimulus. Teachers provide students an opportunity to select how to understand or express their experience better. Lastly, double-focus cross-curricular learning refers to the balancing of single subject focus and cross-curricular approaches at the same time to aid in studying items in depth.

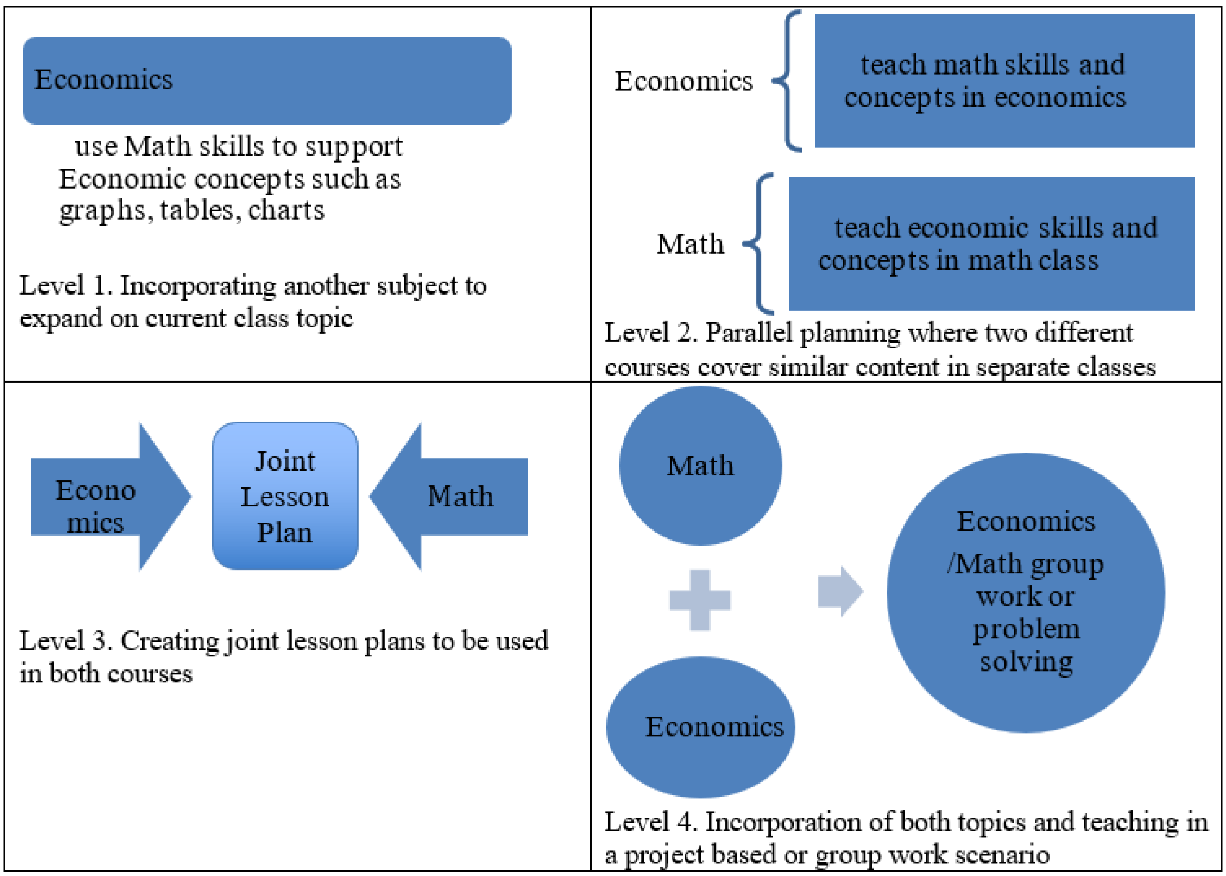
The cross-curriculum approach includes synthesis, knowledge, and skills from various subjects (Savage, 2011). Beckmann (2009) developed a conceptual framework for cross-curriculum teaching with the primary focus being on instruction. In Beckmann's framework, cross-curriculum is "instruction within a field in which subject boundaries are crossed and other subjects are integrated into the teaching (how and for whatever purpose or objective)" (p. 16). Beckmann acknowledges two main forms of cross-curriculum teaching: trans-disciplinary and inter-disciplinary. Trans-disciplinary usually extends from one area of study into another area of study, whereas inter-disciplinary combines and collaborates between multiple areas of study. Inter-disciplinary aligns with Savage's (2011) definition of cross-curricular approach, "characterized by sensitivity towards, and a synthesis of, knowledge, skills, and understanding from various subject areas. These inform an enriched pedagogy which promotes an approach to learning which embraces and explores this wider sensitivity through various methods" (p. 8-9).

There are four levels of cooperation in Beckmann's (2009) conceptual framework as seen in Figure 1. In the first level (topic-and major subject-related form), a teacher incorporates another subject(s) to expand on the current topic or content in his or her subject area. In the second level (parallel topic-related form), teachers plan across different content areas to cover similar content at the same time. In the third level (parallel planning form), teachers from different subject areas create joint lessons that are used in both classes. In the fourth level (joint planning form), teachers focus on topics in which the topics integrate multiple subject areas, and students tend to work in groups.

For this study, we will be using a level one topic-and major subject-related form (Beckmann, 2009). Economics will be the major subject and we will focus on topics and skills that overlap between math and economics. Barnes (2015) would call this hierarchical cross-curricular learning in which one subject, math, is used to enhance the learning of another subject, economics. Using a cross-curricular approach with math can have many benefits for students such as "[familiarizing] pupils with the idea of applying mathematics in context, encouraging them to develop the skills of selecting appropriate mathematics, applying it and critically evaluating its use against real concerns or limitations" (Ward-Penny, 2011, pp.5). A few skills that overlap between math and economics are reading and interpreting graphs, charts, and tables as well as understanding ratios. Basic addition and subtraction are important when calculating GDP (Gross Domestic Product). Additionally, mathematical modeling can be used to demonstrate economic concepts (Ward-Penny, 2011). Students with deficiencies in these math skills will most likely struggle with the correlating concepts in Economics.

Figure 1

Beckmann's Four Levels of Cooperation with Economics and Math examples

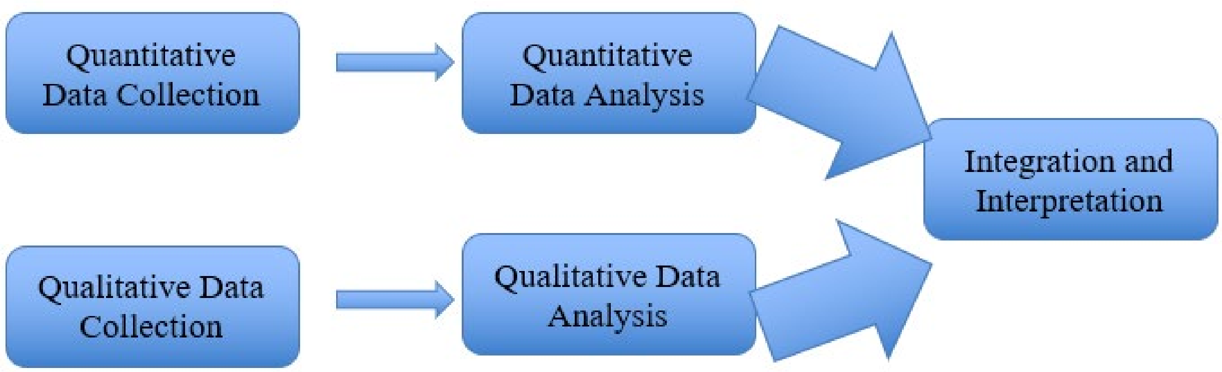


Methodology Overview

This study followed a convergent parallel mixed method design in which the quantitative and qualitative strands of data were simultaneously collected and analyzed before being integrated together as seen in Figure 2 (Creswell & Plano Clark, 2018). In convergent mixed methods design, results from qualitative data (student engagement and motivation) can help support results from quantitative data (higher or lower EOC scores for intervention participants). This provided a fuller picture of the results than could have been derived from a quantitative only, or qualitative only study (Johnson & Onwuegbuzie, 2004). Integration of Mixed Methods research occurred at three levels (design, method, interpretation, and reporting). Joint displays, data transformation, and narration were used to integrate and interpret the quantitative and qualitative data. (Fetters, Curry, & Creswell, 2013).

Figure 2

Convergent Parallel Mixed Methods Research Design (Creswell & Plano Clark, 2018)



Quantitative Strand

The quantitative strand utilized a causal-comparative quantitative research design since the groups were already formed. Economic ability was the construct measured in the study. The independent variable was assignment of students in the math skill support intervention group (experimental group) and no math skill support intervention group (control group). The Economics end of course test scores for December 2018 and 2019 was our dependent variable for Cohort 2018 and Cohort 2019. The Economic end of course test scores were collected by the state's department of education. The dependent variable for Cohort 2020 was the district created Interim Assessments since the end of course test stopped being given in Economics during the fall of 2020. To test if the intervention had a statistically significant impact, we conducted an independent sample t-test to compare the score means between participants in math intervention to the mean score of students not taking part in the intervention. Additionally, we used a pre-test and post-test measure of 15 items on the concepts covered in the intervention to examine if student knowledge changed overtime. A dependent t-test was conducted to measure if the change between pre-tests and post-tests was statistically significant.

The sample population was 11^{th} and 12^{th} grade students from an online high school in the southern United States. We used a cohort model for participants. The first two years of data will be retrospective and represented by two cohorts (Fall 2018 and Fall 2019) because Economics is taught only in the fall semester at the participating school. All retrospective cohorts have participated in a math skills support intervention to improve Economics skills. The interventions consisted of live sessions with a math teacher, and Economics teacher in which the focus is on math skills used in Economics. Fall Cohort 2018 had 30-minute sessions twice a week for 10 weeks. Fall Cohort 2019 had 45-minute sessions once a week for 10 weeks. The third cohort, Cohort 2020, was from fall 2020 and spring 2021. Algebra I and Geometry End of Course scores from 2016 to 2019 were used to purposively sample and invite students to the intervention for Cohort 2020. Students who scored at the Beginning or Developing level on the Algebra I and/or Geometry End of Course tests were invited to participate in the math skills support intervention for Cohort 2020. There were ten total intervention sessions (five in fall and five in spring), which were 45 minutes long once a week. The intervention sessions began around the fifth week of the fall semester. This allowed the researcher time to contact potential participants and receive parental consent to participate in the intervention. The intervention sessions ended the week of the semester finals. Topics for intervention sessions were determined by the economics and math teacher, who looked for Economic topics that utilize math skills. For example, economics uses graphs in supply and demand curves, as well as production possibility curves. Therefore, one or more sessions for the math skills support intervention focused on how to interpret graphs.

Qualitative Strand

The qualitative strand used a phenomenology design (Creswell, 2013). The sample for the qualitative strand consisted of the same students who took part in the intervention during the quantitative strand (Cohort 2020 experimental group). The qualitative strand did not observe the control group students as they did not participate in the intervention. Observations were utilized to study 11th and 12th grade student engagement in math intervention for Economics. Observations were beneficial for researchers to see how people verbally and non-verbally interacted and communicated with each other (Schmuck, 1997). The observation protocol was based on the Behavioral Engagement Related to Instruction (BERI) protocol created by Lane and Harris (2015). The protocol consisted of observing 10 students during a 50 min class and noting how many students within the group of 10 were engaged during different activities. Observation points were taken either after a page of notes, changed to a different activity, or after two-minute interval depending on which time interval was shorter. The observation point could be listening, writing, reading, engaging in computer use, and interaction with instructor and student. Observation points for disengagement could be settling in/packing up, unresponsive, off-task, disengaged computer use, disengaged student interaction, and distracted by another student. Qualitative data was analyzed by looking for trends of student engagement. Trends were measured from the observation notes by tallying on-task and off-tasks behavior, comparing time and engagement during different activities, as well as coding written words and phrases into different categories and themes. Quantitative and qualitative data were integrated using joint display table, data transformations, and weaving (Fetters, Curry, & Creswell, 2013; Guetterman, Fetters, & Creswell, 2015).

Delimitations and Limitations

The consistency in selection criteria and the intervention across the three fall semesters was a limitation. Cohort 2018 was selected based on performance for Economics pre-test and Advanced Mathematical Decision-Making pre-test. Cohort 2019 was selected based on Algebra End of Course test scores and the Northwest Evaluation Association (NWEA) Measures of Academic Progress (MAP) Math levels. The process of selecting participants was refined based on the literature.

Johnson and Onwuegbuzie (2004) identified the following limitations for mixed methods research designs: time constraints, generalizability of research findings, social desirability bias, researcher needs to know multiple research methods, and inability to answer all research questions in one study. Time constraints can be a limitation for sequential mixed methods designs as one phase needs to be carried out prior to the next phase. However, time constraints are not as big of an issue in convergent mixed-methods design where there is simultaneous collection of quantitative and qualitative. Generalizability of research findings is another limitation because the study will be conducted in one online school. Social desirability bias can occur because the participant responds in a way that he or she thinks the researcher wants rather than how that individual truly feels. There is a possibility that divergent results are obtained from the quantitative, and qualitative data analysis due to which it may not be possible to answer all the questions.

Issues of parallel concepts, unequal sample sizes, separation of results, and agreement between conflicting results may arise in convergent parallel mixed methods research design.

These issues can lead to difficulty in integration and interpretation of results. (Creswell & Plano Clark, 2018). Parallel concepts refer to the latent construct(s) of the quantitative and qualitative data that were measured. Typically, the quantitative and qualitative data were used to support the results from both phases. There may be situations when conflicting results cannot be resolved because of time, and resource constraints.

Selection of students in the math intervention control group was based on the state end of course Economics assessment. It is essential to understand the conversion of raw scores into scale scores which may vary each year. To address these limitations, the researcher compared the same state issued exam across three years. The exam is not adaptive and could be used to compare scores across years.

Definition of Terms

- American College Test (ACT) – ACT is an exam high school students take to demonstrate readiness for college and is a preferred entrance exam by some colleges – measure abilities in Math, English, Science, and Reading.
- Beginning Learner – Descriptive label for performance on End of Course test. Student scored between (140 to 474). Grade conversion score equivalent is between 0-67. Student has minimal knowledge of the course content and needs substantial academic support (Georgia Department of Education, 2020).
- Benchmark Assessments– administered by the district every 6 weeks to measure student progress in a course. Some content standards cycle to each assessment but the assessment in not identical every time it is given. This assessment was administered to all students in the control as well as the experimental group. The benchmark assessment for only Cohort 2020 was taken into account.

- Cross-Curricular Approach –"Instruction within a field in which subject boundaries are crossed and other subjects are integrated into the teaching (how and for whatever purpose or objective)" (Beckmann, 2009, p. 16).
- Developing Learner - This is a descriptive label for performance on End of Course test. The score ranged between 475 to 524. Grade conversion score equivalent is between 68-79. Student has a basic understanding of the material but has not mastered the content (Georgia Department of Education, 2020).
- Distinguished Learner - This is a descriptive label for performance on End of Course test. The score ranged between 610 to 830. Grade conversion score equivalent is between 92-100. Student has mastered the content at an advanced level (Georgia Department of Education, 2020).
- Intervention Assessment – There were 15 assessment questions administered to only the experimental group of Cohort 2020
- EOC (End of Course Test) - State made assessment required at the end of the course for graduation credit and is worth 20% of the student's final grade (Georgia Department of Education, 2020).
- NWEA MAP (Northwest Evaluation Association Measure of Academic Performance)
- Proficient Learner - This is a descriptive label for performance on End of Course test. The score ranged between 525 to 609.Grade conversion score equivalent is between 80-91. The student has mastered the content (Georgia Department of Education, 2020).
- SAT (Scholastic Aptitude Test) – The test high school students take for entrance into college. It measures students' abilities in Math, English, and Writing.

Significance of the Study

The main contribution of this study to the literature on math ability and academic performance of high school students in economics courses was its mixed-methods design which utilized triangulation. In triangulation, both quantitative and qualitative strands were combined to provide a clear and holistic view of the issue under investigation, to improve credibility and trustworthiness in the data, to examine the data in innovative ways, and reveal unique results from the data analysis (Jick, 1979). There are four types of triangulation-theoretical, methodological, data and researcher (Denzin, 1970). We used methodological and data triangulation. The methodological contribution to the literature included investigating the effect of math-based interventions in economic classrooms. The results of this study could potentially contribute to knowledge within the field of education by demonstrating that math interventions can improve Economic achievement. The results could encourage more schools to implement math interventions to help economic students. The results from the qualitative phase could provide insights into the behaviors that engage students in a math intervention.

Summary

This study used a convergent parallel mixed methods research design to measure the impact of a math skills support intervention on 11th and 12th grade students' performance on the state's Economics end of course test. Participants were selected based on 2016-2019 end of course test scores in Algebra and Geometry. The researcher compared the mean score of students that participated in the intervention to the mean score of students that did not participate in the intervention to see if there was a statistically significant difference. The researcher also measured the change in students' knowledge on concepts which overlap math and economics at two time points during the semester. Additionally, the researcher observed intervention sessions to explore student engagement. Significant findings could lead to changes in instruction for Economics teachers or implementation of more math interventions for Economics.

Chapter II: Literature Review

Economics education impacts every day, real-life decisions. Students who take Economics courses have higher economic literacy than students who do not (Walstad, 2001). In the United States, high school students have below average performance in Economics courses. (National Center for Education Statistics, 2013). Majority of the past studies have looked at college students and have been quantitative in design. This study examined high school student's economic performance and utilized a convergent parallel mixed-methods study design. This study used a cross-curricular math intervention with Economics students because of a strong correlation between math ability and economics.

Several scholarly databases such as ERIC, EBSCO, ProQuest, and Google Scholar were used to review the literature related to the study. The researcher started with the most specific terms related to our study, economics achievement and math intervention*,* within a five-year time span. The limited search terms yielded only 20 research articles. Thus, the search was expanded to focus on the various aspects of student achievement in Economics, such as student characteristics, teaching styles, professional development of Economics teachers, cross-curricular theories, frameworks, and math-based interventions.

Theoretical Framework

In this study, we used a cross-curricular framework with our intervention. A math teacher planned and co-taught the intervention sessions with an economics teacher. Economics was the dominant course, while Math supported and enhanced the Economics content (Barnes, 2015). Ballard and Johnson (2004) made the correlation a strong math ability leads to strong performance in Economics. It is important to improve student's math to improve their performance in Economics. The researcher planned to accomplish this by finding the areas where math and economics overlap, and then use our intervention to focus on those areas. In this study, the researcher used one content area to enhance topics in another content area like Althaser and Hater (2016). However, cross-curricular approaches can take many different forms.

Althaser and Hater (2016) used Economics to enhance Math content for K-5 students. Their research problem centered around engaging students in math content. The purpose of their research questions was to make math meaningful by tying in Economics and real-world connections. The research design was quantitative, but the researchers did include verbal feedback from teachers about the program used. The participants consisted of 203 elementary (k-5) teachers from 10 schools. These teachers participated in job-embedded economics professional development program, Economics: Math in Real Life. Data sources included a 39-question pre-test and post-test of the Test of Economic Knowledge given to teachers. Students in third through fifth grade received a 29-question multiple choice Basic Economics Test before and after the intervention. Students in Kindergarten through second grade received a 15 question Economics Primary Grades Test before and after the intervention. Data collection included the Test of Economic Knowledge given to teachers prior to professional development workshop in fall and then after the last workshop in the January. The researchers collected feedback from teachers at mid-year (January) workshop. Researchers collected student data during the spring semester. Data analysis consisted of comparing averages of pre-tests and posttests. Researchers decided to use a z-test statistic since not all students had pre-test and post-test scores because some students took one test and not the other. The researchers found that teacher's post-test averaged 73%, which was 8-9 percentage points higher than the pre-test scores (66.59%). The grade level averages of students in third to fifth grades improved from pre-test to post-test. However, only the averages for fourth and fifth grade were found to be statistically significant.

Kindergarten and first grade students had a lower post-test score, but this may be due to issues teachers ran into while administering the K-2 exam. Second grade students did have a higher post-test average than pre-test average, but a statistical test was not run due to low sample numbers. The researchers found that having a higher pre-test score in math tended to be a good predictor of student's improved performance in economics. Gender was not a significant predictor while income level was a negative predictor. The teacher feedback indicated that it made sense to integrate economics into math and students liked the hands-on activities. Teachers also indicated that they needed more time as some of the lessons were very long and requested better alignment with their curriculum maps. Implications of this study are that the Economics: Math in Real Life Program increased teacher's understanding of Economics as well as improved student's performance in Economics and math. The program generated support from the community. Limitations of the study included some technical issues which delayed the original timeframe of data collection. Kindergarten through second grade teachers struggled with testing method and sample numbers were too low to run statistical tests. Additionally, teachers felt they needed more time in certain areas because lessons were long. Future research could look at more instances of teachers integrating economics and financial literacy into their courses.

Naia and Cabrita (2013) researched a new organization of schools in Portugal leading to more teacher autonomy, and different structures. Mathematics was identified as the most problematic subject area. The administration proposed to use a vertical cross-curricular Mathematics planning system at the basic school level. Researchers utilized a qualitative micro ethnographic study. There were 11 participants in total- nine females and two males with eight or more years of experience, and a mix of administrators and teachers. Data sources included formal records, semi-scripted interviews, and direct observations collected by the researchers, or gathered from the school district records keeper. The researchers analyzed the data by document analysis, content analysis, and categorization. The research was presented in a descriptive approach (transcribed relevant statements). The results of the study included careful student characterization, use of a wide variety of assessments, and influenced decisions about which activities would be used. The vertical planning system relied heavily on teacher collaboration. Collaboration in cross-curricular mathematics needs to be improved. The mathematics plan encouraged collaboration among teachers. Math teachers acknowledged the benefit of collaboration but had issues to implement it on a regular basis. Researchers suggested future research should focus more on collaborative based instruction that is regularly implemented. Their version of cross-curricular was slightly different that the current study. They looked at content articulation, whereas the present study focused on cross-curricular disciplines.

Goodman (2010) integrated mathematics and economics to promote a better understanding of economics. The researcher proposed a problem-based learning strategy using math to help teach economics. The research was not experimental. The study proposed economic problems that could be taught in undergraduate math courses. Problem-based learning could integrate mathematics and economics to improve understanding of economic concepts. The researcher suggested future research should focus on trying a problem-based approach in a math classroom. The study focused on using math to improve economics which was similar to the current study.

Jaafar and Baishanski (2012) researched student engagement in math and proposed that teaching math through social-cultural context could increase student learning. Researchers utilized case study using food and commodity prices. Students were asked eight questions, some involving research and developing their own definitions and understanding math in the real world. The researchers also used an anonymous survey for three sections of the college algebra class. The participants were 55 college students. Data sources included surveys with a mix of open-ended questions and 1-5 scale questions. The study results showed gains in quantitative reasoning aptitudes specifically targeted by the project. Many students reported strong improvement in abilities to generate and interpret graphs. Almost all students responded that the project helped them learn more about other content than just the quantitative reasoning skills.

These studies demonstrated a positive effect of using cross-curricular approaches. Naia and Cabrita (2013) focused on cross-curricular within the same discipline of math. The concepts of vertical alignment, and content articulation were relevant to this study because student achievement in economics is impacted by the classes that come before it, and how students learn and perform in high school economics impacts their economic understanding in college. Goodman (2010) suggested that the integration of math and economic concepts. This study utilized math skills to enhance understanding of Economics instead of bringing economic problems to a math class to be solved. Lastly, Jaafar and Baishanski (2012) combined social studies and math as well. Although not specifically looking at economics, their students did incorporate real world scenarios which often related to the economy.

Historical Overview

Early research into Economics education began in the late 1970s. From 1979 through the 1980s, the research focused on the impact of high school economics courses on college economics performance and student achievement; gender differences in economic education; and impact of environment on student performance in economics courses (Lumbsden & Scott, 1987; Palmer, Carliner, & Romer, 1979; Reid, 1983; Siegfried, 1979). In the 1990s, research continued on gender differences in economic knowledge, and the impact of high school economics on college economics (Brasfield, Harrison, & McCoy, 1993; Williams, Waldauer, & Duggal, 1992). Additionally, in the 1990s, researchers started addressing characteristics for success in college economics courses as well as the impact of attendance on class performance, and the role of math background on economics courses (Anderson, Benjamin, & Fuss, 1994; Chan, Shum, & Wright, 1997; Durden & Ellis, 1995; Ely & Hittle, 1990; Fisher, Guilfoyle, & Liedholm, 1998; Park & Kerr, 1990). During 2000 to 2009, researchers moved away from topics related to gender and attendance. Instead, researchers' focus shifted to peer effects, and more to the specifics of math ability and its impact on economic performance (Ballard & Johnson, 2004; Cohn, Cohn, Balch, & Bradley, 2004; Lagerlöf & Seltzer, 2009; Zimmerman, 2003). From 2010 to 2019, researchers continued to examine the impact of math on economic, with a few studies on peer effects and student characteristics (Arnold & Straten, 2012; Benedict & Hoag, 2012; Evans, Swinton, & Thomas, 2015; Hoag & Benedict, 2010; McCrickard, Raymond, Raymond, & Song, 2018; Siegfried & Walstad, 2014; Ullmer, 2012). New studies focused on how economic courses were taught and teacher professional development in Economics (Allgood, Walstad, & Siegfried, 2015; Singh & Bashir, 2018; Swinton, Scafidi, & Woodard, 2012). Additionally, one group of researchers focused on the lack of real-world examples used in economics, which makes economics not approachable by high school students, and they suggested active learning such as using pop culture to teach economics concepts (Hall, Peck, & Podemska-Mikluch, 2016).

Performance of High School Students in Economics

The National Assessment of Educational Progress (NAEP) in Economics was administered in 2006 and again in 2012 to measure the economic literacy of twelfth grade students (National Center for Education Statistics, 2013). Overall, the researchers found three groups of students (traditionally low performing students, students whose parents did not finish high school, and Hispanic students) who performed better in 2012 than in 2006, but there were not large learning gains. Students in the 10^{th} percentile gained, on average, five scale points between the 2006 group and the 2012 group, while students in the 25^{th} percentile increased by two scale points between 2006 and 2012. The changes in the 10^{th}, and 25^{th} percentile groups were found to be statistically significant. Meanwhile, students in the 50^{th} percentile only increased by one scale point. Students in the 75^{th} and 90^{th} percentiles did not have a change in average scores between 2006 and 2012. Students whose parents did not complete high school saw an average of five-point scale score gain between 2006 and 2012. Students whose parents graduated from high school, and students whose parents graduated from college averaged one-point scale score gains, whereas students whose parents had some education after high school saw no change in average scale score. Students whose parents did not finish high school performed significantly better in 2012 than in 2006, but their average scores were still lower than the other three groups, thus supporting the notion that parents' education level could influence the academic performance of their children. However, it was encouraging to see this group showing growth. Students whose parents went to college had the highest average scale scores of 160 in 2006, and 161 in 2012. Students whose parents had some education after high school had average scale scores of 150 in 2006 and 2012. Students whose parents completed high school had average scale scores of 138 in 2006, and 139 in 2012. Lastly, students whose parents did not finish high school had average scale scores of 129 in 2006, and 134 in 2012.

Out of the 11,000 seniors that took the NAEP Economics exam, 61% were white, 16% were Hispanic, 15% were Black, 6% were Asian, 2% were of two or more races, 1% were American Indian/Alaskan Native, and there were not enough Native Hawaiian/Pacific Islanders to report. Asian, White, and students of two or more races had the highest percentages of

Proficient and Advanced achievement levels, while Black, Hispanic, and American Indian/Alaskan Native had the highest percentages in Basic and Below Basic achievement levels. Percentages of Black, and Hispanic students at the Below Basic level decreased while the Basic level increased between 2006 and 2012. American Indian/Alaskan Native students saw an increase in Basic level percentages, but the Below Basic percentage remained unchanged between 2006 and 2012. The average scale scores for White students were 158 in 2006 and 160 in 2012. The average scale scores for Asian/Pacific Islander students were 153 in 2006 and 159 in 2012. The average scale scores for American Indian/Alaskan Native students were 137 in 2006 and 136 in 2012. The average scale scores for Hispanic students were 133 in 2006 and 138 in 2012. The average scale scores for Black students were 127 in 2006 and 131 in 2012. The growth of only Hispanic students' scores was found to be statistically significant.

As for gender, the NAEP Economics exam found that males slightly outperformed females. In 2006, males had an average scale score of 152 compared to the average female scale score of 148. By 2012, both male, and female average scale scores increased with males having an average scale score of 155, and females having an average scale score of 149. While males showed more growth, and higher academic achievement than females in economics, the scores were not found to be statistically different.

The developers of the NAEP Economics exam also included four survey questions for the 2012 seniors to answer. Students had to select “Agree or Disagree” with the following four statements based on their experiences in economics related courses from 9th through 12th grade (National Center for Education Statistics, 2013):

(1) Taking the course(s) helped me understand the US economy

(2) Taking the course(s) helped me understand the international economy

(3) Taking the course(s) helped me understand what I hear on the news about current events and public policy

(4) Taking the course(s) helped me understand how to manage my personal finances, now and in the future

From the 2012 group of seniors, 71% of students indicated that Economics coursework helped them to better understand personal finance as well as international economics, whereas 81% stated the coursework improved understanding of current events and public policy, and 86% found the economics coursework in high school increased their knowledge of the United States economy. Black and Hispanic students felt that their economics courses in high school helped them to better understand personal finance. Hispanic students also indicated a better understanding of international economics than other ethnic/racial groups.

Walstad and Rebeck (2001) investigated economic literacy of high school students based on the type of course instruction they received. In 2001, 95% of high school economic courses were a basic economics course which reviewed core concepts. In some cases, students took honors or Advanced Placement versions of this economics course, and in additional cases some students took a more business aligned economics class. The researchers wanted to focus on student achievement and how much is learnt in these economics' courses. Data for this study came from the third edition of the Test of Economic Literacy (TEL). The TEL has a reliability alpha of 0.89. Over 7,000 students across 36 states took the TEL in the 1999-2000 school year. For this study, the researchers compared the results of 1,000 honors or AP economics students to 545 AP and honors social studies students as well as 4,800 basic economics students to 855 general social studies students. Students in the social studies courses were taught economic concepts integrated into the class. The results showed that having a separate class for economics was much more beneficial to students than integrating it into other social studies curriculums. On average, regular social studies students scored 20 points lower than students from basic economic courses, whereas students in honors or AP economics course scored, on average 17 points higher than students in a non-economics AP or honors social studies course. While students from basic economic courses performed better, their overall performance was still concerning as they averaged 61% correct on the TEL.

As seen in Table 1, both studies focused on the economic literacy of high school students. The National Center for Education Statistics (2013) generated their own exam to test for economic literacy and found that overall, much growth did not occur between 2006 to 2012 except in specific populations. Walstad and Rebeck (2001) utilized the Test of Economic Literacy to measure student performance, and the results indicated students perform better if in a separate economics course. Both studies indicated that high school students in the United States performed below a proficient level for economic literacy.

College Economics

Allgood, Walstad, and Siegfried (2015) synthesized literature about Economics curriculum for American college undergraduates. Their purpose was to provide a comprehensive look at how economics courses were taught and how economic undergraduate students best learnt. They briefly discussed the history of research on teaching economics, which dated back to the late 1960s, and focused on quantitative research and economic theory. The 1970s brought in the development of the Council on Economic Education within the American Economic Association as well as the Journal on Economic Education, and the Test of Understanding College Economics, which was the first standardized measure for economics courses. In the 2011-2012 school year, almost 28,000 undergraduates earned a bachelor’s degree in economics.

Table 1

Performance of High School Students in Economics

Concept	Study	Participants	Outcomes	Uses
Economic Literacy of High school students	National Center for Education Statistics (2013)	11,000 12th grade students	Growth in economic literacy evident in Hispanic students, students whose parents did not finish high school, and traditionally low performing students. Overall, literacy still low as only 3% score in advanced level and 39% were proficient.	Gives a good frame of reference for how students are performing in economics across the country. Although different tests, can compare the student outcomes on this test to the EOC test.
Economic Literacy of High school students based on type of course	Walstad & Rebeck (2001)	7,000 high school students across 36 states	Separate class for economics more beneficial for economic literacy than integrating concepts into other social studies courses. Still, improvements need to be made as students averaged 61% on the Test of Economic Literacy.	Supports having a separate class for economics and encourages finding new ways to improve economic literacy. Might could use test questions from Test of Economic Literacy.

According to Allgood et al. (2015), the main goal for undergraduate economics majors was to think like an economist. Students were primarily taught to use deductive reasoning skills, and how to use various models to understand economic concepts. Economic professors indicated in a survey given by Myers, Nelson, and Stratton (2011) that critical thinking skills were the most important set of skills economics students could possess. Most economics programs around the country require some classes in microeconomics, macroeconomics, and at least basic level statistics. There appears to be a gender gap in number of economics majors. Only about one-third of economics majors are female. There is not much data to support why females are underrepresented in economics education. Introductory courses were found to be a good way to recruit students to become economics majors. Students can take these introductory courses prior to declaring a major. One facet of research in the few decades has been on teaching methods for economics. Many studies have focused on interactive methods including discussions, case studies, classroom experiments, cooperative learning, and more. Studies on classroom experiments had mixed results, in that some students found an improvement in student achievement while others concluded that experiments did not have significant change in the student's performance in economics. Studies on cooperative learning have had positive results. Studies of online classes versus in person classes have found that students performed better in-class than online. However, a study of a hybrid course (part in person and part online) showed that students' performance was similar to those in the full in-person course.

Becker (2000) discussed what economic ideals were being taught at a collegiate level, how these courses were being taught, and how to best assess student learning in these courses. The primary focus for college courses has been on Macroeconomics, so that students could understand what was happening in the economy around them. Becker felt that the information in the Economics textbook was good, but some concepts such as nominal versus real interest rates were being left out. Becker also mentioned that economics teachers struggle with selection of analytical framework which should be used while teaching the course. As for microeconomics, Becker argued that many textbooks use more hypothetical market scenarios instead of real-world examples, so some students had trouble connecting with the information. Becker recommended reordering how the content is taught, so that more student engaging material is towards the beginning of the course. Becker acknowledged the roles of the American Economic Association, the Committee on Economic Education, and the National Council on Economic Education in expanding the teaching and understanding of economics. Becker questioned if there will be a shift of how economics is taught in the coming years. When writing this article in 2000, most economics courses were primarily lectures, even though many other college courses had switched to more of a discussion-based model. Becker predicted that economics courses would become more interactive and based on real world events as well as incorporate more usage of the internet. As for assessment, Becker criticized the use of student evaluations for teachers as an accurate method to determine what learning is taking place and recommended moving beyond just multiple-choice tests towards something that would involve students more with current events.

Singh, Guo, and Morales (2015) researched current upper-level economics courses not offering student opportunities for individual research, and proposed inclusion of student research that could improve student understanding of economics. Researchers utilized a mixed-methods approach. The participants were teachers of the course as well as seven students. Data sources included questionnaire, observations, and previous school surveys. Researchers collected the data by questionnaires. The results indicated that students felt the research, group project, and presentations improved their knowledge of economics, ability to write in a scholarly fashion, and make them employable in the future. Implications of the study indicated that individual research, and time to review professional literature is beneficial to college students.

Happ, Forster, Zlatkin-Troitschanskaia, and Carstensen (2016) discovered that there was little research on prior knowledge of economics and proposed to examine the level of prior economic knowledge at beginning of business, and economics degree program as well as personal factors. Researchers utilized a quantitative survey. The participants were 241 first year college students in Germany. Data sources included the Test of Economic Literacy, which had two versions, each version had 45 items. Researchers collected the data by summer 2014 through Version A. Then, the researchers analyzed the data by regression analysis to look at influences of gender, mother tongue (German), major course in economics at a specialized upper secondary school, commercial vocational training, and grade upon leaving school. The results of the study were gender influenced in favor of male participants in the United States and Germany. Significant differences in test scores were related to a student's completion of economic training in high school or testing in native language. Implications of the study indicated that prior economic experiences could influence student prior knowledge when entering a college level economics class. The researchers suggested expanding their research to other countries.

As seen in Table 2, all four studies gave insight into collegiate economics. Allgood et al. (2015) presented a brief history of economics education and noted trends, such as the benefits of hybrid learning, inclusion of more classes which included interactive elements, and girls were less likely to major in Economics. Becker (2001) made predictions that economic classes can become more interactive and focused on real world scenarios. Singh et al. (2015) made the classes more interactive by including self-led student research projects, which helped the students to improve their content learning experiences. Lastly, Happ et al. (2016) linked performance in high school economics to performance in college economics. These studies encouraged the development of more interactive sessions during the intervention for the purpose of better preparing students for life outside of high school.

Table 2

Post-Secondary Economics

Concept	Study	Participants	Outcomes	Uses
Teaching of College Economics	Allgood, Walstad, & Siegfried (2015)	Not applicable – literature review	History of economics education. questions around gender and why so few female majors. finds that face to face tends to be better than online but hybrid does well also.	Understanding changes in teaching Economics at the collegiate level.
Teaching of College Economics Courses	Becker (2000)	Not applicable – author reflection	Predicted economics courses would need to become more interactive over time. suggested more real-world scenarios for economic concepts.	Be sure to include interactive pieces and real-world scenarios in intervention.
Use of individual research in upper-level college economics courses	Singh, Guo, & Morales (2015)	Teachers of course and 7 students	Students indicated the ability to conduct research, and read scholarly literature helped them better understand the economic concepts.	Might not be able to fit in a full research project during intervention but offering some type of student autonomy or ability to figure things out could be beneficial.
Prior knowledge of economics for business and economics majors	Happ, Forster, Zlatkin-Troitschanskaia, & Carstensen (2016)	241 first year college students	Performance in high school economics played a large role in college economics outcomes.	Better preparing students in high school will help them after the graduate.

Math Ability and Economics

Within the last 20 years, research has focused on performance predictors for success in economics. Most of the research has centered around college students with a few studies on high school students. Cohn, Cohn, Balch, and Bradley (2004) studied the relation between student attitudes toward graphs and performance in economics. Attitude variables included having difficulty with graphs or finding the graphs helpful. The study examined survey responses, and performance data from 663 undergraduate students enrolled in a one semester economics course. Participants signed an informed consent allowing collection of SAT scores and cumulative GPA (grade point average). Researchers used univariate and multivariate distributions as well as looked at frequencies and ordinary least square regression (OLS) of the data. Many students indicated that graphs in microeconomics and macroeconomics were helpful. However, their performance in the economics class did not really change based on graphs being helpful. Females, white and non-white, indicated that the most problems with graphs, whereas males, white and non-white, found graphs to be helpful. Researchers also found that GPA, and SAT scores were statistically significant in predicting economic performance.

Ballard and Johnson (2004) also researched the connection between math ability and economic performance. They used the following criteria to determine math ability: ACT math score; previous enrollment in calculus course; previous enrollment in remedial math; and student score on researcher created assessment of very basic mathematical concepts. Their data sample consisted of 1,462 college students. The researchers conducted OLS regression on the predictor variables along with the students' performance in economics courses. Students that took calculus tended to answer 2.83% more questions on microeconomic exams than students who did not previously take economics. Students who previously took economics in high school had no significant effect on microeconomic performance. Students who were required to take remedial math had an average deficit in microeconomics. Student's math ACT scores were compared to their math-quiz results which helped to substantiate the reliability of the quiz as students demonstrated about the same level of proficiency on both measures. Authors found a connection between success in microeconomics and basic algebra skills. The results of Ballard and Johnson

(2004) study provided the justification to use the Algebra I End of Course exam scores as screeners for participants.

Like Ballard and Johnson (2004), Evans, Swinton, and Thomas (2015) found algebra to be a good predictor of economics performance. The researchers examined which math sub-disciplines had an impact on economics performance. The study focused on the effects of algebra and geometry skills on performance in high school economics. Evans et al. (2015) used a statewide data set of high school students for their research. From 2004 to 2008, 92,680 high school students took the Algebra I EOC, Geometry EOC, and Economics EOC. The study found that one standard deviation increase in Algebra led to 0.20 standard deviation increase in economics EOC score. However, one standard deviation increase in Geometry leads to 0.37 standard deviation increase in economics EOC score. Researchers concluded that algebra and geometry are both good predictors of performance on the economics EOC. Yet, geometry has more predictive power than Algebra. We will use Algebra I and Geometry EOC scores to identify students for the intervention in the present study because of the findings from Evans et al. (2015) study.

Mumuni, Acquah, and Anti Partey (2010) investigated the relationships between math and economics performance among high school seniors in Ghana. Participants were from four high schools in the same region with 92 students from each school. The total sample consisted of 368 students -180 females and 188 males. The researchers used a descriptive survey (questionnaire) that contained a test of economics understanding and a test of mathematics understanding. Data analysis consisted of correlation and regression statistical models. Math performance had a positive impact on economic performance and could be used as a predictor for economics performance. Implications of the study were that students enrolled in Economics should also take an elective in math to improve their performance in Economics. This supports the need for a math intervention for low performing math students enrolled in Economics.

Arnold and Straten (2012) studied motivation and math skills as determinants of first-year performance in economics. They examined the impact of motivational factors on economic success as well as the possibility of motivation overcoming math deficiencies. The researchers provided 629 college freshmen a survey which focused on student choice and motivation. Then, the researchers connected the survey data to a second data set from the school information system which included information on study progress and background of students. The study compared motivation and math skills information to success in first year economics by conducting a factor analysis and regression. Intrinsic motivation was found to be the most correlated with academic performance in first year economics. Additionally, intrinsic motivation could help students with lower math abilities overcome some struggles to do well in economics.

These studies summarized in Table 3 set the basis for the intervention. These studies made the connection between math performance and economics performance. A student that performed well in math could be expected to perform well in Economics. Based on data from Ballard and Johnson (2004) as well as Evans, Swinton, and Thomas (2015), Algebra and Geometry performance was used to select the target population for intervention. Mumuni, Acquah, and Anti Partey (2010) recommended a separate math intervention or course running parallel with economics. Cohn et al. (2004) found that female students struggled with reading graphs in Economics. In the math intervention, skills such as reading, drawing, and interpreting graphs could be improved upon. Arnold and Straten (2012) indicated that students need intrinsic motivation to improve academic performance. The goal of the intervention is to improve math and economics skills to increase student confidence, and intrinsic motivation which should lead to improvement of student performance.

Table 3

Math Ability and Economics

Concept	Study	Participants	Outcomes	Uses
Performance Predictors	Ballard & Johnson (2004)	1,462 college students	Found connection between success in microeconomics and basic algebra skills. More successful in college economics if previously had calculus.	Utilize algebra data to help select potential participants for intervention.
Performance Predictors and perceptions of graphs	Cohn, Cohn, Balch, & Bradley (2004)	663 college/ undergraduate participants	Majority of female students felt intimidated by graphs whereas majority of males found the graphs helpful. SAT and GPA good predictors for economic success.	Find ways to make learning about graphs less intimidating for all students in intervention.
Performance Predictors	Arnold & Straten (2012)	629 college freshmen	Results indicate intrinsic motivation has the largest impact on performance.	Encourage students to participate in intervention based on growing their skills and knowledge.
Performance Predictors	Evans, Swinton, & Thomas (2015)	92,680 high school students	Researchers concluded that while algebra, and geometry are both good predictors performance on the economics EOC that geometry has more predictive power than Algebra.	will use Algebra and Geometry EOC scores to identify students to invite to intervention.
Relationship between math and economics performance	Mumuni, Acquah, & Anti Partey (2010)	368 students – 92 from four schools across region in Ghana	Math performance had a positive impact on economic performance.	Supports the need for a math intervention for low performing math students enrolled in Economics.

Interventions in Economics Classrooms

There have been different types of interventions used within Economics education in the last 20 years. While many have been focused on problem-based learning, a few have tried different approaches as well. Wood, Lu, and Andrew (2015) studied understanding economic concepts through a learning study approach. By identifying the object of learning, one could build lessons from that concept. Researchers were interested to see if and how understanding of price prepares learners to engage meaningfully with everyday contexts in which they experience price, and if the perceived differences between the context had an impact on the learner's response to new content. Participants belonged to two classes of high school economics students. Data collection included 13 questions centering around price in the form of testing and interviews. Researchers analyzed the data by categorizing, and tabulating responses to reveal variation across different contexts. The results indicated that understanding of price in terms of a simple model of supply and demand found in current high school economics courses and textbooks may not support learners' engagement with authentic contexts and may not appear relevant to students. Educators need to start with authentic contexts in the world when learning about price and economics.

Similar to Wood et al. (2015), Karunarante, Breyer, and Wood (2016) also utilized a learning study approach. However, they focused more on threshold concepts than objects of learning. Researchers emphasized diversity in students and called for a diversity in curriculum strategies. Their concern focused on students not being able to apply knowledge and thus, wanted to use threshold concepts to solve problems in economics. Their process included implementing curriculum redesign based on threshold concepts, and then comparing student learning experiences. Student learning outcomes were based on traditional curriculum and the redesigned curriculum. Participants included 1,240 college students who responded to a learner experience unit survey which consisted of 22 questions. Out of the 22 questions, five were relevant to evaluating impact of curriculum redesign. The survey had a 5-point Likert scale from strongly agree to strongly disagree and was given at the end of each semester to gauge student experience of transformed curriculum. The t-test analyses revealed that grades went up, and students indicated they liked the format of the redesigned course in the course survey. There was a significant difference in student performance between threshold-based class, and previously non-threshold-based classes. Limitations of the study included very large sample sizes, and *p*-values near zero, which may indicate a large effect size based on sample size.

The shift in focus from individual learner experiences towards group experiences begins with the discussion of Imazeki (2015) study on team-based learning in Economics. The author identifies the lack of collaborative learning in economics as a major problem in economics education. The study used team-based learning with the goal to improve student engagement. The author utilized a mixed methods approach by combining teacher observations with student survey data. Participants included 276 college students over the course of four semesters. The author who was also the class instructor recorded the observation notes. Qualitative data included teacher observation notes and student open-ended comments on the survey. The teacher made notes and comments on how students respond to the team-based learning. The qualitative data did not appear to be coded and was descriptive. Quantitative data included students' surveys given at the end of the semester. A high percentage of students indicated that the team-based approach makes them more likely to attend class (87-90%). Over four-fifths (85-93%) of participants indicated that team-based learning helped them feel more involved in class, while 80-90% of students said team-based learning makes class feel smaller/more intimate. At least three-fourths (74-80%) of participants agreed or strongly agreed that team-based learning makes students more likely to respond to professors' questions, and 60-80% of students would select a team-based learning approach over another course. Majority of participants (80-93 %) selected working with team applications which allowed them to learn more about their own strengths and weaknesses as a team member while 76-87% of participants indicated that they gained deeper understanding of material than from traditional lectures. Team-based learning could be a good tool to use to teach economics. The author mentioned team-based learning tends to work better with smaller classes and moveable classrooms without rigid fixed seats. The study did not analyze or measure if team-based learning was effective in improving student learning and understanding.

Similar to team-based learning, problem-based learning has a group dynamic as well. Maxwell, Bellisimo, and Mergendoller (2001) examined students engaged in active learning economics lessons. The students did not critically think. The researchers proposed teachers should use problem-based learning approaches to actively engage students and have them think critically about a problem. Their 2001 paper was a proposal of what a problem-based learning lesson could look like in economics, but they did not apply this proposal in classroom teaching. Maxwell, Mergendoller, and Bellissimo (2005) focused on problem-based learning (PBL) in comparison to traditional instructional methods. They utilized a quasi-experimental design to focus on the problem of economic knowledge in high school students. The purpose of their study was to examine if PBL could enhance the knowledge and learning of high school students. The researchers focused on Macroeconomics classes that was taught by five veteran teachers at four different high schools. Participants were 252 high school students who were randomly placed in either a PBL or traditional Macroeconomics course. The data instrument was a 16-item multiple choice economics test, which was administered before and after the implementation. Researchers included descriptive statistics and multivariate analysis. The results showed large effect size and a significant difference between PBL and lecture-discussion classes in learning economics. The study results indicated that PBL can be an effective tool for learning macroeconomics. The authors suggested the difference may lie in the instructor teaching the course which they also considered a limitation of the study.

Chulkov and Nizovtsev (2015) also conducted a quasi-experimental quantitative research design focusing on PBL and economics. Participants included 160 MBA economics students. The study found a positive impact of PBL. The PBL module used an integrated case study that focused on a common theme. Students were placed in PBL courses and non-PBL courses based on course sections. Data came from short answer and multiple-choice questions. Assessment questions and the grading rubrics did not vary across institutions or course sections. Test papers from different sections were mixed. Each test was graded twice independently by two different graders. Data analysis included two-tailed heteroscedastic t-test for equality of sample means (Welch's t-test). Results indicated that learning outcomes covered by the PBL themes received higher scores by PBL students than non-PBL students to a statistically significant degree. The three learning outcomes not covered by PBL which were scored essentially the same by both groups. The study implications indicated that PBL significantly affected student learning. PBL also had a positive impact on student performance.

Finkelstein, Hanson, Huang, Hirschman, and Huang (2010) utilized a randomized control trial to measure the effectiveness of problem-based Economics curriculum. This research was conducted under the United States Department of Education’s National Center for Education Evaluation and Regional Assistance within the Institute of Education Sciences. The participants were high school economics students in California and Arizona. The goal of problem-based learning in economics was to increase class participation and content knowledge. Content knowledge was assessed by the Test of Economic Literacy, which included open-ended responses on performance assessments (composite score). Researchers used an experimental design by randomly assigning teachers to either control group, which received no training or materials on problem-based learning for economics, or intervention groups, which included a 5-day training session during summer on problem-based learning in economics and content materials. Economics courses in California and Arizona were taught in one-semester, so researchers used fall and spring cohorts to discuss results. Initially, 4,000 students were included in study, but 2% (81 students) requested to opt out of participation. Originally, there were 106 participating schools with 90 schools having one teacher participating. Sixteen schools had two or more teachers participating, which totaled 128 teachers. Only 64 teachers returned to baseline data because of staff changes. In the intervention group, there were 1,166 male students and 1,063 female students, 896 non-Hispanic white students, 823 Hispanic students, and 488 students of other ethnicities. The control group consisted of 818 male students and 787 female students, 610 non-Hispanic students and 627 Hispanic students. The Test of Economic literacy indicated growth for the intervention group. The Spring 2008 cohort outscored other peer groups. The implications for future research were to encourage classroom observation for clearer understanding of pedagogical practices.

Gill and Bhattacharya (2019) taught financial concepts to 12th grade economics students. They used four groups -two control groups and two experimental groups. One of the control groups contained 11th graders with no previous economic knowledge. The other control consisted of 12th grade economics students who did not receive treatment. One experimental group with 12th grade economics students received intervention focused on money management topics while the other experimental group with 12th grade economics students received intervention focused on financial investment. There were eight class periods over an eight-week period. There were 1,128 students among the four groups. Four-hundred seventy-six students were in treatment/experimental groups. The treatment group focused on money management which had 291 students, while the treatment group focused on financial investment had 185 students. The researchers gave a 40-question pretest/posttest in which questions 1-32 focused on financial literacy and questions 33-40 focused on knowledge of economics. The researchers examined the pre-test and post test scores through an analysis of variance (ANOVA) statistical test and multivariate regression. The regression controlled for gender, student ability with GPA, working status, and school effects. The experimental groups improved scores between pre-test and post-test. The control groups did not show significant gains. There was no statistical difference between the two experimental groups performance.

Three studies suggested using math as an intervention for economics (Goodman, 2010; Lagerlöf & Seltzer, 2009; Robinson & Liard-Muriente, 2018). Goodman (2010) suggested using PBL to merge math and economics, but there was no experiment or intervention. The paper was a proposal for potential solutions. The author developed a suggestion and proposed using PBL to teach an economics problem in an undergraduate level math course. Lagerlöf and Seltzer (2009) used a math intervention for economic majors at a college in England. The researchers wanted to measure the effects of remedial mathematics on learning economics. Students were identified for a remedial math course based on their grade in a required math course for economics majors or if they had not taken the required math course previously. One-hundred and ninety-three students participated in this intervention. The remedial math course was a condensed version of the full math course except that it was more focused on what aligned with Economics concepts. No tests were given in the remedial math course as the goal was to just review concepts. Researchers felt that the remedial math course lacked incentives for students to put effort into the sessions. The researchers utilized administrative records along with regression analysis to collect and analyze the data. They focused on the end of the year exam in required courses for their sample population, including Quantitative Methods, Economics Workshop, and Principles of Economics. Students were placed in the remedial math course, Foundations of Mathematics, if they did not take or earned a graded lower than a B in the A-Level Mathematics course. The students would take this remedial math course concurrently with their Economics and Quantitative methods courses. The results from the main single-equation OLS regression indicated (when controlling for other factors) that remedial math course was not successful in improving students' grades. Students enrolled in the remedial Foundations of Mathematics course alongside the Economics Workshop course saw some improvement in grades, but this economics course was not very mathematical and mostly assessed by essays. The regression did support the idea that previous math background had a significant impact on student economics outcomes. The results indicated that there was some positive impact of a sub-set of students. Students, who traditionally had good academic performance, but did not take A-Level Mathematics, appeared to improve more than students who earned a grade below a B in A-Level Mathematics. The intervention did not appear to help students who historically struggled with math. The researchers noted that the lack of improvement from historically struggling students could be due to the lack of incentives. As seen in Arnold and Straten (2012), students need intrinsic motivation to work towards improving oneself. Lagerlöf and Seltzer (2009) questioned the policy of paying for remedial math courses if there is little evidence showing effectiveness.

Robinson and Liard-Muriente (2018) studied mathematical tutorial software, Math You Need, used to improve math skills for students in Economic classes. Researchers implemented the program at a college in three introductory economics classes. The program has ten modules, each one contained a pre-test, intervention based on students results on pre-test, and then a post-test. Students could move at own pace within the due dates set by instructors. Students were not targeted based on math ability. All students within the three economic courses had access to the Math You Need software program. The original sample size was 120 students. Researchers examined the statistical difference between pre-test and post-test scores of 118 participants (two students did not complete both the pre-test and post-test) as well as the impact of socioeconomic status and academic factors which influenced the success of the iMath program. The researchers developed a regression with the iMath scores as the dependent variable and controlled for gender (female), ethnicity/race (White, Black, or Latino), level of course, and college major. For the pre-assessment, the two prominent factors for lower pre-test scores were self-identifying as Black and being enrolled in a principles-level (beginning level) economics course. However, after completing the iMath program, there was no statistical difference on the post-test scores based on ethnicity/race, suggesting that Black students had closed or at a minimum reduced the achievement gap between themselves and their White and Hispanic counterparts in the course. There was an 11-point reduction in the difference between students in introductory-level courses and students in upper-level courses. The intervention approached significance with a *p*-value of 0.056 which improved post-test scores of students enrolled in the school of Engineering, Science, and Technology. This finding prompted the researchers to believe the program to be a good fit for STEM classes. Overall, the researchers found that the iMath program could be beneficial at the university level to solidify economic knowledge.

As summarized in Table 4, the previous studies focused on interventions in Economic classrooms. there were two studies which centered around learning study approaches and found that students understood better when tied to real world events (Karunarante et al., 2016; Wood et al., 2015). Four studies which focused on team-based or problem-based learning yielded positive results (Chulkov & Nizovtsev, 2015; Hanson et al., 2010; Imazeki, 2015; Maxwell et al., 2005). Lastly, three studies mentioned using a math intervention or teaching math concepts to help economics students. Goodman (2010) proposed using problem-based learning to converge math and economic concepts, but the idea was theoretical and not tested. Lagerlöf and Seltzer (2009) did use a remedial math course to aid in improving Economics students' understanding at the university level. Robinson and Liard-Muriente (2018) provided a mathematical tutorial software, Math You Need, to Economic students and measured its impact on their performance in introductory college economic classes.

Table 4

Interventions in Economic Classrooms

Concept	Study	Participants	Outcomes	Uses
Learning Study approach to economics	Wood, Lu & Andrew (2015)	Two classes of high school economics students	Students need authentic real-world context to understand economic concepts.	Make sure intervention uses authentic real-world concepts.
Threshold Concepts	Karunarante, Breyer, & Wood (2016)	College students 599 first semester and 641 second semester	Students indicated they liked the format in the course survey. Significant difference in student performance between experimental and control groups.	Explore threshold concepts beneficial to intervention.
Team-based learning of economics	Imazeki (2015)	276 college students	Majority of students felt team-based approach helped them feel more motivated in class and more likely to attend class. Also helped them gain a deeper understanding of economics.	Consider using team-based approach during intervention.
Problem Based learning	Maxwell, Mergendoller, & Bellissimo (2005)	252 high school students	Problem-Based learning effective tool in teaching macroeconomics.	Consider using problem-based approach during intervention sessions.
Problem Based Learning	Chulkov & Nizovtsev (2015)	160 MBA economics students	Problem based learning group outscored control group.	Consider using problem-based approach during intervention sessions.
Problem Based economics	Hanson, Huang, Hirschman, & Huang (2010)	128 teachers; approximately 4000 students	Intervention group (PBL based classrooms) outperformed control on Test of Economic Literacy.	Use of cohorts – economics taught in semester similar to school of study.
Remedial Math	Lagerlöf & Seltzer (2009)	193 college students	Some positive impact of remedial math but mostly for students that are relatively stronger students historically. May not help students that struggle that need it. There could be a lack of incentives issue.	Will use this study for comparison as it used a math intervention for economics as well, but on a college level.
Math software to help Economics students	Robinson & Liard-Muriente (2018)	118 college students	Difference between pre and post test results suggest a relationship between students completing the iMath course and improved performance on Economic assessments.	Will use this study as a comparison because researchers used a math intervention for Economics.
Financial Literacy intervention to improve Economics performance	Gill & Bhattacharya (2019)	1,128 11th and 12th grade students; 2 control groups and 2 experimental groups	Both experimental groups outperformed the control groups; there was no statistical difference between the two experimental groups (financial investing vs money management).	Will use this study as comparison because examining same population (11th and 12th grade students) and using intervention in Economics course.

Interventions in Math Classrooms

Kroesbergen and van Luit (2003) conducted a meta-analysis of math interventions for students with special needs (learning disabilities, mild disabilities, and mental retardation). They distinguished their meta-analysis from previous meta-analyses by focusing on which interventions work best with different math domains as well as considering the within-group and between-group variances of the multi-linear regression. The researchers questioned which math domain (preparatory skills, basic skills, and problem solving) had the highest effect size. The researchers looked for trends among study characteristics and treatment parameters. Their final research question focused on where the most variance lies between studies. After filtering through articles based on their selection criteria, 58 studies were included in the meta-analysis. Effect sizes were calculated for all studies. There were around 2,500 students in the study. Over half of the interventions focused on Math facts, then problem-solving, and lastly preparatory arithmetic. About one-third of the studies were single-subject design, while the other two-thirds were group designs. Single-subject designs were found to have a higher effect size than the group designs. Interventions that had a longer duration had less effect than shorter interventions. As for interventions by domain, interventions based on problem-solving were found to have less effect. Overall, self-instruction was found to be most effective unless the focus was basic skills in which direct instruction was found to be most effective.

Wilson and Räsänen (2008) conducted a literature review focused on numeracy interventions. The researchers questioned which factors determined an effective numeracy intervention, which instructional methods were most effective for numeracy interventions, what were the best delivery models for numeracy interventions, and what limitations were being faced by researchers focused on numeracy interventions. The researchers identified four main types of math difficulties students face: number sense; computation; fractions, decimals, and place values; and problem solving. The literature indicated that interventions were most effective on younger participants but could still be effective on older participants. However, it seemed that the type of intervention mattered more than the age. Conceptual type of interventions tended to be better for secondary students, while more hands-on constructivists type learning was better for younger students.

Maccini, Mulcahy, and Wilson (2007) reviewed which math interventions were effective to help secondary school students with learning disabilities. The authors utilized studies between 1995 to 2006 and noted type of intervention, sample participants, target skill, and general results. Overall, slightly over 1,000 students participated in the studies reviewed. About one-third of those students qualified as having a learning disability. There was almost a 50-50 split between males and females. Participant age ranged from 11 to 16 years. The authors categorized the studies by instructional approach (behavioral, cognitive, or alternative delivery method), and by focus of the intervention (conceptual, procedural, and declarative). Authors found more studies on secondary math students, especially Algebra, since a previous review of literature conducted in 1997. Conceptual learning has improved math performance. Students with a learning disability in Math saw improvement with mnemonic strategy instruction, graduated instructional approach, cognitive strategy instruction, schema-based instruction, and contextualized videodisc instruction. Additionally, other aspects of effective instruction included modeling, independent as well as guided practice, corrective feedback, and monitoring student performance.

Myers, Wang, Brownell, and Gagnon (2015) expanded on Maccini, Mulcahy, and Wilson's 2007 literature review. Myers et al. (2015) found 15 additional studies that focused on math interventions for secondary students with learning disabilities. The authors narrowed down the studies by including only studies in which students with learning disabilities participated. They reviewed journals between 2006 to 2014 against a quality control checklist. Once each study passed quality control, they were coded to notate key aspects of the research. The sum of total participants reached almost 3,300, with slightly over 800 having learning disabilities, almost 600 having mathematics difficulties, and over 1,000 students classified as low achieving. The classifications of studies had to change from Maccini et al. (2007) behavioral, cognitive, and alternative delivery system to Myers et al. (2015) solving word problems with cognitive and metacognitive strategies, increasing conceptual knowledge and problem-solving skills by using representations, and enhanced anchored instruction. This literature review did not find any new research-based practices. All effective practices have been mentioned in previous literature reviews including cognitive, and metacognitive instructional strategies, as well as explicit instruction in the form of modeling and feedback. Additionally, Enhanced Anchor Instruction showed significant gains for students with learning disabilities when problem-solving or during computation. Of the 15 studies, 9 were by the same group of authors. Thus, Myers et al. (2015) suggested increasing research on math interventions.

Dowker (2016) utilized a randomized control trial of 300 primary school children in three groups (Catch-Up numeracy intervention, matched-time teaching, and business-as-usual teaching) with approximately 100 students each. The research compared the pre-tests, and post-tests of the Number Screening Test, as well as the reading and comprehension components of Salford Sentence Reading Test. Students who received either the Catch-Up numeracy intervention or the Matched Time intervention improved significantly in numeracy compared to students in the business-as-usual group, although no significant difference was found between the Catch-Up numeracy program intervention and the Matched Time intervention. Girls started higher in intelligence and comprehension but not numeracy. This allowed for higher gains in comprehension for boys as they started at a lower point. Eligibility for school meals impacted performance on pre-tests. Students eligible for free lunch (low SES) performed significantly worse on pre-tests than students that did not qualify for free lunch. However, lunch eligibility did not impact student gains. Significant Pearson correlation coefficients were found on the post-test standard scores between reading, comprehension, and numeracy. Age and numeracy showed a significant correlation as well. Although literacy and numeracy correlate strongly together, literacy had little influence over the gains from mathematical interventions. This is a good indicator for our study that even if a student struggles in numeracy and literacy, students can show gains based on intervention.

Jitendra, Lein, Im, Alghamdi, Hefte, and Mouanoutoua (2018) conducted a meta-analysis of 19 studies, which focused on secondary students with learning disabilities and math difficulties. The researchers examined the average effect of math interventions on secondary students with learning disabilities or math difficulties, differences in effect based on whether the student has learning disabilities or math difficulties, as well as the factors which moderated the instructional characteristics or methodological characteristics of student outcomes from the math interventions. Twenty effect sizes were calculated from the nineteen studies. Sixteen effect sizes were positive in direction, three were negative, and one was zero. The average effect size for students with learning disabilities was 0.50, placing them around the 69th percentile of the control group, whereas the average effect size for students with math difficulties was 0.14, placing them around the 55th percentile for the control group. However, there was not a statistically significant difference found between students with learning disabilities, and students with math difficulties. For instructional approaches, visual models combined with other strategies produced the largest effect size of 0.52. Instructional time greater than 10 hours had a significant effect on student outcomes. As for methodology characteristics, researcher-implemented interventions had the largest effect size of 0.70 compared to school personnel-led interventions with an effect size of 0.35. However, the difference between the two effect sizes were found to be not statistically significant, so how the intervention was implemented may not impact effect size to a great extent. Also, researcher-developed assessments, and standardized assessments yielded only small to medium effect sizes.

Math-interventions have largely focused on students with learning disabilities, math difficulties, or numeracy issues. Students in the intervention may or may not be identified in one or more of these areas. These strategies can still be beneficial to students that have shown weakness in math. Most of the research provided came from meta-analyses or literature reviews. A summary of all studies in this section can be found in Table 5. Only Dowker's (2016) study was experimental. Still beneficial information can be found in these studies. Kroesbergen and van Luit (2003) found it best to limit the length and amount of time for an intervention. Wilson and Räsänen (2008) supported conceptual based interventions for secondary students. Jitendra et al. (2018) calculated effect sizes of previous studies and found that visual based modules which incorporate at least one additional strategy had a high effect size on students with learning disabilities. Maccini et al. (2007) and Myers et al. (2015) identified several instructional strategies which can be beneficial in the intervention. Lastly, Dowker (2016) showed numeracy focused interventions could improve student outcomes despite other factors.

Table 5

Interventions in Math Classrooms

Concept	Study	Participants	Outcomes	Uses
Math interventions for students with special needs	Kroesbergen & van Luit (2003)	2,500 students – meta-analysis of 58 studies	One-third of studies were single subject design. Two-third of studies were group design. Shorter interventions had greater impact. Self-instruction found to be most effective.	Keep intervention to 10-12 sessions. Duration needs to not be too long. Encourage self-instruction.
Numeracy interventions	Wilson & Räsänen (2008)	Literature review	4 math difficulties - number sense; computation; fractions, decimals, and place values; and problem solving. Conceptual intervention better for secondary students.	Use conceptual based strategies during intervention.
Math interventions secondary school students with learning disabilities	Maccini, Mulcahy, & Wilson (2007)	1,000 students – meta analysis	Improvement with mnemonic strategy instruction, graduated instructional approach, cognitive strategy instruction, schema-based instruction, and contextualized videodisc instruction.	Utilize these strategies in intervention.
Math interventions secondary school students with learning disabilities	Myers, Wang, Brownell, & Gagnon (2015)	3,300 students – meta-analysis - Extension of Maccini et al (2007)	Effective strategies found in Maccini et al. (2007) were found to still be effect and enhanced anchor instruction showed significant gains.	Utilize these strategies in intervention.
Numeracy interventions	Dowker (2016)	300 primary school students	Both interventions showed improvement over control group. Eligibility for free meals had some impact over starting point but did not impact growth. Literacy and comprehension had little impact on numeracy growth from interventions.	Supports impact of interventions.
Math interventions students with learning disabilities or math difficulties	Jitendra, Lein, Im, Alghamdi, Hefte, & Mouanoutoua (2018)	Meta-analysis of 19 studies	16 of the studies had a positive effect size. Visual models paired with other techniques had the largest effect size. Researcher-implemented interventions also had large effect size.	Use visuals models plus additional techniques in intervention. Supports researcher-implemented intervention.

Teaching Styles

Rodgers, Hawthorne, and Wheeler (2004) researched the use of reading-based strategies to teach economic concepts in primary grades. They conducted a state-by-state survey of standards and found all 50 states to include some form of economic concepts for primary grades. However, all parts of the national standards focusing on economic education were not being implemented fully across all states. The authors found six states that do include a majority of the recommended but voluntary national standards. They advocated for using reading-based strategies to help students learn the economic concepts and identified over 200 books that could be used in this endeavor. The researchers noted a lack of assessments to measure the impact of reading-based strategies on teaching economics. There are multiple choice assessments for students in upper elementary grades, but no appropriate instrument for lower elementary grades. Most teachers use integration as their primary teaching strategy. Economic concepts are taught in tandem with other subjects or strategies, instead of teaching economics separately, which is typically done in higher grades. In this case, teachers would use stories that incorporate economic concepts during reading time. The process would address reading and economic standards at the same time. Teachers need to be intentional and point out to students what they should be listening for. The researchers also suggested the use of active learning strategies in combination with children's literature. Materials for these lessons can be provided by the National Council on Economic Education as well as SPEC Publishers. While it may take more time than the first strategy, there may be more options for enrichment afterwards.

Watts (2006) reviewed research on pre-college economics education programs and outcomes for the National Council on Economic Education. Watts noted primary and elementary students learn more economic concepts from teachers who know more economics, spend more time teaching economics, and have better instructional materials. At the secondary level, a separate class for economics is necessary for students to accrue more economics knowledge. However, Watts indicated that one course is not enough to be economically literate. Students who do take economics in high school start off stronger in college level economics courses. The high school economics course will be the students' foundation for understanding the economy around them, especially for those who do not graduate from high school, move on to college after graduation, or do not take economics courses in college. Very little research has been conducted on attitudes towards economics and how taking economic classes can alter attitudes. Watts mentioned more empirical and conceptual research was needed for pre-college economics education. Courses in economics at the secondary or collegiate level aid individual's post-graduation, but there appears to be decline in economic knowledge as times goes on. Watts recommended four courses in economics to see a long-term change in economic behavior. As for research, Watts has found that social studies specific research journals have a very small percentage of economics focused articles. Most research completed with the focus on economics education comes from economists.

Davies and Durden (2010) analyzed economics education for undergraduate students and secondary students in the United Kingdom. There has been an increase in the number of undergraduate economics students and courses between 1997 and 2007. The authors noted that students at different schools may have varying experiences with teachers in Economics classes. More research focused on universities may have a graduate assistant teach undergraduate level courses, while some universities have begun offering teaching only contracts, where professors just focus on classes and not research. The authors also researched how the students' social classes impacted taking economics classes. They found that the number of students from managerial and professional backgrounds decreased in economic courses from 2002 to 2007, while students from intermediate and self-employed backgrounds, as well as routine, and lower supervisory backgrounds increased in economic courses during the same time frame. Most first-year economic courses for undergraduate students focused on microeconomics and macroeconomics taught in a lecture style class. Students did experience some workshops and seminars in their corresponding math and statistics classes. Most of the assessments in economic courses were at the end of unit exams, while math and statistics courses offered continuous assessments. Second year of undergraduate economics was found to be very similar in structure to the first year of economics, but there was a slight increase of teachers using workshops and seminars. Economics degrees are highly sought after in the United Kingdom for employees. This has led to an increase in students taking economics courses at the secondary level. Davies and Durden (2010) mentioned that due to perceptions of economics being a difficult course, some schools have nudged students more towards business classes than traditional economics. The authors did not go into as much detail on how secondary economics courses were taught as they did with undergraduate courses, but they did mention high stakes testing, use of cross-curricular approaches, and economics becoming viewed more as an advanced specialty course than something all students need.

Joshi and Marri (2006) focused on the need for more active learning in economics and proposed teaching pre-service teachers active learning strategies. Researchers utilized a qualitative research design. The participants were pre-services teachers in New York. Data sources included feedback from discussions with the pre-service teachers, course evaluations, and course surveys. First, they discovered that pre-service teachers struggled with the philosophical underpinnings of economics. Second, pre-service teachers indicated a need for more exposure to the economics content to feel comfortable teaching the course. Lastly, the participants felt the New York State standards for economics were too vague and preferred using information from organizations like the National Council on Economics Education. The researchers suggested future research should focus on how to best prepare pre-service teachers to teach economics, using active learning methods with economic courses, and if social studies methods courses should have a separate section on economics. This study relates to the problem of low achievement in economics courses because, if teachers are not adequately prepared to teach economics, then that impacts their ability to educate students about economics.

Grimes, Millea, and Thomas (2010) studied variation in teacher delivery of economics content. They determined the level and nature of economic literacy of 350 kindergarten through 12th grade teachers in Mississippi using a quantitative survey and Test of Economic Literacy (TEL) at a spring and summer workshop in 2005. Researchers used a vector model where personal economics knowledge equaled a vector of the teacher's demographic characteristics, vector of teacher's educational endowments, vector of teachers' human capital investments, and vector of teachers' classroom and work environment variables. Researchers also used OLS regression techniques to analyze the data. The only significant variation was in international economics, which was consistent with nationwide survey results. High school teachers had higher TEL scores which was in-line with the fact they attended more economics workshops than elementary teachers.

As seen in Maxwell et al. (2005) and Chulkov and Nizovtsev (2015), Singh and Bashir (2018) also compare the impact of PBL (project-based learning) and Conventional learning on economic learning. The researchers used 12th grade students in India, and purposive sampling to create a control group of 31 students (conventional teaching model), and an experimental group of 31 students (problem-based learning model). Researchers developed a critical thinking ability test in economics. Both groups received 15 days of teaching in their respective methods and were given pre- and post-tests. Raw scores were analyzed with a *t*-test. The pre-test means for the two groups were very close, and researchers did not find a statistical difference between the pre-test means. The control group did show growth between pre-test and post-test scores. However, the experimental group showed a high percentage of growth when compared to the control group. The mean scores of the post-test scores for both groups displayed a statistically significant difference indicating problem-based learning has a greater impact on understanding economics than conventional teaching methods.

Walstad and Watts (2015) researched educators teaching economics in countries that recently changed or transitioned to a market economy. The researchers examined the impact of the International Education Exchange Program (IEEP) training on teachers and student outcomes in these countries going through transition. Researchers utilized a nonequivalent control group with pre and post testing. The participants were an experimental group of 77 teachers trained by IEEP seminars, and a control group of 59 teachers not trained by IEEP seminars. There were 4,151 students in the study. The experimental group of teachers taught 2,328 students, while the control group of teachers taught 1,823 students. Data sources included the Test of Economic Literacy. Researchers collected the data by pretest in October 1996 and posttest in March 1997. The researchers analyzed the data by descriptive statistics and regression model where student and teacher variables were expected to influence the economics learning over time. The study results indicated that students benefited from having a teacher with IEEP training over not having IEEP training. Students showed approximately 11 % growth between pre-test and post-tests. Years of teaching economics experience also had a positive influence on student outcomes.

Student gains were different by country. Kyrgyzstand and Lithunia had higher gains than Poland and Ukraine. The study results indicated that teacher preparation is important for impact gains in students. Limitations of the study were non-random assignment into experimental and control groups; certain types of teachers may have been more inclined to go to IEEP seminars; different countries experiencing different things during the transition. Future research should focus on stronger control subjects and consistent selection criteria.

Valletta, Hoff, and Lopus (2014) researched on teacher characteristics that impact student achievement. The researchers proposed looking at teacher skills of content knowledge, and pedagogical knowledge which could impact student outcomes. Researchers utilized experiment design. The experimental group received federal reserve materials, while the control group learned in a traditional manner. The participants were 62 teachers with two preparations of similar economic classes, and 1,290 high school economic students. Data sources included student and teacher questionnaires and a student test which included 20 multiple choice questions and one essay question to measure student outcomes after intervention. The teachers administered the surveys. The scores of essay questions were completed by a panel of six experienced high school economics teachers. The researchers analyzed the data by regression analysis on post-tests by using a value-added framework. Study results indicates that students' high school GPAs, higher peer GPAs, and self-reported attitudes towards economics had large and significant impacts on post-test scores. Student outcomes experienced growth if teachers majored or minored in economics, had an advanced degree, or more years of experience teaching economics. Post-test scores were one standard deviation higher for students with similar peer GPA than students in the experimental group with the federal reserve materials. Implications of the study included specialized training for teachers which could have a large impact on student outcomes. Small samples were a study limitation.

Balaban, Gilleskie, and Tran (2016) researched teachers not adopting active learning style in economics and proposed flipped classroom model to build on benefits from active learning. Researchers utilized a quantitative research design based on observational data. The participants were college undergraduates in introductory level economics. One cohort was taught in a traditional lecture style, and one cohort was taught by flipped classroom design. Both groups had around 800 students, but not all took the final, so around 720 students completed mid-term and final. Data sources included course mid-term and final test grades; student records including SAT and ACT scores. Researchers collected the data by student records from the administrative office, and class grades from professors. The researcher analyzed the data by looking at demographics, student performance on final exams, previous courses, and other background characteristics. Study results indicated that students in the flipped classroom performed, on average, almost 7 points higher than the traditional lecture format on the final. Even when considering additional factors, the flipped classroom maintained an overall positive effect on student performance and effort. Study implications indicated that students of different backgrounds, and demographics were impacted differently by the flipped classroom model but still saw positive effects. Some groups showed more positive effects from flipped classrooms than others.

Caviglia-Harris (2016) studied the use of a flipped classroom module in an undergraduate economics course. The research design was quasi-experimental. The research utilized two different treatments. There were three main groups - the control group led by traditional lecture; experimental group 1 - the partial flipped classroom with mini lectures and online videos; and experimental group 2 - fully flipped classroom. The two experimental groups were assigned two videos from Khan Academy each week for the flipped classroom assignments. Approximately, 160 students were a part of the study. The results indicated that students in either experimental group performed higher on the course final than students in the traditional or control group.

Vasiliki, Panagiota, and Maria (2016) researched how to teach economics through art, cooperative, and experimental learning, and project methods so that students can understand the subject and the content is relevant in everyday situations. Researchers utilized a qualitative questionnaire as well as semi-structured interviews based on qualitative questions. The participants were 26 1st year senior high school students (15-16 years old). Data sources included questionnaires and semi-structured interviews. Researchers collected the data in two rounds of questionnaires - first round to check for previous knowledge, and second round completed at the end of method intervention. Data was analyzed by reviewing student responses and found common items as well as differences. Results showed that majority of students found the use of art and role playing very helpful in understanding economics. Study implications indicated that using these methods can be beneficial in social studies, especially economics.

The studies addressed in this section are summarized in Table 6. These studies detailed many different teaching styles that school systems can use to teach economics. The studies spanned from primary school to secondary schools to universities. The consensus seems to be a shift away from conventional teaching by lecture to more interactive methods, and more engaging materials for students. This also requires more training, and support for teachers as they make these adjustments to their instruction.

Table 6

Teaching Styles

Concept	Study	Participants	Outcomes	Uses
Reading-based strategies to teach economic concepts in primary grades	Rodgers, Hawthorne, & Wheeler (2004)	State by state survey of all 50 states	States are implementing standards differently and not to the same effect. 200 books could be used to help increase primary student knowledge of economics.	Might can implement some reading strategies in intervention especially for word problems.
Precollege economic programs	Watts (2006)	Precollege economics education programs	Separate class is necessary for economic literacy. Highly recommends more than one economic course.	Better high school performance leads to better college performance in economics.
Economics education for college and high school students in United Kingdom	Davies & Durden (2010)	Undergraduate students and secondary students	Desire for economics degrees to work has increased interested at secondary level. teaching at college level is mostly lecture for first two years and then becomes more interactive.	Try to use more interactive and discussion-based elements in intervention to get students interested.
Active learning and pre-service teachers	Joshi & Marri (2006)	Pre-service teachers in New York	Pre-service teachers were not comfortable with philosophical economic topics and wanted more exposure to content.	Make sure pre-service teachers are prepared and comfortable with economic concepts.
Teacher delivery	Grimes, Millea, & Thomas (2010)	350 teachers – kindergarten to 12^{th} grade	Teachers struggled most with international economics; teachers that attended more economic workshops tended to do better of test of economic literacy.	Better prepare teachers by focusing on professional development and finding resources for where teachers need more support.
PBL	Singh & Bashir (2018)	62 high school students – 31 control group and 31 experimental group	Problem Based learning has a greater impact on understanding economics than conventional teaching methods.	may try to incorporate aspects of PBL into our intervention.
Intervention program for teachers	Walstad & Watts (2015)	77 teachers experimental group and 59 teachers control group	Teachers that took part in the International Education Exchange Program had higher scores of the test of economic literacy than teachers	Supports the use of interventions and training for teachers.

Concept	Study	Participants	Outcomes	Uses
			that did not participate in the intervention.	
Teacher characteristics that impact student achievement in economics	Valletta, Hoff, & Lopus (2014)	62 teachers and 1290 high school economic students	High school GPA; higher peer GPA; and self-reported attitudes towards economics had large impact on student outcomes as well as teachers majoring/minoring in economics or having and advanced degree.	Student's motivation will impact their engagement in intervention.
Flipped Classroom model	Balaban, Gilleskie, & Tran (2016)	720 College undergraduates	Students in flipped classroom cohort performed higher on final than conventionally taught group.	If not able to find an appropriate teacher, could use a flipped model in intervention.
Flipped classroom	Caviglia-Harris (2016)	160 undergraduate economics students	Students in the fully flipped classroom group as well as the partially flipped with mini lectures group both performed higher on final than control group	Khan academy videos could be helpful in intervention.
Teaching economics through art, cooperative learning, and experimental learning	Vasiliki, Panagiota, & Maria (2016)	26 senior high school students	Students found the use of art and role playing helpful in understanding economics	Utilize multiple approaches and avenues to relate math and economics in intervention

Professional Development of Teachers in Economic Courses

McKenzie (1971) researched the economic understanding of elementary teachers. At this time, more elementary teachers were being required to incorporate economic concepts into their courses. The researcher compared how the elementary teachers performed on the Test of Economic Understanding to how many previous economic courses they had. Participants of the study were from three counties in Virginia. One-hundred and forty-four teachers participated in the study. Of those 144 participants, 6% had a master's degree, 87% had a bachelor's degree, and 7% did not have a four-year college degree. In general, participants performed higher on the Test of Economic Understanding if they had taken more economics courses. Participants who had previously taken four or more economic courses scored almost five scale points higher than participants who had not taken any economics courses. Participants who took one to three economic courses scored two to three scale points higher than participants who had not taken any economics courses. While teachers who had taken more economic courses were more knowledgeable in economics, their scores were still relatively low, ranging between 56-75% correct answers. The study dispelled the idea that elementary teachers with training would perform worse than high school teachers with training. The author suggested summer institutes to provide more training to elementary teachers on economics.

Choi (2011) questioned differences between economics and other social studies classes. The researcher searched for the best way to teach economics. The researcher wanted to know pre-service teachers' beliefs about economics. The researcher developed a new instrument to measure beliefs about economics, and additionally used surveys and interviews to obtain information on beliefs about economics. The participants were undergraduate and graduate students potentially teaching economics in middle or high school. The average amount of economic classes taken during high school and college by the participants were 1.47 courses. Out of the 230 student participants, 51.7% were females and 48.3 % were males, while 11%, 17%, 45%, and 27% were sophomores, juniors, seniors and graduate students respectively. Of the 230 participants, 27 agreed to participate in interviews. Data sources included Discipline-focused Epistemological Beliefs Questionnaire, and Beliefs about Effective Teaching Economics Questionnaire (BETEQ), and interviews. The researcher collected the data by using class time in teacher education programs to administer surveys for 25 minutes. Interviews took about 50 minutes and were recorded then transcribed. The researcher analyzed the survey data by factor analysis while the interview questions were transcribed and coded. Study results showed that pre-service teachers valued personal experience and opinions in learning economics alongside expert options and theories. Pre-service teachers discussed using multiple sources to acquire economics knowledge and did not rely on one source. Pre-service teachers believed that theories and principles were better supported through real world examples. Many pre-service teachers found textbooks to be outdated, so they used additional and more up to date materials to verify or expand on what was found in the textbook. There was some difference of opinion across the preservice teachers as to whether economics is an academic discipline or a practical discipline. As for effective teaching strategies for economics, many preservice teachers believed high-order practices are great for high learning ability students, but low-order practices are probably better for lower learning ability students. Interviewed preservice teachers discussed the need for structure, multiple examples, and hands-on activities for lower ability students. Study results found two divergent views of economics. One view sees economics as an academic discipline with lots of math and structured information. The other view sees economics as a practical discipline with more flexibility and less structure. The researcher suggested future research should focus on preservice teacher beliefs on teaching and knowledge of economics by grade level and major.

Leet and Lopus (2012) researched how to teach economics effectively in high school. Researchers noted more requirements for economics education in the United States, but little teacher training on economic concepts, and proposed teacher training for new teachers. Researchers summarized Lopus (2011) suggestions, added suggestions from the Council on Economics Education (CEE), and added their own suggestions. Lopus (2011) made the following suggestions for first year economics teachers: to not be afraid of economic concepts, focus on economic literacy and economics as a way of thinking, use real world events to relate economic concepts to students, use activity based learning, emphasize on personal finance, use a good high school level textbook, and a variety of supplemental materials, utilize college entry level economics textbooks for guidance, as well as seek professional development, and find a mentor. The intended audience for this article were new economics teachers and teacher preparatory programs. The authors referenced additional articles that recommend using literature, movies, or music to engage students in learning Economics content as well as emphasized the importance of utilizing active learning in Economics.

Swinton, Scafidi, and Woodard (2012) researched the impact of teacher training on student outcomes in Economics. Authors were concerned about the lack of teacher training specific to economics. They proposed studying a specific economics workshop and its impact on student outcomes. Researchers utilized a quantitative research design in which they compared student scores on the Economics End of Course test based on if the teacher did or did not attend Council on Economic Education workshop in the past five years. The participants were students of teachers who have or have not attended a Georgia Council of Economic Education workshop.

Data sources included attendance records of workshops for teachers and student scores on state assessment (end of course test) segregated by teacher. Researchers collected the data by accessing state records and workshop records. Then, the researchers analyzed the data by creating a model where the Economics End of Course Test score equaled student characteristics plus Geometry End of Course test score, teacher attendance of specified workshop, interaction term between Geometry score and teacher's attendance in the specified workshop, and a variable on student's location in a metropolitan area. The study results indicated a positive increase in student outcomes when a teacher had attended a Georgia Council of Economic Education workshop in the last five years.

Smirnova (2015) proposed professional development for teachers which integrates the knowledge of the American Institute of Economics Research, and current pedagogy for best practices. The program was called Teach-the-Teachers, which encouraged active learning and varied instruction. The researcher found high school students learn the most when teachers are well trained to teach economics, have a thorough understanding of economic concepts, and have access to high-quality resources. The program focused on economics across the curriculum as well as active and collaborative learning. The three main topics of the workshop were money and the impact of inflation, business cycles including unemployment, and the role of government in the economy. Participants in the program were encouraged to use various assessment methods. Teachers who attended the first workshop in 2014 implemented their lessons developed at the workshop. Students in these field-test classes were given a survey to supply feedback on the lessons. A total of 162 students responded from this group. Two-thirds of students believed their teacher knew the content well. Three-fifths of students strongly agreed that student engagement and interaction were encouraged. Lastly, over half (55%) of students felt the goals of the lesson were clear. The study concluded that the Teach-the-Teachers program was successful in increasing student engagement and teacher content knowledge.

Khadka (2016) researched teacher preparedness in engaging students in economics and proposed that teacher training programs which provided sufficient support to teachers were effective in teaching economics at secondary level. Researchers utilized quantitative structural equation modeling (SEM). The participants were 204 economic teachers from different regions and schools across Nepal. Data sources included questionnaire surveys. Researchers collected the data by quota sampling technique during the training program. Then the researchers analyzed the data by SEM - mix of factor analysis and multiple regression. The results indicated that technology helped both novice and highly qualified teachers to teach economics. Teacher demographics and experiences did not largely impact teaching or learning of economics.

Damalie (2018) examined training of pre-service teachers in Economics and their instructional experiences as Economics teachers. Researchers utilized qualitative case study. The participants were 28 second year Bachelor of Arts with Education degree students at Makerere University in Uganda (17 male and 11 female). Data sources included four focus groups and in-person interviews of seven students. Researchers collected the data by groups discussing field experience and presented it to class. The purpose was to gain general views of the class. The researchers analyzed the data by document analysis of pre-service teachers records, their reflective journals, and content analysis of focus group transcripts. The study results indicated that most pre-service teachers planned their lessons well. The pre-service teachers used a variety of teaching methods, which included traditional lecture, question and answer, discussion, as well as demonstration. Some of the economic topics were difficult for new teachers to teach. Most pre-service teachers used illustrations to aid teaching economics. There was a mix of experience regarding classroom management. Some students really struggled with classroom management, while others did not have any problems. Most assessments took the form of quizzes, tests, and exercises. Most pre-teachers found planning for economics courses easy, but some struggled teaching the content. Researchers suggested future research should focus on larger sample sizes and more pre-service institutions.

Teacher professional development is essential to student performance in Economics. This can be seen in the summarized studies in Table 7. McKenzie (1971) established the need for further teacher training in Economics. Choi (2011) and Damalie (2018) focused on concerns of pre-service teachers which usually involved being comfortable with the content and possessing the appropriate training and resources to be successful in the classroom. Smirnova (2015) and Khadka (2016) further supported the idea that training is essential for students to feel supported and teachers to feel confident in their abilities in the classroom. Swinton et al. (2012) made the quantitative connection between student performance, and teacher training showing that students do better when their teacher has had economics specific training. Lastly, Leet and Lopus (2012) recommended different strategies, and resources teachers can use when teaching economics. Multiple studies pointed to using real world examples and personal experiences when teaching economics (Choi, 2011; Leet & Lopus, 2012; Smirnova, 2015).

Table 7

Professional Development of Teachers in Economic Courses

Concept	Study	Participants	Outcomes	Uses
Economic understanding of elementary teachers	McKenzie (1971)	144 elementary teachers	Teachers that had previously taken 4 or more economic courses scored higher on test of economic understanding; overall scores were still relatively low ranging from 56-75% correct.	Economic teachers need to be appropriately trained and supported; more exposure to economic concepts leads to better results; supports intervention.
Best way to teach economics	Choi (2011)	230 graduate and undergraduat e pre-service teachers	Valued personal experience and opinions in addition to expert opinions; want use of real-world examples.	Better support teachers by providing real world examples to use with students. Connect concepts with personal experiences.
Teach economics effectively	Leet & Lopus (2012)	Research/ no participants	Focus on economic literacy, economics as a way of thinking, use real world examples, textbook is a tool but use other methods as well.	Ways of approaching economics; talk to students in intervention how to approach different issues; again, use real world examples.
Impact of teacher training on student outcomes	Swinton, Scafidi, and Woodard (2012)	Students of teachers that did or did not attend a specific workshop	Students of teachers that attended an economics workshop in past 5 years scored higher on end of course test.	Teacher training impacts student outcomes.
Professional development suggestions	Smirnova (2015)	162 high school students	Students of teachers that went through the training believed their teachers knew their content well, many were engaged with the content and felt encouraged by teacher.	Training of teachers is essential to student success.
Teacher preparedness in engaging students	Khadka (2016)	204 economic teachers	Technology can help with teaching economics; being highly qualified to teach also helped.	Teaching training and resources will help students succeed in economics.
Pre-service teacher training	Damalie (2018)	28 second year education degree students	Lessons were well planned with a variety of teaching methods. some topics were more difficult to teach than others.	More training and experience with economics material help teachers feel more confident with concepts.

Student Engagement

McBrien, Jones, and Cheng (2009) examined a synchronous online classroom to support student engagement in online learning. They wanted to know if these synchronous platforms would increase social interaction among students, and possibly increase positivity towards online learning. The study also examined the strengths and weaknesses of synchronous online platforms. The researchers included an open-ended survey on their course evaluations asking what students liked or did not like about the platform, what worked and did not work, as well as the student's opinion if the platform should be used again. The sample consisted of 90 university students total (35 graduate and 55 undergraduate). Out of the 90 students who were given the survey, 62 surveys were returned with responses. Analysis of the survey responses resulted in six main themes - dialogue, structure, learner autonomy, technical difficulties, convenience, and pedagogy. Most comments towards dialogue were positive with students being grateful to talk to fellow classmates and hear other opinions. A few opinions mentioned lack of participation and feeling disconnected from the rest of the class. The theme of structure had three sub themes including student confusion about how things worked, experience of a virtual classroom, and convenience. Some students felt they did not know how to operate the tools in the online classroom or were unable to follow the instructor’s directions. One student mentioned the chat box felt chaotic when several students entered comments at the same time. Some students liked being introduced to the new technology and thought it could be beneficial to future teachers. Students enjoyed the convenience of being able to participate online when they would have not been able to take the face-to-face class. Under the theme of learner autonomy, the researchers found subthemes of student involvement, support of student processing ideas, technical issues, and negative impact on student involvement. Students felt they were more empowered to speak up and give opinions or answers in class. Some really liked being able to explain their ideas on the microphone. Others liked the polling tools and being able to vote on different issues. Students did have frustrations when technology would not let them sign in or participate. Additionally, some students felt the platform had too many things happening at once - viewing a PowerPoint, listening to the teacher, and watching the chat box - while other students felt like there was no interaction or engagement with students or teachers. Some students even mentioned missing non-verbal gestures. Students did enjoy the synchronous component and the ability to discuss ideas with the class.

Calafiore and Damianov (2011) analyzed the time spent in an online course and how that impacts student achievement. The researchers used the online tracking feature in the Blackboard Campus Edition to measure real time. Their sample consisted of 438 undergraduate students at a public university in Texas. The researchers also included overall student GPA, and grade in the course as factors. The results showed that a student's GPA had the greatest impact on the course grades when more time was spent in the course.

Paulsen and McCormick (2020) focused on student engagement in the online environment. They used data from the 2015 National Survey of Student Engagement (NSEE), which included 130,000 responses from over 500 universities. They applied propensity score matching (PSM) to account for different demographic characteristics across various studies. This helped diminish bias and increase covariates across the comparisons. The researchers focused on three groups – face to face learners, online learners, and dual-mode learners. According to the student characteristics, more than 50% of the students who have taken at least one online course are 23 years of age or older, enrolled in school for a mix of either full-time or part-time, typically work 30 or more hours per week, and usually a single parent. Students that prefer face to face courses are under 23 years old, do not have kids, are full-time college students that are either not employed or work less than 30 hours a week. This demographic data supports McBrien et al. (2009) findings of convenience being a positive factor for online classes. The National Survey of Student Engagement (NSEE) uses the following student engagement indicators: student-faculty interaction, learning strategies, quality of interactions, collaborative learning, and supportive environment. For collaborative learning, face to face appeared to be the preferred method over online and dual mode. While the adjustments from PSM lowered the differences between the three groups, there still existed a statistically significant difference between face to face and online as well as face to face and dual mode. For quality interactions, online learning rated higher than face to face and dual mode. PSM lessened the gap, but online learning was still rated highest. In a supportive environment, face to face was higher without PSM, but once PSM was applied the differences between face to face, online, and dual mode was negligible. The researchers stated this could be because once individual characteristics were accounted for by PSM, the idea of a supportive environment really depends on the opinion of the individual. For student-faculty interactions, face-to-face, and dual mode rated much higher than online learning ever after PSM was applied. Online learning did have the higher rating for Learning Strategies until PSM was applied, which found the differences between online learning, face-to-face learning, and dual mode to be not significant. Lastly, online learning appeared to have an edge on higher order learning as well as reflective and integrative learning when compared to face-to-face learning and dual mode learning. This study supported many previous studies in its findings, but it also showed some findings were overexaggerated based on the populations being sampled.

Student engagement can take many forms. The previous studies are summarized in Table 8. Online learning tends to have a synchronous component as described by McBrien et al. (2009)

and an asynchronous component as described by Calafiore and Damianov (2011). Paulsen and McCormick (2020) included synchronous and asynchronous aspects in their study. Online platforms need to work on collaboration opportunities but have found success with synchronous chats and discussion. Measuring student engagement can include time spent in synchronous live class or asynchronously in online platform, use of tools in synchronous class or asynchronous platform, as well as activities completed in synchronous live sessions or asynchronous platform.

Table 8

Student Engagement

Concept	Study	Participants	Outcomes	Uses
Student perceptions of synchronous online learning platform	McBrien, Jones, & Cheng (2009)	65 graduate and undergraduate students	Convenience of technology and ability to connect with students and teachers were positives; technology issues and unclear instructions were some of the frustrations.	Be sure to make directions clear and try to have work arounds for technology issues; build community and relationships in live sessions.
Time spent in online classroom vs student performance	Calafiore & Damianov (2011)	438 undergraduate students	More time spent in class and high GPA were the greatest factors on course grades.	Make sure students are spending time and engaging with course material.
Student engagement	Paulsen & McCormick (2020)	122,347 face-to-face leaners 11,334 online learners 7, 081 dual mode learners	Face-to-face learning is still the preferred method for collaboration while online learning had high marks in quality instruction.	Need to increase collaboration component of online classes.

Summary

While the focus on Economics education research has shifted over the last few decades, major trends include observation on gender and economics performance, predictors for student success in economics, connections between math ability and economics, and different ways to teach economics including group approaches like team teaching and problem-based learning. Based on the literature, this study utilized state's end of course test scores for Algebra I and Geometry to identify potential participants to the math intervention (Ballard & Johnson, 2004; Evans, Swinton, & Thomas, 2015). The researcher attempted to incorporate threshold concepts and some PBL strategies in the intervention to make graphs and other economic concepts less intimidating as well as encourage students to participate based on their intrinsic motivation to take part in the intervention (Arnold & Straten. 2012; Cohn, E., Cohn, S., Balch, & Bradley, 2004; Karunarante, Breyer, & Wood, 2016; Singh & Bashir, 2018). Lastly, the researcher compared results to Lagerlöf & Seltzer (2009) study since they also conducted a math intervention for economics students except, they looked at college students instead of high school students. This study is unique because an intervention was conducted which focused on high school students rather than college students. An economics teacher and math teacher would co-teaching in the intervention. Past studies have not paired math and economics teachers together to co-teach in the live sessions. The benefit of co-teaching allows the researcher to help solve students' questions in real time.

Chapter III: Methodology

National testing of high school 12th grade students found their knowledge of Economics to be below average (National Center for Education Statistics, 2013). Students need knowledge of economics to be functional citizens and adults after high school. Previous research has found a strong correlation between math ability and performance in economics (Ballard & Johnson, 2004; Evans, Swinton, & Thomas, 2015; McCrickard, Raymond, A., Raymond, F., & Song, 2018). This study utilized a convergent parallel mixed-methods design to implement a math intervention on Economic students.

In this chapter, the overarching mixed-methods research design of the study is explained along with the quantitative and qualitative research design. The sample characteristics and data collection measures for both quantitative and qualitative strands are explained. The last section in the chapter discusses the quantitative and qualitative data analysis procedures and mixed-methods data integration techniques.

Research Questions and Hypotheses

- Quantitative Question 1: What is the difference in Economics End of Course scores (Cohort 2018 and Cohort 2019) OR Economics benchmark assessment scores (Cohort 2020) between 11th and 12th grade high school students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention?
    - *Null Hypothesis (H_o) for RQ1* There is no statistically significant difference between students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention on the

Economics End of Course test (Cohort 2018 and Cohort 2019) or Economics Benchmark Assessments (Cohort 2020) for high school Economics students.

  - *Alternative Hypothesis (H_a) for RQ1* There is a statistically significant difference between students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention on the Economics End of Course test (Cohort 2018 and Cohort 2019) or Economics Benchmark Assessments (Cohort 2020) for high school Economics students.

- Quantitative Question 2: What change can be seen in Cohort 2020 11^{th} and 12^{th} grade high school students' knowledge between pre-test and post-test scores who participated in the math skills support intervention?
  - *Null Hypothesis (H_o) for Quantitative Question 2* There is no statistically significant difference in knowledge between pre-test and post-test scores of 11^{th} and 12^{th} grade students' who participated in the math skills support intervention.
  - *Alternative Hypothesis (H_a) for Quantitative Question 2* There is a statistically significant difference in knowledge between pre-test and post-test scores of 11^{th} and 12^{th} grade students' who participated in the math skills support intervention.
- Qualitative Research Question: What forms of student engagement and teaching strategies can be observed during the math intervention for 11^{th} and 12^{th} grade high school economics students?
- Mixed Methods Research Question: To what extent did student engagement during the math intervention for Cohort 2020 11^{th}, and 12^{th} grade students improve performance on Economic Benchmark Assessments?

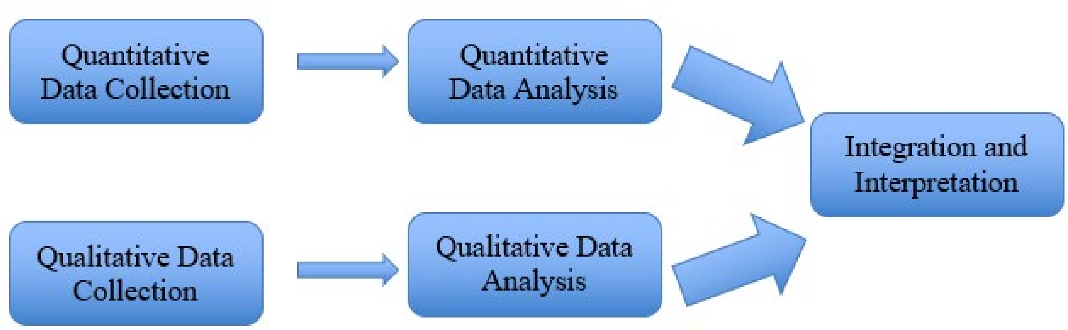
Research Design

The goal of this study was to measure the effect of math intervention on Economics performance. To measure if the math intervention had an impact, the researcher analyzed the difference in Economics End of Course scores between 11th and 12th grade high school students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention. The researcher measured the change in economic knowledge of 11th and 12th grade high school students, who participated in the math skills support intervention, through the pre-test and post-test scores of the assessment.

For a fuller understanding of the math intervention, the researcher also observed student engagement during the intervention sessions for two reasons. First, the researchers examined the forms of student engagement that could be observed during the math intervention for 11th and 12th grade high school economics students. Second, the researcher observed types of teaching strategies during these sessions and examined possible connections between the student behavior and the teaching strategy.

A convergent parallel mixed-methods design was utilized in this study. In a convergent parallel mixed-methods design, the quantitative strand of data and the qualitative strand of data are collected simultaneously, analyzed separately, and then the results are integrated together (Figure 2). In this study, the assessment data (quantitative) and observations on student classroom engagement (qualitative) data were collected simultaneously, but the analysis occurred separately. The quantitative strand used a causal-comparative research design because the students were being observed in their natural settings and the students were already enrolled in the 11th and 12th grade levels. Furthermore, the researcher measured the impact of a math intervention on the students' End of Course test scores without randomly assigning them to the experimental (math intervention) and control (no math intervention) groups. Causal-comparative research design was selected because it measures cause and effect relationships with participants that could not be randomly assigned (Schenker & Rumrill, 2004). The qualitative strand used a phenomenological research design to observe student engagement during a math intervention in an Economic classroom. The qualitative strand of the study focused on student observations and examined how students engaged during the intervention as well as what type of activities increased student engagement (Creswell & Poth, 2016). Math intervention sessions were observed to study the different types of student engagement taking place in the classroom and the extent to which students were engaging or participating in the intervention. Observations can offer more insight into why, or how a participant behaves than interviews or surveys (Marshall & Rossman, 1995). Students were observed to see how they engaged during the intervention and which particular activities promoted engagement or disengagement in the Economics classroom. The rationale behind using a convergent parallel mixed methods design was to build a strong narrative for results by combining the quantitative and qualitative approaches to derive deeper and richer insights on the influence of math intervention on student engagement and academic performance (Creswell & Plano Clark, 2018).

Figure 2



The goal of the quantitative strand was to examine the impact of a math skills support intervention on Economics students' achievement at an online high school in the southern United States from 2018 to 2020. We measured if participants in the math skills support intervention [independent variable] performed better on the Economics End of Course test or district benchmark tests [dependent variable] than students who did not participate in the math skills support intervention. The researcher controlled for Economic students identified as having high math ability [covariates] in the non-participant control group. High math ability was a covariate defined as proficient or distinguished learner on the Algebra and/or Geometry End of Course exam. The intervention was developed by Economics and Math teachers. The dependent variable was the Economics End of Course exam for Cohort 2018 and Cohort 2019, which is a state standardized test, and district created benchmarks for Cohort 2020.

Role of the Researcher

The researcher's role as a supervisor should not influence the teacher's instruction and there was no conflict of interest. The researcher acted as an observer-as-participant. According to Gold (1958), an observer-as-participant is a part of the group, but their main function is to collect data. Participants were aware of the observer. The researcher was present during the intervention sessions as an observer to collect the observational data on student engagement, and to assist the primary teacher to answer student questions, when the need arose. The researcher was a supervisor of the teachers and did not have a direct relationship to the participants themselves.

Participants

The participants for this study were 11th and 12th grade high school students who had taken Economics. The setting of this study was an online high school of approximately 4,000 students in the state of Georgia. Approximately 600 to 800 students in the 11th and 12th grade take Economics each year. For the 2018-2019 and the 2019-2020 school year, about 200 to 300 students were purposefully selected and invited to participate in the school's math skill support sessions.

Participants in the study were 11th and 12th graders at an online high school in the southeastern United States. In the 2018-2019 school year, the general population of 11th and 12th grade students consisted of two male American Indian students (0.11%) and one female American Indian student (0.05%), 13 male Asian students (0.70%) and 29 female Asian students (1.56%), 256 male Black students (13.76%) and 388 female Black students (20.85%), 52 male Hispanic students (2.79%) and 85 Hispanic female students (4.57%), two male Pacific Islander students (0.11%) and five female Pacific Islander students (0.27%), 37 males of two or more races (1.99%) and 53 females of two or more races (2.85%), as well as 414 male White students (22.25%) and 524 female White students (28.16%), as seen in Table 9.

In the 2019-2020 school year, the general population of 11th and 12th grade students consisted of three male American Indian students (0.18 %) and three female American Indian students (0.18%), 15 male Asian students (0.92%) and 32 female Asian students (1.95%), 260 male Black students (15.87%) and 331 female Black students (20.21%), 43 male Hispanic students (2.63%) and 75 Hispanic female students (4.58%), three female Pacific Islander students (0.18%), 39 males of two or more races (2.38%) and 47 females of two or more races (2.87%), as well as 360 male White students (21.98%) and 427 female White students (26.07%). In the 2020-2021 school year, the general population of 11th and 12th grade students consisted of five male American Indian students (0.33%) and three female American Indian student (0.20%), ten male Asian students (0.66%) and 24 female Asian students (1.59%), 246 male Black students (16.25%) and 313 female Black students (20.67%), 42 male Hispanic students (2.77%) and 64

Hispanic female students (4.23%), one female Pacific Islander student (0.07%), 37 males of two or more races (2.44%) and 47 females of two or more races (3.10%), as well as 326 male White students (21.35%) and 396 female White students (26.16%) (Georgia Department of Education, 2021).

Table 9

Demographics of General 11th and 12th Grade Population at Focus School

Ethnicity	Cohort 2018		Cohort 2019		Cohort 2020	
	Male	Female	Male	Female	Male	Female
American Indian	2 (0.11%)	1 (0.05%)	3 (0.18%)	3 (0.18%)	5 (0.33%)	3 (0.20%)
Asian	13 (0.70%)	29 (1.56%)	15 (0.92%)	32 (1.95%)	10 (0.66%)	24 (1.59%)
Black	256 (13.75%)	388 (20.85%)	260 (15.87%)	331 (20.21%)	246 (16.25%)	313 (20.67%)
Hispanic	52 (2.79%)	85 (4.57%)	43 (2.63%)	75 (4.58%)	42 (2.77%)	64 (4.23%)
Pacific Islander	2 (0.11%)	5 (0.27%)	0 (0.0%)	3 (0.18%)	0 (0.0%)	1 (0.07%)
Two or more races	37 (1.99%)	53 (2.85%)	39 (2.38%)	47 (2.87%)	37 (2.44%)	47 (3.10%)
White	414 (22.25%)	524 (28.16%)	360 (21.98%)	427 (26.07%)	326 (21.53%)	396 (26.16%)

During the 2018-2019 school year, Fall Cohort 2018 was selected to participate based on Economics pre-tests performance and Advanced Mathematical Decision-Making pre-test scores. Eligibility based on Economic pre-test was determined by looking at individual standards performance. Focus standards were selected based on the overlap between Economic concepts and math skills such as production possibility curves, supply and demand graphs, as well as exchange rates. If a student missed 50% of questions related to these standards, then the research examined the students' Advanced Mathematical Decision-Making pre-test score. The average pre-test scores were approximately 35%. Therefore, any student who scored 15% or lower were invited to the intervention. During the 2019-2020 school year, Fall Cohort 2019 was selected based on Algebra End of Course scores, Geometry End of Course scores, and NWEA MAP Math 6+ scores. The cut off scores for the Algebra and Geometry End of Course tests were 67 or below for Beginning learners and 79 to 68 for Developing Learners on both exams. Students had to be a Beginning Learner on at least one of the exams. NWEA MAP Math 6+ is an adaptive assessment which measures students' growth and academic ability in Math. Student performance on these assessments were categorized as above grade level (11^{th} grade = 252.3+; 12^{th} grade = 254.6+), on grade level (11^{th} grade = 211.1-252.2; 12^{th} grade = 211.4-254.5) , or below grade level (11^{th} grade = less than 190.5; 12^{th} grade less than 190). Students that were categorized as below grade level on the NWEA MAP Math 6+ Growth exam were invited to participate in the intervention. During the past two retrospective years, approximately 50 to 60 students who were invited to the intervention actively participated during the sessions

Cohort Fall 2020 participants were purposefully selected and invited to participate in intervention based on their previous End of Course Test scores for Algebra and Geometry. The cut off score was 67 or below (Beginning Learner) on either the Algebra or Geometry End of Course tests. Studies conducted by Ballard and Johnson (2004) and Evans, Swinton, and Thomas (2015) have found strong positive correlations between Algebra and Geometry performance in predicting Economics performance. Once students were identified for the intervention, their parents were sent a recruitment email detailing the intervention. A Qualtrics survey link was included in the email for families to indicate if they do or do not want their child to participate in the study. The first page was the informed consent letter. In this letter, the parent/legal guardian could select if they wanted their child to participate or did not want their student to participate in the study. The survey closed if they selected “I Do Not Want my child to Participate.” The survey moved on to the next page if the parent/legal guardian selected “Yes, I consent for my child to participate.” The parent/legal guardian then entered the student identification number, student name, and parent name

The researcher used G-Power to calculate minimum sample size for each analytical test - the independent *t*-test and the dependent *t*-test. The power was changed from the default of 0.95 to 0.80 for all sample size calculations. The settings for the *t*-test are shown in Figure 3. The default setting on one-tail was changed to two-tails, but the default settings of effect size (0.5), error probability (0.05), and allocation ratio (1) were not changed. Based on this calculation, a minimum of 128 students in 11th and 12th grade were required for the independent *t*-test, with 64 students in the experimental group and 64 students in the control group.

The researcher conducted a dependent *t*-test. The independent variable was time (pre-test and post-test). The dependent variable was the assessment scores at the two time points. Normality of the data was assumed. The researcher tested for homogeneity of variance.
The settings for the dependent *t*-test can be seen in Figure 4. Again, the default power was changed from 0.95 to 0.80. Additionally, the number of groups was changed from two to one since the research is only looking at the experimental group for the dependent *t*-test. For the test to reach a power of at least 0.8, the researcher required at least 27 participants for the sample.

Figure 3

G-Power Test for Required Sample Size in Independent Sample t-test

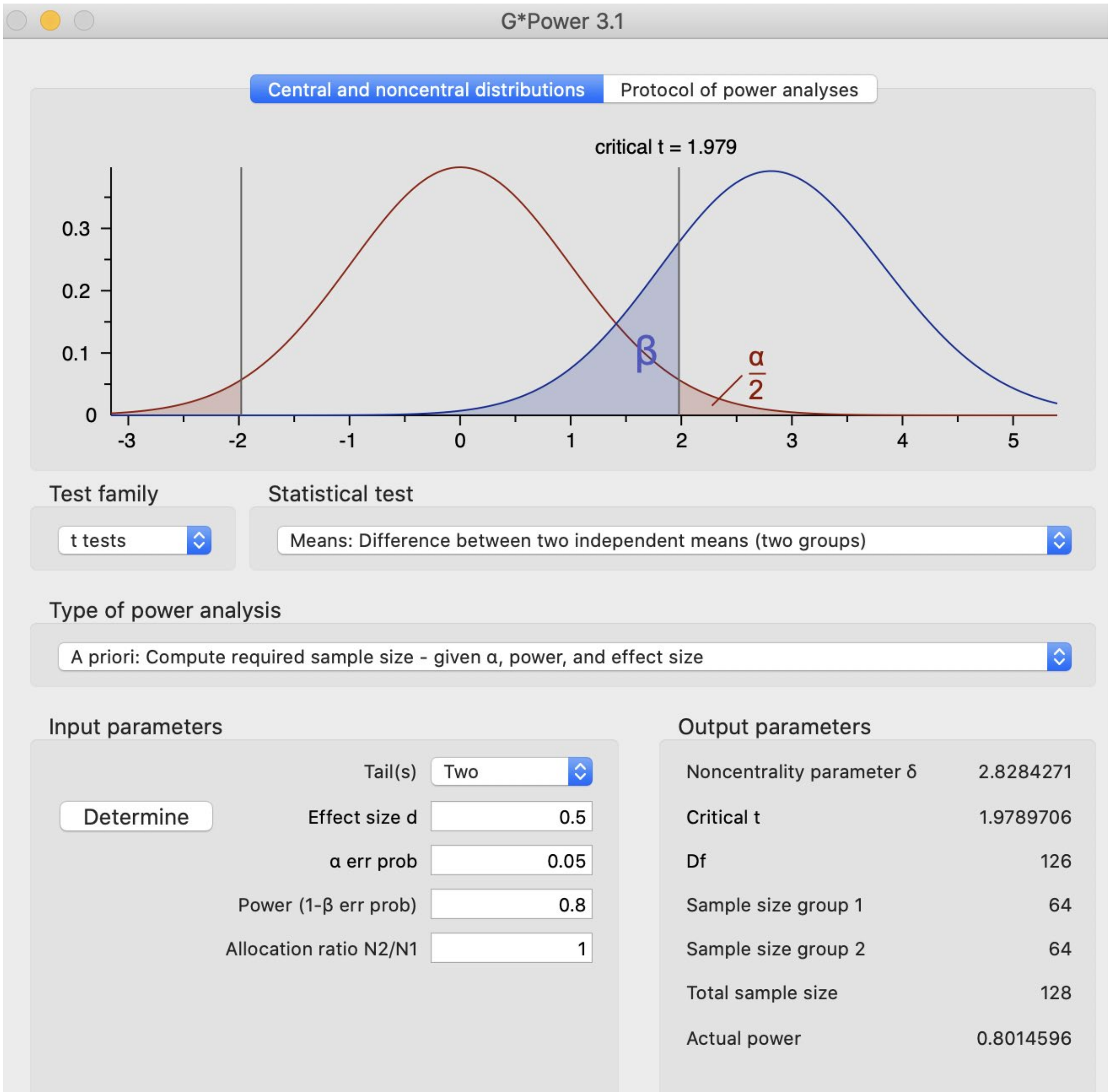
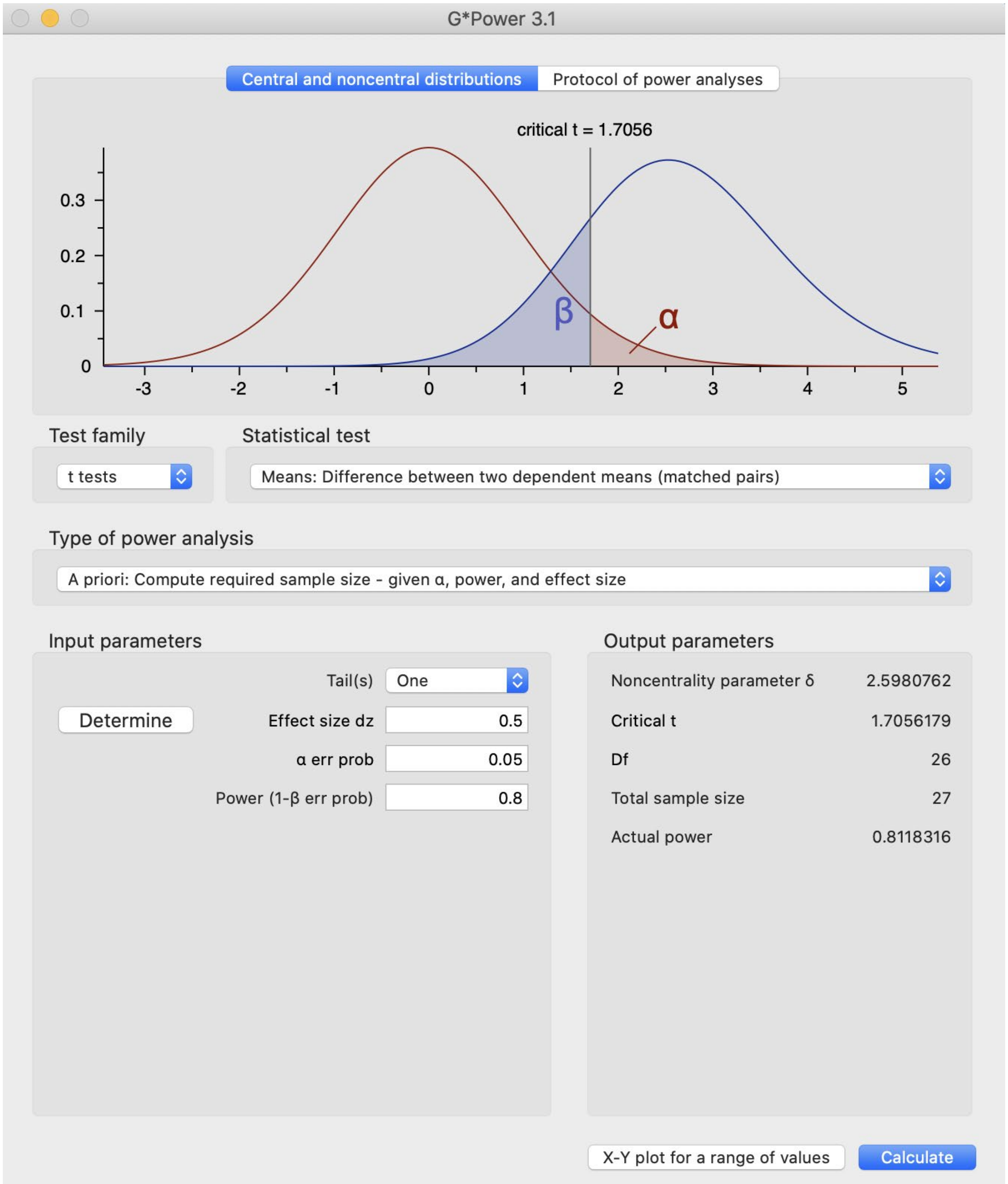


Figure 4


G*Power 3.1
Central and noncentral distributions
Protocol of power analyses
critical t = 1.7056
0.3
0.2
0.1
0
-3
-2
-1
0
1
2
3
4
5
β
α
Test family
t tests
Statistical test
Means: Difference between two dependent means (matched pairs)
Type of power analysis
A priori: Compute required sample size - given α, power, and effect size
Input parameters
Tail(s)
One
Determine
Effect size dz
0.5
α err prob
0.05
Power (1-β err prob)
0.8
Output parameters
Noncentrality parameter δ
2.5980762
Critical t
1.7056179
Df
26
Total sample size
27
Actual power
0.8118316
X-Y plot for a range of values
Calculate

Instrumentation

Quantitative Instruments

The primary instrument for Cohort 2018 and Cohort 2019 was the Economics End of Course test, which was a state generated summative assessment for Economic high school classes. The test covered five domains (Fundamental Economics, Microeconomics, Macroeconomics, International Economics, and Personal Finance) in 70 to 80 questions split between two sections. Students received a minimum of 45 minutes and a maximum of 70 mins per section (unless they have accommodations for extended time). Most questions were multiple choice. However, the state department of education added performance-based questions such as matching or drag-and-drop (Georgia Department of Education, 2019). The Economics End of Course test was discontinued after the 2019-2020 school year. Therefore, a district-created benchmark test was made to take the place of the End of Course test. The test was approximately 40 to 45 questions and covered all five economic domains. This test was used to compare overall economic knowledge between the control and experimental groups. The focus school gave the benchmark tests three times a semester - once after the first six weeks, next after the second six weeks, and then the third cumulative benchmark at the end of the semester.

The third instrument, for Cohort Fall 2020 only, was the 15-question pre-test and post-test. Unlike the End of Course test and benchmark assessments, the questions in the secondary instrument focused on the topics from the intervention rather than covering all five economic domains. The researcher generated the test in Illuminate DNA (school testing platform). There were two questions on Production Possibilities Curve, two questions on Supply graphs, two questions on Demand graphs, two questions on comparative advantage, two questions on exchange rate, two questions on calculating Gross Domestic Product, two questions of word problems focused on budgeting or saving, and one question on simple versus compound interest.

Qualitative Instrument

Observation notes were generated for each math intervention session for Fall 2020 cohort only. The format of the observation forms was based on the forms from the Behavioral Engagement Related to Instruction (BERI) protocol. The BERI protocol was designed to measure engagement in a large lecture hall for a college Economics course (Lane & Harris, 2015). Lane and Harris (2015) created a process to simultaneously observe 10 students during a 50-minute class. Two observers would take notes on the engaged or unengaged behavior of the same group of students. Observation points were taken every two-minutes or with the change of activity or at the end of a page with notes (Lane & Harris, 2015). For this study, the researcher created an observation form (Figure 5) with a table to check off certain teaching strategies and student behaviors as well space to take notes. The top of the form included the date of the session, instructor names (later changed to teacher A, B, or C), and the estimated attendance. The researcher used the phrase estimated attendance because on the recordings only a certain number of participants could be seen in the participants' window. Additional accurate numbers were pulled from attendance report. The left Time Stamp column was divided into two-minute intervals to match the process seen in the BERI Protocol from Lane and Harris (2015). The center of the form had checkboxes for teaching strategies of lecture, multiple choice question, scenario-based question, polling, and other as well as checkboxes for student behaviors of written response, ask question, polling response, verbal response, off task behavior, non-responsive, and other. These categories were developed based on the researcher's experience with online instruction. The far-right column allowed for additional comments to further explain an area that was checked or to add something that may not be covered in the checkboxes.

Figure 5

Observation Form for Math Intervention Sessions

Observation Protocol Data Collection													
Date of Observation:					Instructor(s):			Est Attendance:					
Time Stamps (Minutes)	Teacher Instruction					Student Actions							Additional Comments
	Lecture	Multiple Choice	Scenario Based Questions	Polling	Other	Written Response	Ask Question	Polling Response	Verbal Response	Off-Task Behavior	Non-Responsive	Other	
0-2													
2-4													
4-6													
6-8													
8-10													

Intervention

Wilson and Räsänen (2008) reviewed literature focusing on numeracy interventions. They identified four main areas of math interventions – 1) Number sense; 2) Computation; 3) Fractions, decimals, and place values; and 4) Problem solving. This intervention focused mostly on problem solving skills, but at times number sense, computation as well as fractions, decimals, and place values were used. Economics students used problem solving skills almost every day. Examples of problem-solving included students determining how a tradeoff would impact production possibilities, figuring out how a change in price would impact quantity supplied or quantity demanded, or how a change in consumer preference could shift demand. Economics students also needed to use fractions and decimals mostly in the form of ratios. For example, when students needed to solve an exchange rate problem, they must use fractions and ratios. Additionally, students calculated the lowest opportunity cost for comparative advantage when they used fractions again. Number sense was mostly used in conjunction with rational decision making, absolute advantage, and productivity. Computation was used with calculating GDP, interest rates, as well as exchange rates. Examples of these kinds of questions can be found in the Appendix D. Dowker (2016) supported the notion that interventions work best in younger students. However, Kroesbergen and van Luit (2003) as well Jitendra et al. (2018) found interventions were just as effective in older students.

Empirical studies by Wilson and Räsänen (2008), Kroesbergen and van Luit (2003), and Xin and Jitendra (1999) justify the need of math-based interventions to improve the quantitative skills of students. The focus was on 11th and 12th grade high school students, who were enrolled in Economics courses and had performed below proficient on past Algebra or Geometry state assessments. The intervention was mostly cognitive in which the focus was on teaching students to think and strategize to solve problems. There were also elements of situated cognition, in which economic, and math concepts were linked to real-world scenarios (Wilson & Räsänen, 2008). Maccini, Mulcahy, and Wilson (2007) found that cognitive, and situated cognition interventions were effective with secondary students to improve their problem-solving skills.

Cross-curricular planning occurred between math and economics teachers for the intervention sessions. The math teacher led the session, and the economics teacher supported the lesson. There was a total of nine sessions – four in the fall and five in the spring. Each session were 45 to 50 minutes in duration. Live synchronous sessions were taught through the school's online platform, Jigsaw Interactive.

Data Collection

Quantitative Data Collection

Pre-existing data for Cohort Fall 2018 and Fall 2019 consist of Economics End of Course test scores from the state department of education and list of students from previous intervention groups. Pre-test and post-test data for the intervention group of Cohort Fall 2020 was collected through Illuminate DNA. Students took the pre-test prior to the first intervention session and the post-test after all five intervention sessions. The Economics End of Course test scores were collected for an intervention and control group from the school data coordinator and the state department of education.

Qualitative Data Collection

Like Lane and Harris (2015), the primary researcher and a secondary researcher observed intervention sessions and used the BERI Protocol to measure student engagement. However, for this study, the observations were collected from recordings of live sessions rather than in-person live sessions. The researchers intended to focus on 10 students per session. However, most sessions had less than 10 students. Tally marks were placed on the observation form for teaching strategies and student actions in the Economics classroom. Notes were taken on types of activities used during the session and if engagement levels changed with different types of activities. Transcriptions of the main chat box were downloaded to be coded during analysis as well.

Data Analysis

After data collection, the qualitative and quantitative data was analyzed separately after which both data strands were integrated and interpreted together. The research questions, the data analysis technique used to answer the research question, and how the results were interpreted are displayed in Table 10.

Quantitative Data Analysis

Assessment data (end of test scores, benchmark scores, intervention assessment pre-test and post-test scores) were exported to SPSS software Standard GradPack 26 (IBM Corp, 2018). The assumptions of independent sample *t*-test were tested: (1) dependent variable was continuous, (2) independence of observations, (3) homogeneity of variance, (4) normal distribution, and (5) no large outliers. Normality was tested using the Kolmogorov test and the Shapiro Wilk's test. The Levene's test was used to examine the homogeneity of variance assumption. A statistically non-significant (p >.05) test indicates that the variance assumption was met. A statistically significant (p <.05) test indicates that the variance assumption was not met. For the dependent *t*-test, the researcher assumes a normal distribution and homogeneity of variance (Field, 2013).

An independent sample *t*-test was used to address the longitudinal impact of the intervention. The independent sample *t*-test examined the difference in means between the control group (students who were invited to participate based on cut-scores but declined) and the experimental group (students who were invited based on cut scores and participated). The purpose of an independent sample *t*-test was to determine the statistical significance of the difference between the means of two groups which were independent of each other (Schlomer, 2009). The independent variable was the group having two levels-experimental group (students receive the math intervention) and control group (students do not receive the intervention). The dependent variable for Cohort 2018 and Cohort 2019 was the Economics End of Course test scores. We were not able to use the Economics End of Course test scores for 2020 cohort because the state's department of education ended the use of that particular test. Therefore, we used the district created benchmark assessments as our dependent variables for 2020 cohort.

Table 10

Data Analysis Table

Research Question	Data Analysis Technique	How the results will be interpreted
What is the difference in Economics End of Course scores or benchmark assessments between 11th and 12th grade high school students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention?	Independent sample *t*-test	$\alpha = 0.05$
What change can be seen in 11th and 12th grade high school students' knowledge between pre-test and post-test scores who participated in the math skills support intervention?	Dependent *t*-test	$\alpha = 0.05$
What forms of student engagement can be observed during the math intervention for 11th and 12th grade high school economics students?	Data transformation Descriptive Coding	Quantified results Themes
To what extent does student engagement during the math intervention for 11th, and 12th grade students improve performance on the End of Course test for Economics?	Triangulation Joint Table Display	Discussion

There were three benchmark assessments administered to the 2020 cohort. Benchmark 1 was given during the 6th week of the semester. Benchmark 2 was given during the 12th week of the semester. Benchmark 3 was given during the 18th week of the semester. SPSS generated two outputs – summary statistics and Levene's test for homogeneity of variance. (Field, 2013). The summary statistics displayed the means, sample size for each group, standard deviations, standard errors, and confidence intervals for both groups. The researcher could conclude that the math intervention has been effective if there was a statistically significant difference between the experimental group and the control group.

A dependent *t*-test was used to address the effectiveness of the intervention and to measure if there were statistically significant differences in the pre-test and post-test within the experimental group. The independent variable was the math intervention, and the dependent variables were the pre-test and post-test scores. The assumptions of dependent *t*-test were tested: (1) dependent variable was continuous, (2) independence of observations, (3) homogeneity of variance, (4) normal distribution, and (5) no significant outliers (Field, 2013). The researcher can conclude that the math intervention has been effective if there is a statistically significant increase from pre-test to post-test scores.

Qualitative Data Analysis

This study established credibility (internal validity) by having math teachers from the intervention review observation notes for accuracy. Transferability (external validity) was established from the observation form and collection methods on BERI protocol (Lane & Harris, 2015). The researcher used the following terms from the BERI protocol to generate *a priori* codes for the observations – listening, reading, writing, engaged computer use, engaged student interaction, engaged interaction with instructor, settling in/packing up, unresponsive, off-task, disengaged computer use, disengaged student interaction, and distracted by another student (Lane & Harris, 2015). Descriptive coding summarized key ideas and topics into one-word or just few word phrases (Saldaña, 2009). The researcher used descriptive coding on the observation notes to summarize main ideas of the intervention sessions. Dependability (reliability) was established if similar patterns emerged while observing different groups of students within the intervention. Confirmability (objectivity) will be established by detailing the observation procedures taken. The observation protocol is provided in Appendix B.

Inter-rater reliability was used in this study, which measured the consistency of ratings between different evaluators (Cohen, 2017). The researcher and another educator utilized the observational protocol to measure student behaviors on the observation form. Student behavior, which was a direct measure of student engagement, was coded to derive the themes. Inter-rater reliability was measured by accounting for the consistency between evaluators throughout the observations (Belur, Tompson, Thornton, & Simon, 2018). Kappa Coefficient were calculated across themes to determine interrater reliability (Hallgren, 2012). Kappa Coefficients can vary from perfect disagreement (-1) to perfect agreement (+1), with 0 indicating completely random agreement and inbetween those values the kappa coefficient can range from slight (0.0-0.2), fair (0.21-0.40), moderate (0.41-0.6), substantial (0.61-0.80), and almost perfect to perfect (0.81-1.00) (Hallgren, 2012; Landis & Koch, 1977).

Mixed Methods Data Analysis

At the design level, this study utilized a convergent parallel research design, meaning the qualitative and quantitative data were collected simultaneously instead of one after the other (Creswell & Plano Clark, 2018). This study integrated at the method level by connecting the sample participants and merging the qualitative and quantitative data (Creswell & Plano Clark, 2018; Fetters, Curry, & Creswell, 2013). Quantitative and qualitative data were merged through methodological and data triangulation. Methodological triangulation involved the use of both quantitative (causal comparative) and qualitative (phenomenology) research methods. Data triangulation involved utilization of both quantitative and qualitative data collection methods

(Denzin, 2012). In this study, Economic End of Course scores, district-created benchmark tests, and intervention specific assessment pre-test and post-test as well as observations (qualitative) during the math intervention in the Economics classrooms were used. Integration during the interpretation and reporting level were in the form of joint displays, data transformation, and narration (Fetters et al., 2014). A joint display combined qualitative and quantitative data in a visual way. For example, in this study, the researcher created a table as a joint display through comparison of participants' assessment scores and engagement levels. This comparison could indicate why or why not some students' scores improved. Data transformation is the process of converting qualitative data into quantitative data or vice-versa. For example, the number of engaging and disengaging behaviors exhibited by the students were counted during the math intervention in the Economics classroom is an example of data transformation. Narration is a way of discussing the process of analysis and how the quantitative and qualitative segments are arranged in the analysis section. Contiguous narration was used to separately explain the quantitative and qualitative results with one section following the other, which was then used in the data analysis phase. Weaving narration was used when qualitative and quantitative data was bended inside the sections, which was then used in the mixed-methods interpretation phase. The weaving technique was implemented when the discussion of quantitative analysis was followed by explanation of a qualitative quote which aligned with the quantitative result. The integration of qualitative and quantitative data made the results stronger through evidence provided from two different methods. Integration can lead to further research questions if there are differences found between the quantitative and qualitative data (Creswell & Plano Clark, 2018; Fetters et al., 2013).

Summary

This convergent parallel mixed method study took place through two different yet simultaneous strands. The quantitative strand measured the growth of student economic knowledge through pre-test and post-test as well as compared the overall economic knowledge of intervention participants and non-participants based on the Economics End of Course test. The qualitative strand examined student engagement in the intervention through observations of intervention sessions. A more holistic picture developed of how student engagement during the intervention could impact results of Economics End of Course test by bringing the qualitative and quantitative strands together.

Chapter IV: Findings

Students need to understand the basics of Economics in order to function as adults after high school. Students who historically have had low math performance tend to struggle with Economic concepts (Ballard & Johnson, 2004; Evans, Swinton, & Thomas, 2015; McCrickard, Raymond, A., Raymond, F., & Song, 2018). This study attempted to see if an intervention focused on these students and math concepts that overlap in Economics would improve student performance. In this chapter, we will discuss the participants of the study, analyze the findings of the quantitative and qualitative phases, and synthesize the mixed methods results.

Quantitative Participants

There were 232 students in cohort 2018 who were invited to participate in the intervention (Table 11). One-hundred thirty-two students attended one or more intervention sessions (56.9% participation). Students who withdrew during the semester and students that did not take the Economics End of Course test were removed from the data set resulting in 62 students in the control group and 102 in the experimental group. In order to balance groups, 40 students with the lowest amount of duration in sessions were removed from the experimental group. This resulted in the control group and the experimental group having 62 students each for a total of 124 students. As seen in Table 12, the control group had 5 Black male participants (8%) and 19 Black female participants (31%), 5 Hispanic male participants (8%) and 1 Hispanic female participant (2%), as well as 12 White male participants (19%) and 20 White female participants (32%). The experimental group had 6 Black male participants (10%) and 12 Black female participants (19%), 5 Hispanic male participants (8%) and 2 Hispanic female participants (3%), 2 multi-racial (two or more races) male participants (3%) and 3 multi-racial female participants (5%), as well as 15 White male participants (24%) and 18 White female participants (28%).

Table 11

Intervention Participant Numbers by Cohort Year

	Cohort 2018	Cohort 2019	Cohort 2020
Invited	232	275	269
Attended intervention	132	71	50
Participation Rate	56.9%	25.8%	18.6%
Control Group	62	69	48
Experimental Group	62	69	46
Total Participants	124	138	94 (Independent t-test) 22 (dependent t-test)
Desired Participants based on G*Power *a priori* sample size	128	128	128 (independent t-test) 27 (dependent t-test)

For Cohort 2019, 275 students were invited to participate in the intervention. Seventy-one students attended one or more intervention sessions (25.8% participation). Students who withdrew during the semester and students that did not take the Economics End of Course test were removed. This left 89 students in the control group and 71 in the experimental group. In order to balance groups, two students who only had one minute each for total duration were removed from the experimental group while 20 students were removed from the control group because of incomplete criterion data (missing Math MAP or Algebra EOC score). This resulted in the control group and the experimental group having 69 students each for a total of 138 students. The control group had 16 Black male participants (23%) and 14 Black female participants (20%), 2 Hispanic male participants (3%), 1 multi-racial (two or more races) male participant (2%) and 3 multi-racial female participants (4%), as well as 18 White male participants (26%) and 15 White female participants (22%). The experimental group had 1 Asian/Pacific Islander female participant (2%), 16 Black male participants (23%) and 12 Black female participants (17%), 2 Hispanic male participants (3%) and 2 Hispanic female participants (3%), 2 multi-racial (two or more races) male participants (3%), as well as 16 White male participants (23%) and 18 White female participants (26%).

Table 12

Demographic Information for Quantitative Control and Experimental Groups

Ethnicity/ Race	Groupings	Cohort 2018		Cohort 2019		Cohort 2020	
		Male	Female	Male	Female	Male	Female
American Indian or Alaskan Native	control	0	0	0	0	1	0
	experimental	0	0	0	0	0	0
Asian or Pacific Islander	control	0	0	0	0	0	1
	experimental	0	0	0	1	0	0
Black	control	5	19	16	14	6	9
	experimental	6	12	16	12	11	16
Hispanic	control	5	1	2	0	3	2
	experimental	4	2	2	2	1	1
Two or more Races	control	0	0	1	3	2	3
	experimental	2	3	2	0	1	3
White	control	12	20	18	15	8	11
	experimental	15	18	16	18	4	11

For Cohort 2020, 269 students were invited to participate in the intervention. Fifty students attended one or more sessions (18.6% participation). Students who withdrew during the semester were removed. Two students that participated under 10 minutes were excluded from the experimental group. This resulted in 48 students for the experimental group and 46 students for the control group for a total of 94 students The control group had 1 American Indian/Alaskan Native male participant (2%), 1 Asian/Pacific Islander female participant (2%), 6 Black male participants (13%) and 9 Black female participants (20%), 3 Hispanic male participants (7%) and 2 Hispanic female participants (4%), 2 multi-racial (two or more races) male participants (4%) and 3 multi-racial female participants (7%), as well as 8 White male participants (17%) and 11 White female participants (24%). The experimental group had 11 Black male participants (23%) and 16 Black female participants (34%), 1 Hispanic male participant (2%) and 1 Hispanic female participant (2%), 1 multi-racial (two or more races) male participant (2%) and 3 multi-racial female participants (6%), as well as 4 White male participants (8%) and 11 White female participants (23%).

Quantitative Findings

Research Question 1

What is the difference in Economics End of Course scores (cohort 2018 and cohort 2019) or benchmark assessments (cohort 2020) between 11th and 12th grade high school students who participated in the math skills support intervention, and students who did not participate in the math skills support intervention?

Independent sample *t*-tests were used to address Quantitative Research Question 1 and the longitudinal impact of the intervention. An independent *t*-test compares the means of two independent groups - experimental and control groups - to determine if there was a significant difference between the end of course test scores (Cohort 2018 and Cohort 2019) or benchmark assessments (Cohort 2020) of students that participated in the intervention (experimental group) and those that chose not to participate in the intervention (control group). The independent variable was the math intervention for Economics students while the dependent variable was the Economics End of Course test scores for Cohort 2018 and Cohort 2019 and the benchmark exams for Cohort 2020. The observations were independent of each other. The sample was normally distributed. The sample variances were similar. The dependent variable (test scores) was on an interval scale.

The tests were conducted using an alpha of 0.05. The null hypothesis was the population means are equal, meaning there was not a statistically significant difference between experimental and control group means. The alternative hypothesis was the population means are not equal, meaning there was a statistically significant difference between experimental and control group means. The hypothesis was symbolized as follows:

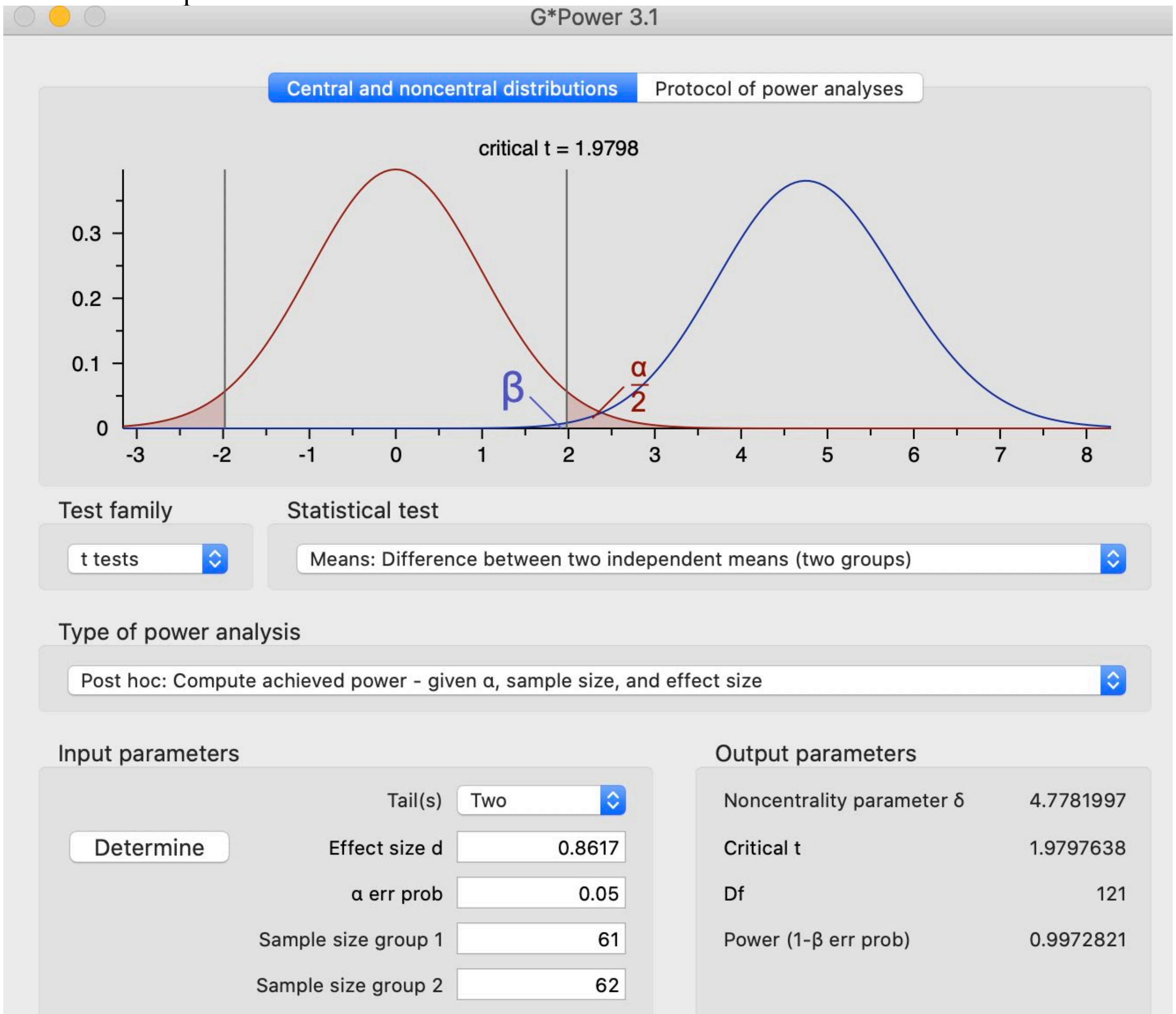
$$H_0 : \mu_1 - \mu_2 = 0$$

$$H_1 : \mu_1 - \mu_2 \neq 0$$

For Cohort 2018, review of the Shapiro-Wilk's tests for normality of the control group ($p = 0.048$) and experimental group ($p = 0.007$) indicated normality may not be a reasonable assumption for both groups. The skewness of the control group (0.657) and the experimental group (-0.304) met the criteria of normality (±1). However, the kurtosis statistic for the experimental group (-1.009) was slightly higher than the recommended criteria for normality (±1), while the kurtosis statistic for the control group (0.076) was within normal limits. The boxplot of the control group indicated a potential outlier. After removal of the outlier from the control group, normality indicators improved. The skewness (0.505) and kurtosis (-0.287) statistics and boxplot indicated that normality may be a reasonable assumption for the control group. The Shapiro-Wilk's test for normality improved from $p = 0.048$ to $p = 0.88$ for the control group with the removal of the outlier. The analyses presented excludes the potential outlier. Levene's test indicated that the assumption of homogeneity of variances was met ($F = 0.001$, $p = 0.970$). The test was statistically significant, t (121) = -4.739, $p < .001$, thus the null hypothesis was rejected. Participants in the experimental group, on average, scored higher on the Economics End of Course test ($n = 62$, $M = 71.4677$, $SD = 8.62463$) than students in the control group ($n = 61$, $M = 63.7705$, $SD = 9.37798$). The 95% confidence interval for the difference between means was -10.91269 to -4.48181. The effect size in relation to variance was calculated by eta squared and found to be .1565 indicating that approximately 15.65% of the variance in the tendency towards Economics End of Course test scores was being accounted for by whether the student took part in the math intervention for Economics. Cohen's d was calculated to measure the effect size of the difference between the experimental and control means. For the 2018 cohort, Cohen's d was calculated to be 0.8617, suggesting a large effect. Based on this effect size, the power was calculated to be 0.997, as seen in Figure 6. The results provide evidence to support the conclusion that students engaged in the math intervention performed higher on the End of Course test for Economics during the 2018-2019 school year.

Figure 6

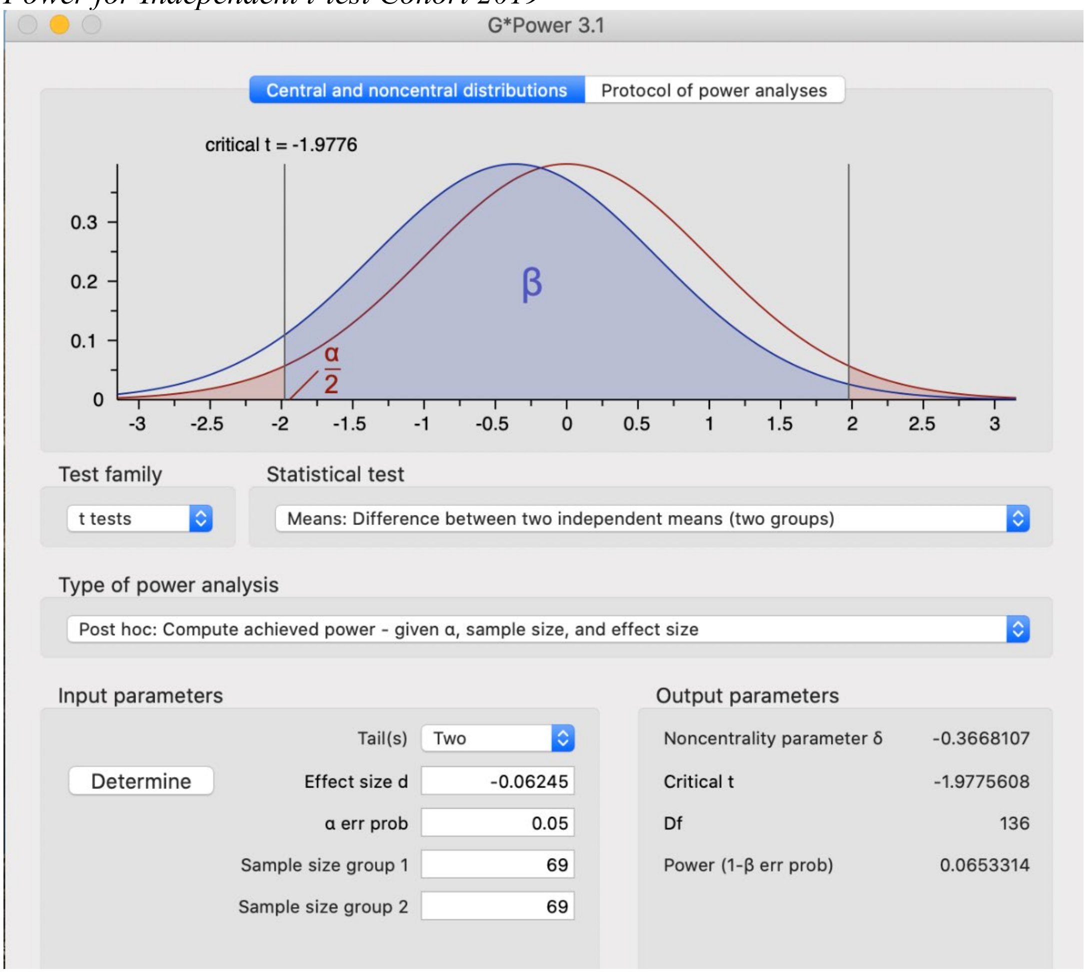
Power for Independent t-test Cohort 2018



For Cohort 2019, review of the Shapiro-Wilk's tests for normality of the control group (p = 0.002) and experimental group (p = 0.036) indicated normality may not be a reasonable assumption for both groups. The skewness of the control group (0.072) and the experimental group (0.004) met the criteria of normality (±1). However, the kurtosis statistic for the control group (-1.327) and the experimental group (-1.048) were slightly higher than the recommended criteria for normality (±1). The Q-Q plots and the boxplots of the control and experimental groups did not indicate any potential outliers. Levene's test indicated that the assumption of homogeneity of variances was met (*F* = 0.007, *p* = .931). The test was not statistically significant, *t* (136) = 0.364, *p* = 0.716, therefore we failed to reject the null hypothesis. Cohen's d was calculated to measure the effect size of the difference between the experimental and control means. For the 2019 cohort, Cohen's d was calculated to be -0.06245, suggesting a small effect. Based on this effect size, the power was calculated to be 0.06533, as seen in Figure 7.

Figure 7

Power for Independent t-test Cohort 2019



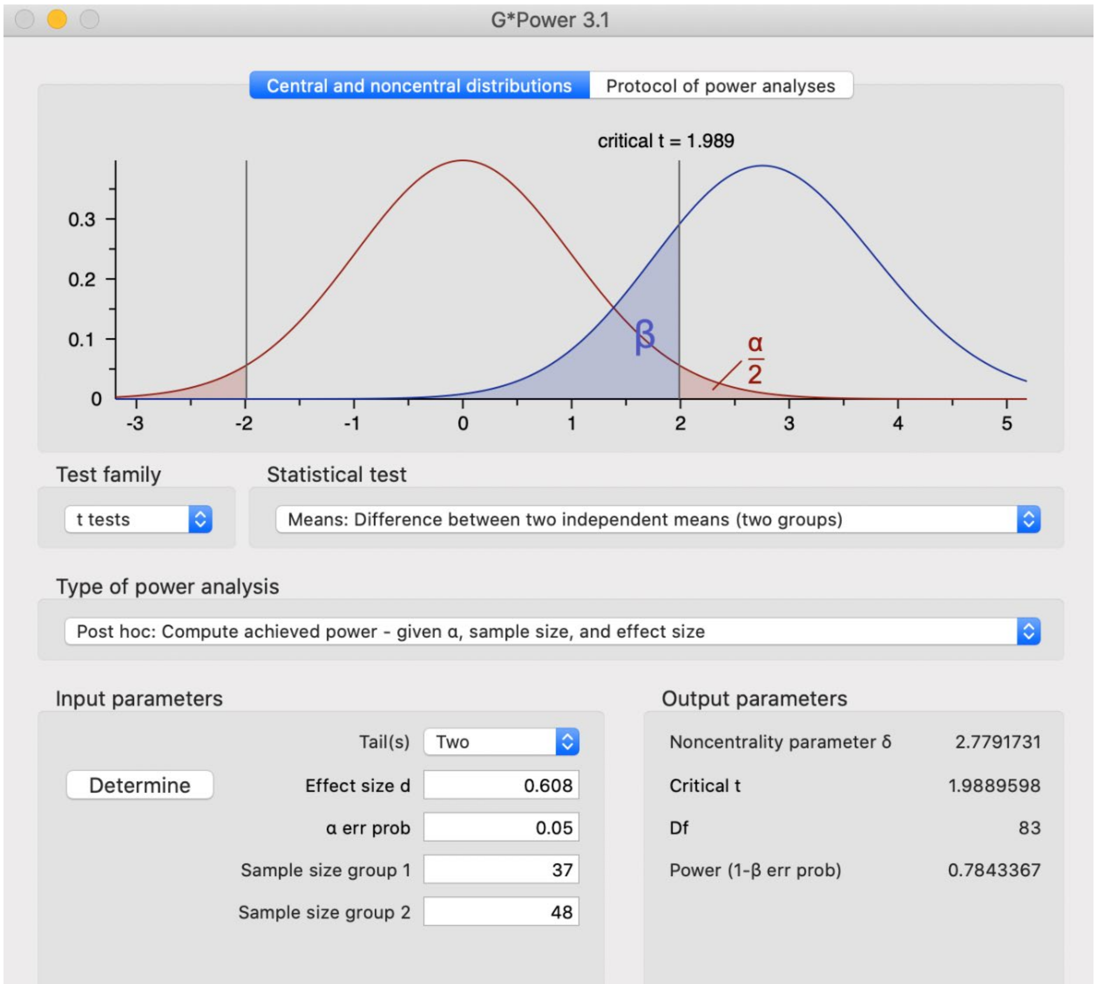
Participants in the experimental group, on average, scored within a point on the Economics End of Course test (*n* = 69, *M* = 72.4058, *SD* = 13.05116) than students in the control group (*n* = 69, *M* = 73.2029, *SD* = 12.66140). The 95% confidence interval for the difference between means was -3.53188 to 5.12608. The results indicate students engaged in the math intervention during the 2019-2020 school year performed about the same on the End of Course test for Economics as students that did not participate in the intervention.

For Cohort 2020, the independent *t*-test was conducted three times, once for each benchmark test. The third benchmark test was the semester final exam, which was a district created exam equivalent to the state created End of Course test that was phased out after the 2019-2020 school year. First, for Benchmark 1, normality can be assumed for both groups, experimental and control, as the skewness (control = -0.056; experimental = -0.819), kurtosis (control = -0.020; experimental = 0.254), and Shaprio-Wilk (control - p =0.345) were within normal limits. However, the Shaprio-Wilk statistic (0.932) and significance (p = 0.008) suggested the distribution of the experimental group may not be normal. The Q-Q plots and box plots for both groups do not indicate any outliers. Levene's test indicated that the assumption of homogeneity of variances was met (F = 0.092, p = .762). The t-test was statistically significant, t (83) = -2.747, p =0.007, thus the null hypothesis was rejected. Participants in the experimental group, on average, scored higher on the Benchmark 1 assessment (n = 48, M = 55.9896, SD = 22.91656) than students in the control group (n = 37, M = 42.4324, SD = 22.91656). The 95% confidence interval for the difference between means was - 23.27.269 to -3.73961.

The effect size related to variance was calculated by eta squared and found to be .0833 indicating that approximately 8.33% of the variance in the tendency towards Benchmark 1 test scores was being accounted for by whether the student took part in the math intervention for Economics. Cohen's d was calculated to measure the effect size of the difference between the experimental and control means. For the 2020 cohort benchmark 1, Cohen's d was calculated to be 0.608, suggesting a medium effect. Based on this effect size, the power was calculated to be

0.784, as seen in Figure 8. The results provide evidence to support the conclusion that students engaged in the math intervention performed higher on the Benchmark 1 test during the 2020-2021 school year.

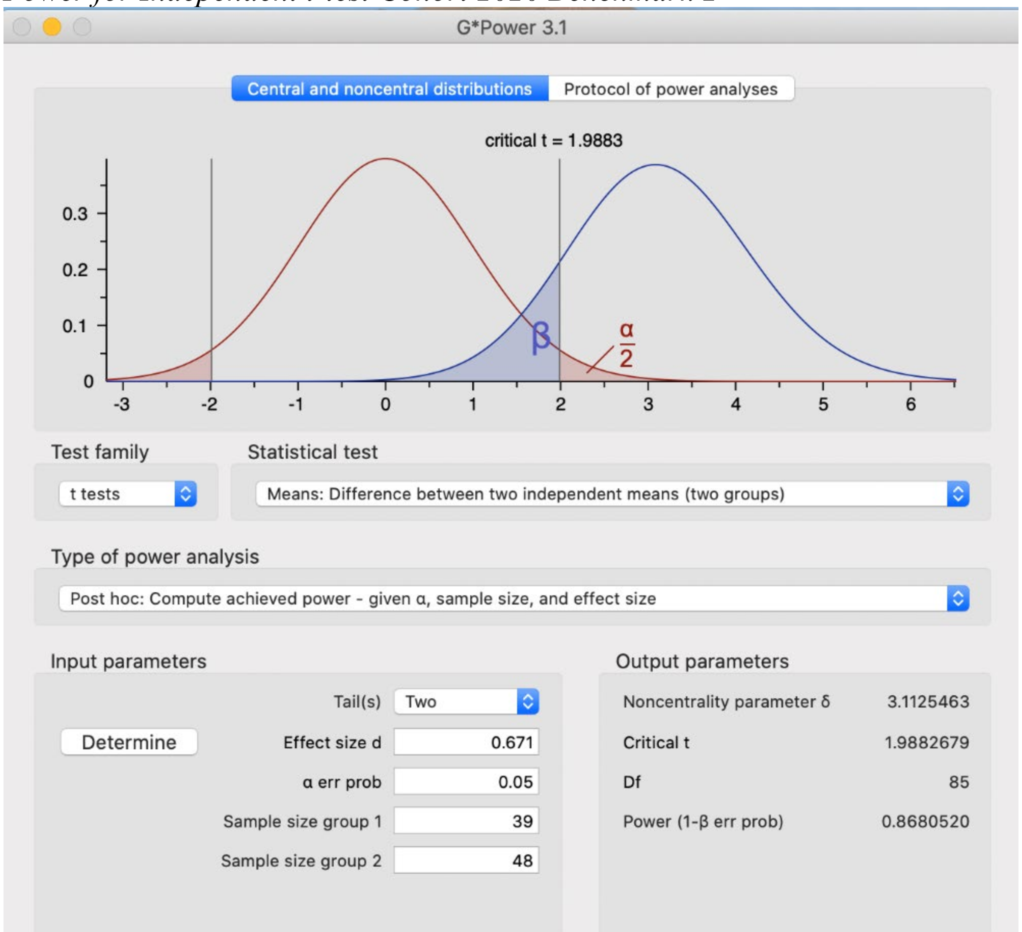
Figure 8



Secondly, for Benchmark 2, normality can be assumed for both groups, experimental and control, as the skewness (control = -0.045; experimental = -0.333), kurtosis (control = -0.299; experimental = -0.707), and Shaprio-Wilk (control - *p* =0.752) were within normal limits. However, the Shaprio-Wilk statistic (0.949) and significance (*p* = 0.037) suggested the distribution of the experimental group may not be normal. The Q-Q plots and box plots for both groups do not indicate any outliers. Levene's test indicated that the assumption of homogeneity of variances was met ($F = 1.196$, $p = .277$). The t-test was statistically significant, $t\ (85) = -3.077$, $p = 0.003$, therefore we reject the null hypothesis. Participants in the experimental group, on average, scored higher on the Benchmark 2 assessment ($n = 48$, $M = 58.3688$, $SD = 17.92886$) than students in the control group ($n = 39$, $M = 45.1282$, $SD = 22.22011$). The 95% confidence interval for the difference between means was -21.79669 to -4.68440. The effect size for variance was calculated by eta squared and found to be .1002 indicating that approximately 10.02% of the variance in the tendency towards Benchmark 2 test scores was being accounted for by whether the student took part in the math intervention for Economics. Cohen's d was calculated to measure the effect size of the difference between the experimental and control means. For the 2020 cohort benchmark 2, Cohen's d was calculated to be 0.671, suggesting a medium effect. Based on this effect size, the power was calculated to be 0.868, as seen in Figure 9. The results provide evidence to support the conclusion that students engaged in the math intervention performed higher on the Benchmark 2 test during the 2020-2021 school year.

Figure 9

Power for Independent t-test Cohort 2020 Benchmark 2

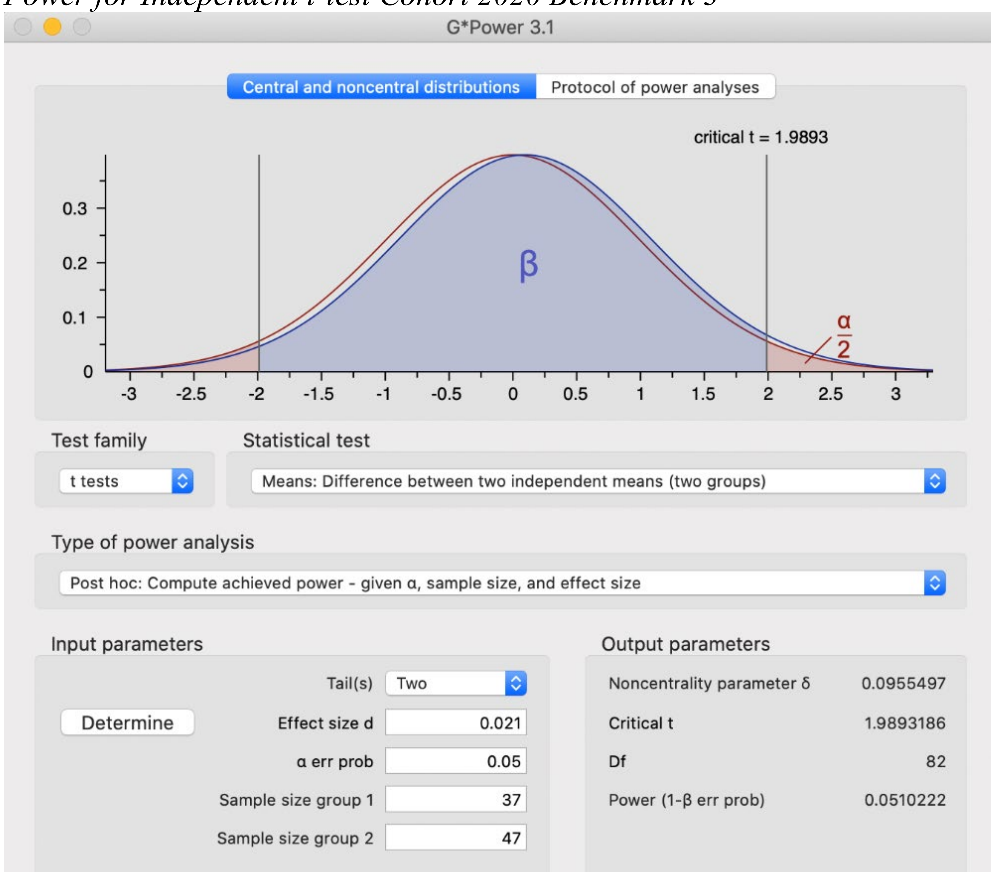


Lastly, for Benchmark 3 (semester final), the skewness (control = -0.866; experimental = -0.946) and kurtosis (control = 0.524; experimental = 0.419) values indicate a normal distribution for both groups, but the Shaprio-Wilk value (control p = 0.012; experimental p = 0.002) suggest the distribution of both groups may not be normal. The Q-Q plots and box plots for both groups do not indicate any outliers. Levene's test indicated that the assumption of homogeneity of variances was met (F = 0.151, p = 0.699). The t-test was not statistically significant, t (82) = -0.095, p =0.925, thus we failed to reject the null hypothesis.

Participants in the experimental group, on average, scored slightly higher on the Benchmark 3 assessment (n = 47, M = 52.3936, SD = 19.74675) than students in the control group (n = 37, M = 51.9595, SD = 22.24497). The 95% confidence interval for the difference between means was -9.56335 to 8.69503. Cohen's d was calculated to measure the effect size of the difference between the experimental and control means. For the 2020 cohort benchmark 3, Cohen's d was calculated to be 0.0217, suggesting a very small effect. Based on this effect size, the power was calculated to be 0.051, as seen in Figure 10.

Figure 10

Power for Independent t-test Cohort 2020 Benchmark 3



The results indicate students engaged in the math intervention during the 2020-2021 school year performed about the same on the Benchmark 3 test for Economics as students that did not participate in the intervention. All five independent *t*-test results are summarized in Table 13.

Table 13

Summary Table for Independent t-test Results

Cohort Year	Assessment	Significance	T-value	Null Hypothesis for Research Question 1	Cohen D effect size	Power
2018	EOC	Significant	t (121) = -4.739, p < .001	Reject	0.8617	0.9973
2019	EOC	Not significant	t (136) = 0.364, p = 0.716	Failed to reject	-0.06245	0.0653
2020	Benchmark 1	Significant	t (83) = -2.747, p =0.007	Reject	0.608	0.7843
2020	Benchmark 2	Significant	t (85) = -3.077, p =0.003	Reject	0.671	0.8681
2020	Benchmark 3	Not significant	t (82) = -0.095, p =0.925	Failed to reject	0.021	0.0510

Research Question 2

What change can be seen in Cohort 2020 11th and 12th grade high school students' knowledge between pre-test and post-test scores who participated in the math skills support intervention?

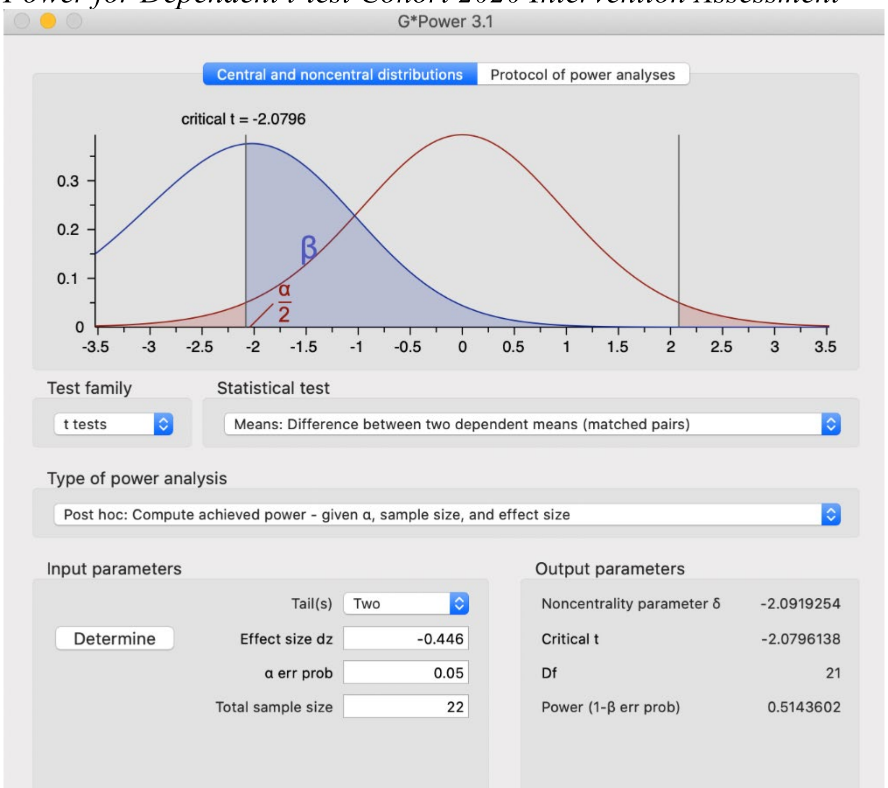
A dependent *t* test was conducted to determine the effectiveness of the intervention for Cohort 2020. The intervention would be considered effective if students who participated in one or more intervention sessions improved their Economics knowledge (as measured by the 15 question intervention specific pre-test and post-test). The test was conducted using an alpha of

0.05. The null hypothesis is that the means of the pre-test and post-test are equal, and the alternative hypothesis is that the means of the pre-test and post-test are not equal. The hypothesis is symbolized as follows: $H_0 : \mathbf{\mu}_d = 0$ $H_1 : \mathbf{\mu}_d \neq 0$

When checking for normality, the pre-test data met all assumptions for skewness (0.046), kurtosis (-0.684), and Shapiro-Wilk's test for normality ($p = 0.523$). The post-test data satisfied the skewness (0.049) and Sharpiro-Wilk's test (p = 0.179), but it's kurtosis (-1.145) was a little high. Similarly, the difference variable had acceptable skewness (0.706) and Sharpiro-Wilk's values (0.101), but it's kurtosis (1.366) was slightly high as well. The Q-Q plots indicated that normality is a reasonable assumption for pre-test, post-test, and difference values. However, the boxplot for the difference variable did display a possible outlier, while the boxplots for the pre-test and post-test did not have outliers. With the outlier removed, the skewness (difference = -0.168; pre-test = -0.044; post-test = -0.033) and Sharpiro-Wilk's test values remain acceptable (difference = 0.169; pre-test = 0.343; post-test = 0.268), while the kurtosis improved for the difference variable (-0.662) and remained in normal range for the pre-test variable (-0.698). However, the post-test kurtosis (-1.057) is still slightly out of range. With the outlier removed, the t-test was statistically significant, t (21) -2.094, p = 0.049 for two-tailed test, which means the null hypothesis was rejected. Participants in the intervention, on average, scored higher on the post-test ($n = 22$, $M = 43.6359$, $SD = 13.12925$) than the pre-test ($n = 22$, $M = 37.8791$, $SD = 14.01272$). The 95% confidence interval for the difference between means was -11.47488 to -0.03875. The effect size for variation was calculated by eta squared and found to be .0925. Therefore, approximately 9.25% of the variation in the difference between pre-test and post-test scores was accounted for by the math intervention for Economics. Cohen's d was calculated to measure the effect size of the difference between the pre-test and post-test means. For the 2020 cohort, Cohen's d was calculated to be -0.446, approaching a medium effect. Based on this effect size, the power was calculated to be 0.514, as seen in Figure 11. The results provide evidence to support the conclusion that students engaged in the math intervention improved upon their Economics knowledge and math skills.

Figure 11

Power for Dependent t-test Cohort 2020 Intervention Assessment



Quantitative Summary

The statistical tests indicated significant results for the independent t-test of cohort 2018 as well as Benchmark 1 and 2 of Cohort 2020. The independent t-test for Cohort 2019 and Benchmark 3 of Cohort 2020 were found to be not statistically significant. Therefore, three out of the five statistical tests show that students who participated in the intervention outperformed students those chose to not participate in the intervention. Additionally, the dependent t-test for

Cohort 2020 was also statistically significant and the results show that students engaged in the intervention improved their Economic knowledge and performance through the school year.

Qualitative Participants

As seen in Table 14, students observed for the Qualitative Phase were the same students from the experimental group of Cohort 2020. These students attended one or more intervention sessions., the experimental group of Cohort 2020 consisted of 11 Black males (22.9%) and 16 Black females (33.3%), 1 Hispanic male (2.1%) and 1 Hispanic female (2.1%), 1 male of two or more race (2.1%) and 3 females of two or more races (6.3%), as well as 4 White males (8.3%) and 11 White females (22.9%).

Table 14

Intervention Participants' Subgroups for Cohort 2020

Ethnicity/ Race	Cohort 2020	
	Male	Female
Black	11 (22.9%)	16 (33.3%)
Hispanic	1 (2.1%)	1 (2.1%)
Two or more Races	1 (2.1%)	3 (6.3%)
White	4 (8.3%)	11 (22.9%)

Percentage based on number divided by total experimental group number. For example, 11 Black Males/48 total experimental group *100 = 22.9%

Qualitative Findings

Research Question 3

What forms of student engagement and teaching strategies can be observed during the math intervention for 11th and 12th grade high school economics students?

As discussed in Chapter 3, we utilized the BERI protocol developed by Lane and Harris (2015) to observe student engagement in an Economics classroom. We made modifications to the observation instrument to account for time stamps and commonly observed behaviors based on researcher's previous experiences with past cohorts for this type of intervention. Due to the virtual setting of this intervention, we were unable to observe reading, listening, unengaged computer use, and settling in/packing up as Lane and Harris (2015) did in their study. In addition to student behaviors, we added categories to observe teacher instructional strategies being employed during the live sessions. The instructional strategies we looked for were lecture, use of multiple-choice questions, use of scenario-based questions, and polling tools. We also included a option for other so that we could take notes on any additional strategies being used.

Table 15, provided below, displays the average duration of certain teaching strategies and Table 16 focuses on the average duration of student behaviors in each observation. The average was derived from the time stamp notes of the two observers. The observation notes used the following codes in conjunction with time stamps - polling responses (engaged computer use), ask questions (engaged interaction with instructor), written response (engaged interaction with instructor, engaged student interaction, disengaged student interaction, distracted by another student), verbal response (engaged student interaction and engaged interaction with instructor), unresponsive, and off-task behavior. Our version of off-task behavior aligned more with what Lane & Harris described as disengaged student interaction. To observe off-task behavior and disengaged computer use as described in the BERI Protocol (Lane & Harris, 2015), we would have needed to use a third-party program that could see student computer screens. Observing listening and reading as described by Lane and Harris (2015) might have been possible if student cameras were on during the live session.

Table 15

Average Time (in minutes) for each teacher strategy on observation instrument

Strategy	Session One	Session Two	Session Three	Session Four	Session Five	Session Six	Session Seven	Session Eight	Session Nine
Lecture	11	24	27	27	31	25	36	41	28
Multiple Choice	4	8	2	7	0	4	15	11	14
Scenario Based Questions	33	25	24	21	25	28	26	18	15
Polling Tools	4	4	1	1	2	4	2	1	10
Other (teacher)	1	13	4	4	13	8	7	5	7

Table 16

Average Time (in minutes) for each student behavior on observation instrument

Behavior	Session One	Session Two	Session Three	Session Four	Session Five	Session Six	Session Seven	Session Eight	Session Nine
Written Response	32	26	27	20	32	25	35	16	24
Ask Question	4	0	6	8	8	2	7	3	3
Polling Response (Engaged Computer Use)	11	12	3	1	3	11	6	1	8
Verbal Response	0	0	0	0	0	0	0	0	0
Off Task Behavior (Disengaged student interaction)	1	2	0	0	0	0	0	1	2
Unresponsive	2	4	0	7	0	0	1	7	5
Other (student)	2	4	4	1	0	0	0	0	1

To establish interrater reliability, we decided to calculate the Kappa Coefficient. First, we transformed the data by coding if the strategy or behavior was marked present or absent by both or one of the observers in each timeslot per session. For example, we looked at the strategy of lecture across all nine sessions. We compared observer one marks per timeslot to observer two marks per timeslot. If both observers did not mark anything for that timeslot, the strategy or behavior was coded as a one for being absent according to both observers. If observer one left the spot blank but observer two marked the strategy or behavior as present, then it was coded as two (absent for observer one and present for observer two). If observer one marked the strategy or behavior as present, but observer two did not mark it as present then it was coded as three (present for observer one but absent for observer two). If both observers marked the strategy or behavior as present, then it was coded as a four. We tracked the code on an Excel spreadsheet. The totals per session were calculated and then we created the table to help calculate percent agreement and the Kappa Coefficient for interrater reliability. We used the formula seen below from Hallgren (2012):

$$\text{Kappa Coefficient} = \frac{p_a - p_e}{1 - P_e}$$

P(a) is equal to the observed percentage of agreement, indicated by the sum of the diagonal values divided by the total number of subjects. The Kappa Coefficients for student behaviors can be found in Table 17 and the Kappa Coefficients for teaching strategies are in Table 18. For example, as seen in Table 17, Observers 1 and 2 marked Written Response absent 81 times and present 93 times which would compute to 0.773 observed percentage of agreement if (81+93)/100 = .773. To compute P(e), we note from the marginal means that Observer 1 rated the written response observation to be present 115/225 = 0.51 times. Observer B rated the written response observation to be present 122/225 = 0.54 times. The probability of obtaining agreement about the presence of written response observation if ratings were assigned randomly between coders would be 0.51 × 0.54 = 0.276, and the probability of obtaining chance agreement about the absence of written response observation would be (1-0.51) × (1-0.54) = 0.49 x 0.46 = 0.225.

The total probability of any chance agreement would then be 0.276 + 0.225 = 0.501, and $\kappa = (0.773 - 0.501)/(1 - 0.501) = 0.272/0.499 = 0.545$. Under these conditions, a value of 0.545 would be considered to have moderate agreement. The remaining agreements can be viewed in Tables 17 and 18. The highest level of agreement between Observer 1 and Observer 2 was seen in their coding of Lecture across all nine sessions. The Kappa Coefficient was 0.641, which is substantial agreement. Observer 1 and Observer 2 had moderate agreement in the areas of Multiple Choice (kappa coefficient = 0.474), Written Response (kappa coefficient = 0.545), and Polling Response (kappa coefficient = 0.509). There was fair agreement between observers in the areas of Scenario Based Questions (kappa coefficient = 0.353), Non-Responsive Behavior (kappa coefficient = 0.333), and Asking Questions (kappa coefficient = 0.386). Slight agreement could be seen in the areas of Polling by the teacher (kappa coefficient = 0.19), Other – Teaching Strategies (kappa coefficient = 0.051), and Other – Student Behaviors (kappa coefficient = 0.131). Lastly, Verbal Response had a kappa coefficient of zero, which indicated random agreement between observers, and Off-task Behavior had a negative kappa coefficient (-0.0227), which indicated a slight disagreement between observers. However, both observers indicated that no students got on the microphone to speak so Verbal Response was not present in any observations. The Kappa Coefficient for seven out of twelve categories suggested fair to substantial agreement between Observer 1 and Observer 2. It appears the observers had different ideas of what should be marked under Other for Teaching Strategies and Student Behavior as well as different ideas of what constituted Off Task Behavior. Polling on the Teacher Strategy side may have been difficult to identify as the polls generally did not appear on the observers' screen and therefore observers had to listen to teacher cues to know that a poll was occurring. Additionally, experience of the observers in the virtual education setting may have accounted for some of the differences in markings. Observer 1 has over five years working in the virtual education environment, while Observer 2 has been primarily a brick-and-mortar teacher other than recent experience due to the Covid pandemic.

Table 17

Kappa Coefficients for Student Behavior

Type of Observation	Observer 2	Observer 1		Total	% Agreement	Kappa Coefficient
		Absent	Present			
Written Response	Absent	81	22	103	77.3% [(81+93)/225] *100	0.545 (Moderate Agreement)
	Present	29	93	122		
	Total	110	115	225		
Asking Questions	Absent	193	8	201	89.8% [(193+9)/225] *100	0.386 (Fair Agreement)
	Present	15	9	24		
	Total	208	17	225		
Polling Response	Absent	185	16	201	89.3% [(185+16)/225] *100	0.509 (Moderate Agreement)
	Present	8	16	24		
	Total	193	32	225		
Verbal Response	Absent	225	0	225	100% [(225+0)/225] *100	0.00 (random agreement)
	Present	0	0	0		
	Total	225	0	225		
Off-Task	Absent	219	4	223	97.3% [(219+0)/225] *100	-0.0227 (slight disagreement)
	Present	2	0	2		
	Total	221	4	225		
Non-Responsive	Absent	207	6	213	93.8% [(207+4)/225] *100	0.333 (Fair Agreement)
	Present	8	4	12		
	Total	215	10	225		
Other	Absent	212	3	215	94.7% [(212+1)/225] *100	0.131 (slight agreement)
	Present	9	1	10		
	Total	221	4	225		

Table 18

Kappa Coefficients for Teaching Strategies

Type of Observation	Observer 2	Observer 1		Total	% Agreement	Kappa Coefficient
		Absent	Present			
Lecture	Absent	81	25	106	82.2%	0.641
	Present	15	104	119	[(81+104)/225]	(substantial
	Total	96	129	225	*100	agreement)
Multiple Choice	Absent	150	25	175	80.9%	0.474
	Present	18	32	50	[(150+32)/225]	(moderate
	Total	168	57	225	*100	agreement)
Scenario Based Questions	Absent	82	17	99	66.7%	0.353
	Present	58	68	126	[(82+68)/225]	(Fair
	Total	140	85	225	*100	agreement)
Polling	Absent	199	23	222	89.8%	0.190
	Present	0	3	3	[(199+3)/225]	(slight
	Total	199	26	225	*100	agreement)
Other	Absent	166	48	214	75.6%	0.051
	Present	7	4	11	[(166+4)/225]	(Slight
	Total	173	52	225	*100	Agreement)

As seen in Table 16, there were no verbal responses from students during the nine sessions. The only forms of communication for students were written responses in the chat and the use of polling tools. We decided to code items from the transcript of written chat responses with the following codes - engaged student interaction (written response about content - more than yes/no response), engaged interaction with instructor (written response - yes/no, one-word answers, greetings, etc.), disengaged student interaction, and distracted by another student. The counts for these codes can be seen in Table 19. According to these counts, students were most engaged through the chat for sessions one, two, five, six, and seven. These counts will be explained more within the context of the narration for each intervention session.

Table 19

Code Counts for Written Chat Responses

Session	Total responses by students	engaged student interaction	engaged interaction with instructor	disengaged student interaction	distracted by another student
Session One	107	51	55	1	0
Session Two	78	30	39	5	4
Session Three	39	22	16	1	0
Session Four	37	14	13	6	4
Session Five	63	38	15	4	6
Session Six	69	60	8	1	0
Session Seven	101	70	24	6	1
Session Eight	39	16	22	1	0
Session Nine	46	26	19	1	0

Session One Observation Analysis. Session one focused on rational decision making, interest rates, and taxes which are related to the math intervention topics of problem solving, number sense, computation, fractions and decimals. Six students were in attendance. As seen in Table 15, the primary strategy being used by the instructor was scenario-based questioning (33 mins). Since students had already received initial instruction on this topic by their primary economics teacher, we used this session to dive deeper into the math skills tied to the topic and student reasoning as well as thought process. Lecture was used to a lesser extent (11 mins). Polling tools (4 mins) and multiple-choice questions (4 mins) were used but to a lesser degree during this session. Students primarily responded in the chat (32 mins). Coding of the written responses revealed students primarily were engaged with the instructor and the content. Out of 107 total written responses, 51 were coded as engaged student interaction and 55 were engaged interaction with instructor. Only one statement was coded as a disengaged student interaction and there were no statements coded as distracted by another student. No students volunteered to get on the microphone to verbally respond to the instructor, discuss an answer, or ask a question. Questions that were asked (4 mins) were written in the chat. Students did respond when the teacher used the polling tools (11 mins). However, the teacher had to occasionally prompt students to respond with the polling tools (2 mins). The teacher offered for students to use a red x if they did not feel they could answer the question. This allowed for the instructor to know the student was listening but needed more support. Other strategies (2 mins) used by the instructor included greeting students to foster relationships and redirecting students when responding with incorrect answer. Other behaviors by the students included responding to teachers' greeting and farewells.

Session Two Observation Analysis. .Session two focused on Absolute and Comparative Advantage, which relates to number sense, computation, fractions, and decimals, as well as problem solving. Five students were in attendance. The primary strategies used by the instructor were lecture (24 mins) and scenario-based questioning (25 mins). Time spent using polling tools (4 mins) remained the same between sessions one and two. However, we saw more use of multiple-choice questions during session two (8 mins compared to 4 mins). Again, students primarily responded in the chat (26 mins) and did not use the microphone to respond to the instructor, discuss an answer, or ask a question. Coding of the written responses revealed students primarily were engaged with the instructor and the content. Out of 78 total written responses, 30 were coded as engaged student interaction and 39 were engaged interaction with instructor. Five statements were coded as disengaged student interaction and four as distracted by another student. Most of these statements centered around a student repeatedly getting kicked out of the session because of internet issues and then coming back in and catching up on what was missed. Students did not ask questions during this session. Students did respond when the teacher used the polling tools (12 mins). However, the teacher prompted students to respond with the polling tools (2 mins). Other strategies (13 mins) used by the instructor included greeting the students and redirecting students like in session one, as well as using resolving technical issues. Students were prompted to take notes in certain sections of the lecture. We were not able to visually see if they were complying.

Session Three Observation Analysis. Session three focused on supply and demand, which relates to number sense, problem solving, and computation. Six students were in attendance. The primary strategies used by the instructor were lecture (27 mins) and scenario-based questioning (24 mins). Polling tools (1 min) and multiple-choice questions (2 mins) were used less than in sessions one and two. Students primarily responded in the chat (27 mins). Coding of the written responses revealed students primarily were engaged with the instructor and the content. Out of 39 total written responses, 22 were coded as engaged student interaction and 16 were engaged interaction with instructor. Only one statement was coded as disengaged student interaction and no statements were coded as distracted by another student. Disengaged student interaction was a student apologizing for being late to the session. No one got on the microphone to respond to the instructor, discuss an answer, or ask a question. Students spent more time asking questions in the chat (6 mins) during this session than they did with sessions one and two. Students did respond when the teacher used the polling tools (3 mins). No off-task or non-responsive behavior observed during this session. Other strategies used by the instructor included asking extension questions related to the topic (4 mins). Other behaviors by the students included entering the session late and providing additional examples in the chat (4 mins).

Session Four Observation Analysis. (Last session of Fall semester) Session four focused on Production Possibility Curve graphs, GPD calculations, and concept of productivity, which relate to computation and problem solving. Six students were in attendance. Seven students were in attendance. The primary strategies used by the instructor were lecture (27 mins) and scenario-based questioning (21 mins). The time spent using polling tools (1 min) mirrored the time spent in session three and was also less than the time spent using polling tools in sessions one and two. The time spent using multiple choice questions (7 mins) however increased during session four from what was observed in session three and mirrored the amount of time used on multiple choice questions during session two. Students primarily responded in the chat (20 mins). Coding of the written responses revealed students primarily were engaged with the instructor and the content. Out of 37 total written responses, 14 were coded as engaged student interaction and 13 were engaged interaction with instructor. Six statements were coded as disengaged student interaction and four as distracted by another student. These comments occurred at the very beginning and the very end of the session. Comments at the beginning surrounded complimenting another student's name and the comments at the end were asking questions about an upcoming break. No one got on the microphone to respond to the instructor, discuss an answer, or ask a question. The time students spent asking questions (8 mins) increased from session three to session four. One student confused subsidy with surplus. Teacher defined subsidy and gave examples. Students appeared to be more unresponsive (7 mins) and needing teacher redirection during this session. Students did respond when the teacher used the polling tools (1 min), but polling was barely used during this session. Off-task behavior was not noted on observation instrument, but coding of chat responses found some instances of non-content related communications. Other strategies used by the instructor included requesting what topics students needed further review on and then spending a few minutes reviewing the requested topic. Other behaviors by the students included making suggestions for examples and requesting help with monetary versus fiscal policy.

Session Five Observation Analysis. (First session of Spring semester) Session five focused on Production Possibility Curve graphs, GDP calculations, and concept of productivity, which relate to computation and problem solving. Six students were in attendance. The primary strategies used by the instructor were lecture (31 mins) and scenario-based questioning (25 mins). The time spent using polling tools (2 mins) was slightly more than the time spent in sessions three and four but was also less than the time spent using polling tools in sessions one and two. Multiple choice questions were not used in session five. Students primarily responded in the chat (32 mins). Coding of the written responses revealed students primarily were engaged with the instructor and the content. Out of 63 total written responses, 38 were coded as engaged student interaction and 15 were engaged interaction with instructor. Four statements were coded as disengaged student interaction and six as distracted by another student. These statements occurred at the beginning of the session and centered around the students' dual enrollment courses. No one got on the microphone to respond to the instructor, discuss an answer, or ask a question. The time students spent asking questions (8 mins) mirrored the time in session four. Students did respond when the teacher used the polling tools, but polling was barely used during this session (3 mins). Off-task behavior observed in chat during this session. Other strategies used by the instructor included having students compare and contrast production possibilities curves to supply and demand graphs as well as conducting an opening polling asking students to identify their level of comfort with math concepts. Other behaviors by the students included discussion around math abilities and think analytically about the differences between the graphs of production possibility curves and quantity supplied or demand.

Session Six Observation Analysis. Session six focused on supply and demand, which incorporated number sense, computation, and problem solving. Eight students were in attendance. The primary strategies used by the instructor were lecture (25 mins) and scenario-based questioning (28 mins). The time spent using polling tools (4 mins) mirrored the time spent in sessions one and two. The time spent using multiple choice questions (4 mins) mirrored the amount of time used in session one. Students primarily responded in the chat (25 mins). Coding of the written responses revealed students primarily were engaged with the instructor and the content. Out of 69 total written responses, 60 were coded as engaged student interaction and eight were engaged interaction with instructor. Only one statement was coded as disengaged student interaction and there were no statements coded as distracted by another student. The statement was a tangent related to the example the teacher was giving. No one got on the microphone to respond to the instructor, discuss an answer, or ask a question. The time students spent asking questions (2 mins) decreased from previous sessions. Students did use more time responding with polling tools (11 mins), which mirrored the time spent during sessions one and two. Other strategies used by the instructor (8 mins) included reviewing student requested topic (circular flow) at the beginning of class, using what will happen if questions, and asking students to describe the difference between scarcity and a shortage.

Session Seven Observation Analysis. During session seven, we focused on rational decision making, interest rates, and taxes, which connected to the math topics of problem solving, fractions, decimals, computation, and problem solving. Ten students attended the session. The primary strategies used by the instructor were lecture (36 mins) and scenario-based questioning (26 mins). Only two minutes were spent using polling tools, which mirrored session three the time spent using multiple choice questions (15 mins) significantly increased from previous sessions. Students primarily responded in the chat (35 mins). Coding of the written responses revealed students primarily were engaged with the instructor and the content. Out of 101 total written responses, 70 were coded as engaged student interaction and 24 were engaged interaction with instructor. Six statements were coded as disengaged student interaction and only one as distracted by another student. These statements were at the very beginning of the session and centered on the student not being able to access a previous class recording. No one got on the microphone to respond to the instructor, discuss an answer, or ask a question. The time students spent asking questions (7 mins) increased from session six and mirrored the amount of time from sessions four and five. Students did respond when the teacher used the polling tools (6 mins). Other strategies used by the instructor included using acronyms for the determinants, asking what if style questions, and asking students to provide ideas for examples. Other behaviors by the students included engaging with instructor by providing example ideas in the chat.

Session Eight Observation Analysis. Session eight focused on absolute and comparative advantage, which relates to the math topics of number sense, computation, fractions, and problem solving. Eighteen students were in attendance. The primary strategy used by the instructor was lecture (41 mins) with the second most used strategy being scenario-based questioning (18 mins) followed by multiple-choice questions (11 mins). Polling tools were used, but barely (1 min). Students primarily responded in the chat (16 mins), but much less than any other session. Coding of the written responses revealed students were less engaged in the chat than previous sessions. Out of 39 total written responses, 16 were coded as engaged student interaction and 22 were engaged interaction with instructor. Only one statement was coded as disengaged student interaction and no statements were coded as distracted by another student. The disengaged student interaction occurred at the beginning of the session when a student mentioned they had applied to a college and were wondering how long it would take to hear back. No one got on the microphone to respond to the instructor, discuss an answer, or ask a question. The time students spent asking questions (3 mins) decreased from session seven and was similar to session six. Students were more non-responsive (7 mins) and off task (1 min) during this session. Students did respond when the teacher used the polling tools, but polling was barely used during this session (1 min). Other strategies used by instructor included adding numbers to example question so that the concept was not so abstract for students.

Session Nine Observation Analysis. Session nine focused on exchange rates and a review of comparative advantage. These topics relate to the math topics of factions, decimals, computation, and problem solving. Twenty students were in attendance. The primary strategies used by the instructor were lecture (28 mins), scenario-based questioning (15 mins), and multiple-choice questioning (14 mins). More time was spent using polling tools during this session (10 mins). Students primarily responded in the chat (24 mins). Coding of the written responses revealed students primarily were engaged with the instructor and the content. Out of 46 total written responses, 26 were coded as engaged student interaction and 19 were engaged interaction with instructor. Only one statement was coded as disengaged student interaction and no statements were coded as distracted by another student. The disengaged student interaction was related to the example the instructor gave but it was more of a tangent. No students used the microphone to respond to the instructor, discuss an answer, or ask a question. The time students spent asking questions (3 mins) mirrored the time from session eight. Students did respond when the teacher used the polling tools, but polling was barely used during this session (2 mins). Two minutes of off-task behavior was observed during this session, as well as five minutes of students being unresponsive. Other strategies used by the instructor included relationship building, explaining why countries trade, as well as working out the steps for the math problem.

Qualitative Summary

A summary of the topics, math connections, and assessment questions can be found in Table 20. The primary forms of teacher instruction were through lecture and scenario-based questioning. Lectures were more discussion and review based rather than introducing new information. Scenario-based questioning and what if style questions were used to help students apply the information they had learned. Multiple-choice questions and polling tools were used throughout the sessions but comprised a small percentage of the overall time in each session. Students engaged primarily by writing in the chat. Students would also use polling tools including the emoji polling. There were some instances of off topic conversations but those primarily occurred at the beginning or at the end of the session. Students being unresponsive at times tended to be more of a consistent issue than students being off task. Again, our version of off-task means to be discussing something not in line with the topic of the session since we were unable to see students on camera and unable to track their computer usage.

Table 20

Intervention Sessions connections to Math Topics and Assessment Questions

Session Number	Number of Attendees	Economics Topic	Math Relationship/ Category	Questions on Intervention assessment
Session 1 (FALL)	6	Rational Decision Making, Interest Rates, and Taxes	Number sense, Computation, Fraction, decimals, and problem solving	1, 4, 7, 11
Session 2 (FALL)	5	Absolute and Comparative Advantage	Number Sense, Computation, Problem Solving	13, 15
Flipped Recording (FALL)	0	Exchange Rates	Computation, Fractions, Problem Solving	2
Session 3 (FALL)	6	Supply and Demand	Problem solving, Computation	5, 8, 9, 14
Session 4 (FALL)	7	PPC, GDP, productivity	Computation, Problem Solving	3, 6, 10, 12
Session 5 (SPRING)	6	GDP, Productivity, PPC	Computation, Problem Solving	3, 6, 10, 12
Session 6 (SPRING)	8	Supply and Demand Graphs	Problem solving, Computation	5, 8, 9, 14
Session 7 (SPRING)	10	Rational Decision Making, Interest Rates, and Taxes	Number sense, Computation, Fraction, decimals, and problem solving	1, 4, 7, 11
Session 8 (SPRING)	18	Absolute and Comparative Advantage	Number Sense, Computation, Problem Solving	13, 15
Session 9 (SPRING)	20	Exchange Rates	Computation, Fractions, Problem Solving	2

Mixed Methods Participants

As described in Chapter 3, this study integrated mixed methods at three levels. First, the research design was convergent, which meant the quantitative and qualitative data were collected and analyzed at the same time rather than in sequential phases. Second, the quantitative and qualitative data were connected through sampling. The experimental group of the quantitative phase became the participants in the qualitative phase. Lastly, a joint table display was used for interpretation and reporting. The joint table display provided a visual way to view the quantitative and qualitative data together and potentially draw new insights that would have not been possible when the data was separated (Fetters, Curry, & Creswell, 2013).

For the joint display tables, the researcher compared the assessment averages of participating students in the five most engaging intervention sessions. Table 21 shows the total attendees for each of these sessions as well as how many students completed the assessments that are in the joint display tables. Two tables were created. Table 22 displays the averages of the pre-test and post-test of the intervention assessment, while Table 23 & shows the averages of Benchmark 1, Benchmark 2, and Benchmark 3. As seen in Chapter 3, the intervention assessment consisted of 15 questions and was given at two time points during each semester – once before the sessions started (pre-test) and once after the sessions were over (post-test). The intervention assessment questions did not change from the pre-test to the post test and were specific to topics covered in the intervention. The benchmark assessments consisted of 40 questions, which varied from each test as they were measuring different Economics standards. The benchmark assessments were given at three time points (6th week, 12th week, and 18th week of semester) by the students' regular instructors. The purpose of including this data was to measure students' overall Economics knowledge since the Economics End of Course test was no longer available. Again, students of the 2020 cohort did not take the Economics End of Course Test because the state discontinued the Economics End of Course Test after the 2019-2020 school year.

Table 21

Attendance and Assessment Completion of Most Engaging Sessions

Session	Total Attendees	Completed Pre and Post Interim Assessment	Completed Benchmarks 1, 2, and 3
Session 1	8	4 (50%)	7 (87.5%)
Session 2	6	5 (83%)	5 (83%)
Session 5	6	5 (83%)	5 (83%)
Session 6	8	6 (75%)	7 (87.5%)
Session 7	8	4 (50%)	3 (37.5%)

Table 22

Intervention Pre-test and post-test averages from students in most engaging sessions

	Fall Semester 2020 Cohort		Spring Semester 2020 Cohort		
Test Scores (mean score)	Session One ($n = 4$)	Session Two ($n = 5$)	Session Five ($n = 5$)	Session Six ($n = 6$)	Session Seven ($n = 4$)
Pre-test	30.00	38.67	58.67	61.11	70.00
Post-test	33.33	42.67	72.00	70.97	80.00
Difference	3.33	4.00	13.33	9.86	10.00
Most observed Teaching Strategy	Scenario Based Questions (33 mins)	Scenario Based Questions (25 mins)	Lecture (31 mins)	Scenario Based Questions (28 mins)	Lecture (36 mins)
Most observed Student Behavior	Written Response (32 min; 106 engaged student responses)	Written Response (26 min; 69 engaged student responses)	Written Response (32 min; 53 engaged student responses)	Written Response (25 min; 68 engaged student responses)	Written Response (35 min; 94 engaged student responses)

**Pre-test score: Mean benchmark assessment for students*

**Post-test scores: Mean benchmark assessment for students*

Mixed Methods Findings

Research Question 4

To what extent does student engagement in the math intervention for 11th, and 12th grade students impact their academic performance on assessments in Economics?

The joint display tables integrated the quantitative and qualitative results. Both joint display tables focused on the participants from the five most engaging sessions as identified in our Qualitative Results section (Sessions one, two, five, six, and seven). As seen in Table 19, the average pre-test score from participants in these five sessions ranged from 30.00 to 70.00. The average post-test score ranged from 33.33 to 80.00. The difference between the intervention assessment pre-test and post-test averages ranged from 3.33 to 13.33, which suggest that students engaged in the math intervention improved their Economics performance. Spring Semester 2020 Cohort demonstrated the most growth and mastery of material on the Intervention assessment. This could potentially be due to some students repeating the course in the spring so they may have a higher base line than students in the Fall semester. Scenario Based Questions were predominantly the most observed teaching strategy in the five most engaging sessions. However, the two sessions where lecture was observed more than scenario-based questions had higher differences between the pre-test and post-test. Written response was the most observed student behavior across all sessions.

As seen in Table 23, students in the Fall semester experienced a positive difference of four or more points between Benchmark 1 and Benchmark 3. However, students in the Spring semester scored higher on Benchmark 1 than they did on Benchmark 3 therefore resulting in negative difference values. Again, we see that students in the Spring semester had a higher baseline than students in the Fall semester, which may be due to students repeating the course.

Fall Semester participant averages ranged from 39.29 to 47.94 on their benchmark tests whereas Spring Semester participant averages ranged from 70.00 to 87.5. We see again that Lecture and Scenario based questions were the most observed strategies during these engaging sessions. One noticeable difference in the data includes that the two lecture heavy sessions have a higher negative difference between Benchmark 1 and Benchmark 3. Two out of the three Scenario Based Question sessions had positive differences between Benchmark 1 and Benchmark 3.

Additionally, the amount of time between the most observed teaching strategy and the most observed student behavior are almost identical. Sessions one, two, five, and seven are within one minute of each other. Only session six is the outlier with a three-minute difference between scenario-based questions and written responses. This reflects what was observed in that the lecture and scenario-based questions were discussion based and were designed to engage the students in dialogue. The most engaged responses were seen in session one (106) and session seven (94). Sessions two (69) and session six (68) were in the middle while session five (53) had the lowest engaged responses out of the most engaged sessions.

Table 23

Economics Benchmark averages from students in most engaging sessions

	Fall Semester 2020 Cohort		Spring Semester 2020 Cohort		
Test Scores (mean score)	Session One (*n* = 7)	Session Two (*n* = 5)	Session Five (*n* = 5)	Session Six (*n* = 7)	Session Seven (*n* = 3)
Benchmark 1	39.29	43.00	76.50	80.71	87.50
Benchmark 2	40.00	47.94	77.50	83.21	87.50
Benchmark 3	43.57	47.00	70.00	80.60	85.83
Difference between Benchmark 1 and Benchmark 3	4.28	4.00	-6.50	-0.11	-1.67
Most observed Teaching Strategy	Scenario Based Questions (33 mins)	Scenario Based Questions (25 mins)	Lecture (31 mins)	Scenario Based Questions (28 mins)	Lecture (36 mins)
Most observed Student Behavior	Written Response (32 min; 106 engaged student responses)	Written Response (26 min; 69 engaged student responses)	Written Response (32 min; 53 engaged student responses)	Written Response (25 min; 68 engaged student responses)	Written Response (35 min; 94 engaged student responses)

Benchmark 1 – given at 6th week during semester
Benchmark 2 – given at 12th week during semester
Benchmark 3 – given at 18th week during semester (final exam)

Mixed Methods Summary

Intervention assessment averages suggest that participation in the intervention potentially helped students improve math-based skills in economics. Benchmark assessment averages has mixed results towards the impact of the intervention. Some students saw a positive difference between benchmark 1 and benchmark 3 while others did not show growth. The benchmark tests measured overall academic knowledge so the students could have struggled with topics no discussed in the intervention. Overall, Spring semester students outperformed Fall semester students on all measures. Students that attended intervention sessions typically engaged in the sessions. The biggest challenged we faced was getting students to attend the sessions.

Summary

Overall, the statistical tests suggest that there may be a relationship between students participating in a math intervention for Economics and improved performance on Economic assessment measures. Three out of the five independent t-tests were statistically significant indicating that three out of five times the students that participated in the intervention outperformed the students that chose to not participate in the intervention. The dependent t-test was significant, which suggest that the intervention had some impact in improving student knowledge and performance in Economics on math-related topics.

Observations for Cohort 2020 indicated the two primary teaching strategies used during the intervention sessions were Lecture and Scenario Based Questions while the primary student behavior was Written Response. The Kappa Coefficient for interrater reliability indicated there was fair to substantial agreement between observers for Lecture, moderate agreement between observers when notating Written Response, and fair agreement between observers when indicating Scenario Based Questions. Coding of the written responses indicated that students were primarily engaged and only discussed off topic items occasionally, mainly towards the beginning or end of class. As seen in the joint display table, students that participated in the five most engaging sessions showed growth between their intervention assessment pre-test and post-test. There were mixed results when examining the differences between Benchmark 1 and Benchmark 3. Fall Semester participants grew on average four points between Benchmark 1 and Benchmark 3. Spring Semester participants actually regressed between Benchmark 1 and Benchmark 3. However, their baseline started much higher than Fall Semester participants and their achieved higher mastery of the material even with little growth.

Chapter V: Conclusions

Summary of the Study

In the United States, we face the problem of students having limited knowledge of economics, which can impact their daily lives outside of school. One contributing factor to this limit knowledge is potentially students' math ability. Studies have shown math ability can be a predictive factor in how students may perform in Economics classes (Ballard & Johnson, 2004; Evans, Swinton, & Thomas, 2015; McCrickard, Raymond, A., Raymond, F., & Song, 2018). Students who perform well in math tend to also perform well in Economics whereas students who struggle with math typically struggle with economics as well. Our studied attempted to address this issue by providing an intervention to Economics students who had indicators of poor math performance. The goal was to improve their math ability to improve the Economics performance. This study used a convergent parallel mixed methods design. The quantitative phase was causal comparative while the qualitative phased utilized phenomenology. Previous studies showed math ability impact economic performance, but few studies target students based on math ability for economics intervention. This study addressed gaps in the literature by conducting the study at a high school rather than a college and utilizing a mixed methods research design.

Quantitative analysis included independent t-tests on the Economics End of Course Test scores between the control groups and experimental groups of Cohort 2018 and Cohort 2019. The independent t-test for Cohort 2018 was found to be statistically significant (p-value< 0.001) while the independent t-test for Cohort 2019 was found to not be statistically significant (p-value = 0.716). Due to changes at the state level, Cohort 2020 did not take an Economics End of Course Test. Instead, we used the three district created benchmark tests to measure overall economic knowledge of the control and experimental groups. The independent t-test results for Benchmark 1 (*p*-value = 0.007) and Benchmark 2 (*p*-value = 0.003) were found be significant, whereas the results for Benchmark 3 were found to not be significant (*p*-value = 0.925). To measure the impact of the intervention, the experimental group took an intervention specific pre-test and post-test. The dependent t-test results for this assessment were found to be significant (*p*-value =0.049).

Observations by two researchers found lecture and scenario-based questions were the primary teaching strategies used across nine sessions. Pooling tools and multiple-choice questions were used but to a lesser extent. Students primarily engaged through written communication in the chat box. Throughout the nine sessions no students got on the microphone to speak even though there were opportunities to do so. Students did respond with polling tools when prompted by the instructor. There were some instances of off-task and non-responsive behavior, but the instances were relatively few and far between. Attendance in the sessions were relatively low ranging from five to twenty students and averaging nine to ten students (x = 9.55).

The mixed methods joint display table suggested students that participated in sessions with scenario-based questioning tended to perform higher on assessments. In the sessions with the most student engagement, the duration of students' written responses closely aligns with the lecture or scenario-based instruction during those sessions. As the observers notated, students were active and responding in the chat to prompts from the instructor for most of the time in the session.

There are four studies which closely relate to aspects of this study and will be used to compare findings. The studies by Robinson and Lairde-Muriente (2018) and Lagerlöf and Seltzer (2009) are the most like the current study in that they examined math interventions impact on

Economics students' outcomes. However, their sample populations were in college rather than high school and their research designs were quantitative rather than mixed methods. The study by Gill and Bhattacharya (2019) used a sample population from 11^{th} and 12^{th} grade students and implemented an intervention for economics students like the current study. However, the intervention was based on financial investment and money management concepts rather than math skills. This study was also quantitative rather than mixed methods. Lastly, Althaser and Hater (2016) study mirrored this study in that they examined an Economics intervention on Math students in kindergarten through fifth grade. While their student was predominantly quantitative, they did conduct follow up interviews with teachers that participated in the program to help expand upon the results. Therefore, their student could qualify as a mixed methods explanatory study. In the following paragraphs, we compare the findings of these studies in more detail to the current study.

Lagerlöf and Seltzer (2009) studied the effects of a remedial mathematics course on university students studying economics. Students were placed in the remedial math course based on university requirements, which included earning a grade lower than a B in a required math course for Economics majors. The study examined the end of year test scores and other control factors of 193 students. The results indicated there was not strong evidence the remedial math course was successful in improving students' grades except for a subgroup of students that did not take the initial math class. The OLS regression did support the idea that previous math background had a significant impact on student economics outcomes. The intervention did not appear to help students who historically struggled with math. The researchers noted that the lack of improvement from historically struggling students could be due to the lack of incentives. The statistically non-significant findings of our independent t-tests for Cohort 2019 Economics End of Course scores and Cohort 2020 Benchmark 3 scores appear to confirm Lagerlöf and Seltzer (2009) findings that the math intervention did not have a significant impact on most students. Additionally, as seen in Table 23, the Spring semester Cohort 2020 students showed a decline in overall economic mastery on the Economic benchmark assessment. However, this group grew on the intervention specific assessment. It is possible the decline from benchmark 1 to benchmark 3 could be due to the cumulative nature of benchmark 3. It is possible students struggled with being tested on more standards. Yet this issue was not seen with the Fall Semester Cohort 2020 students. Another possible explanation could be students in the Spring Semester struggled with Economics topics outside of what was focused on in the intervention, which could account for their growth on the intervention specific assessment but the decline on the overall assessment.

The statistically significant findings for the independent t-tests of Cohort 2018 Economics End of Course scores and Cohort 2020 Benchmark 1 and Benchmark 2 scores suggest there may be a positive impact on students that participated in the math intervention for Economics, which would disconfirm the findings of Lagerlöf and Seltzer (2009) and could confirm Dowker's (2016) findings that students who struggle with math can benefit from intervention. Some of the differences in results may be due to sampling and procedural differences. For sampling, we focused on high school 11th and 12th grade students instead of college students. For procedural differences, our criteria for our sample were based on achievement scores for end of the year tests rather than overall grades. Our statistically significant tests suggest algebra and geometry End of Course scores were good indicators for which students needed to be targeted for intervention (Ballard & Johnson, 2004; Evans, Swinton, & Thomas, 2015). This study also shows NWEA MAP Math 6+ growth data can also be a good indicator for math and economics performance. Lastly, Lagerlöf and Seltzer (2009) found students who performed poorly in math (C to F grades) did receive much benefit from the remedial course. While our students with the lowest levels of math ability did not show mastery in Economics like students in more developing levels, these students did show growth on the intervention assessments and the benchmark assessments, which suggest the intervention had a positive impact for these students.

Robinson and Liard-Muriente (2018) studied the effects of the mathematical tutorial software, Math You Need, on college Economic students. While the current study used live teaching sessions for the math intervention, the Math You Need program was automated and consisted of ten modules students worked through at their own pace within the instructor deadlines. Unlike the current study, students were not targeted based on math ability. All students within the three economic courses had access to the Math You Need software program. Analysis of the pre-assessment found the two primary factors for lower initial scores were ethnicity/race and being enrolled in beginning levels course. However, after completing the iMath program, there was no statistical difference on the post-test based on ethnicity/race and there was an 11-point reduction in the difference between students introductory-level courses and students in upper-level courses. Overall, the researchers found that the iMath program could be beneficial at the university level for solidifying economic knowledge. While we did not use the same program, we agree that math interventions for Economic courses can be beneficial. Our dependent t-test on the intervention assessment was statistically significant indicating students in the intervention displayed growth in Economic knowledge from the pre-test to the post test. Additionally, three of the five independent t-tests were statistically significant when comparing the assessment scores of the control groups to the experimental groups.

Gill and Bhattacharya (2019) also focused on 11th and 12th grade economics students. Instead of using a math intervention, however, they used financial investment concepts and money management concepts. The researchers examined the pre and post test scores through an ANOVA statistical test and multivariate regression rather than a dependent t-test. The regression controlled for gender, student ability with GPA, working status, and school effects. The experimental groups improved scores between pre-and post-test test like our Cohort 2020 experimental group did. We did not use pre and posttests with our control groups. We only looked at the post-test scores for control groups across all three cohorts. Gill and Bhattacharya (2019) study suggest that interventions targeted at filling gaps in Economic knowledge, whether it is math skills or more specific economic concepts, can benefit students.

Althaser and Hater (2016) used job-embedded economics professional development program, Economics: Math in Real Life, to enhance Math content for K-5 students. Their study could be considered explanatory mixed methods since they did collect teacher feedback to help expand upon the results. Third through fifth grade level averages for students improved from pre to post test. Yet only the averages for fourth and fifth grade were found to be statistically significant. In a similar vein, the experimental groups scored on par with or above the control groups across all five assessments (two end of course tests and three benchmark assessments) even though only three were found to be statistically significant. For Althaser and Hater (2016), Kindergarten and first grade students had a lower post-test score potentially due to technical issues while administering the exam. Similarly, when looking at our mixed methods joint table display, the Spring semester participants in the most engaged sessions had a lower average post test score. This could be due to having some exposure to the course during fall semester.

Regarding student engagement, the researcher observed that students who came to the intervention sessions were engaged and interacted well with the instructors and other students. McBrien et al. (2009) found students enjoyed being able to talk to other classmates and share opinions in synchronous online sessions. Observations from this study appear to confirm that finding. However, students were not surveyed or interviewed about their experiences in the intervention. Calafiore and Dam (2011) found that more time spent in virtual classroom setting (Blackboard) along with higher GPAs had an impact on course averages. While duration in the intervention sessions for each student was collected, the researcher did not analyze that data to see how it impacted quantitative assessment scores. Students did have to attend at least one intervention session to be included in the quantitative results, which suggest time spent in the course helped improve economic knowledge as shown by the statistically significant finding for the dependent *t*-test.

This study extends the field of education by observing an intervention in fully virtual setting while notating teaching strategies and student engagement in virtual environment. We adapted and applied the BERI protocol in virtual environment (Lane & Harris, 2015). This study used live teaching in a virtual environment rather than an automated program. Additionally, this study looked at an intervention over three cohort years.

Limitations of the Study

Generalizability of research findings are limited because participants were 11th and 12th grade high school students in one school. The intervention was conducted fully online rather than face to face. Student participation was a limitation as well. Students were identified for needing the intervention, but participation had to be voluntary due to school policies and intervention sessions being offered outside of normal class hours. Additionally, we were limited on what kind of incentives we could offer students. As seen in Lagerlöf and Seltzer (2009), we found engagement without incentives can be very challenging. Any type of extra credit had to be offered to all students and not a targeted group. This led to participant numbers being lower than desired as well as lack of consistency in participants completing the intervention assessment pre-test and post-test. Althaser and Hater (2016) experienced a similar issue in that some students did not complete their pre-tests and posttests, which impacted the sample sizes and results.

Originally, we planned to give a pre-test, mid-test, and post-test so that we could have three time points for a repeated measures ANOVA. Due to low engagement, we decided to drop the mid-test requirement in favor of just the pre-test and post-test, which led us to change from a repeated measures ANOVA test to a dependent t-test. Grades were given by content teachers for the End of Course test for Cohort 2018 and Cohort 2019 and for the Benchmark Assessments for Cohort 2020 thus students had a higher completion rate for these items. We were limited in being able to compare End of Course score across all three cohorts due to the state stopping the administration of the Economics End of Course test in the 2019-2020 school year. Studies where researchers have more control of participation, engagement, and incentives might see different results.

Inter-rater reliability was within the acceptable range but the results are solely based on the accuracy and of the raters and the speed at which they could code the different types of student engagement behaviors in each class session. The Kappa coefficients were low in a few areas and there was some disagreement between observers. This may be due to different levels of experience with the content area and virtual setting between the two observers. The observers did meet and discuss their first round of observations to try and clear up any differences, but the data indicates this follow-up may should have occurred a few more times during the process.

Recommendations for Future Research

Future research focused cross curricular teaching and interventions between math and economics courses could be beneficial in the field of education. We only focused on Level I of Beckmann's model for cross-curricular planning. An expansion into the higher cross curriculum planning levels could potentially yield positive results. Level 2 in Beckman's (2009) model would be a Math and Economics teacher plan together to cover similar content in their separate classes. For example, a math teacher could introduce or review graphs around the same time the Economics teacher would introduce Supply and Demand graphs or Production possibilities curves. At Level 3 (Beckman, 2009), the economics and math teacher work together to create a joint lesson plan to be used in both courses. For example, both teachers use exchange rates to be an example of solving for x and ratios. At Level 4, students from both classes would work on a type of group project or problem-solving project. For example, students would track the prices of a particular item, generate a supply and demand table (teacher may have to help with demand side), graph the table, and then explain what might have caused the increases or decreases in supply and demand of the item. This could also help expand the topics of the intervention, which may be needed to help improve overall economic knowledge as seen with the Spring semester of Cohort 2020.

A potential mixed methods study to expand upon the current research could be conducting cognitive interviews with intervention participants on scenario-based economics questions (Willis & Artino, 2013). The researcher could track if participants are able to identify the math skills needed to solve the problem, apply those skills, and interpret those results through their understanding of economics. The study could measure and compare students' conceptual fluency to their procedural fluency. By discussing the questions and procedures out loud, the student would be taking part in a form of meta cognition. Cognitive interventions that use meta-cognitive have been found to be effective in secondary students (Wilson & Rasanen, 2008). The qualitative results could be quantified, and then statistical tests could be run on that quantitative data. Additionally, based on the concepts participants struggle with, an intervention could be developed to improve those areas and then students could be re-tested. A factorial ANOVA could be used to see if there are trends in certain responses. In fact, a factorial ANOVA could be run on the current data set to see if there are any trends in assessment scores or participation levels based on gender, ethnicity/race, and math ability determinants (Algebra/Geometry EOC scores and/or NWEA MAP Math 6+ Growth scores). Future research could also examine if participants in a math-economics intervention see improvement in both math and economics class grades or assessments.

Lastly, due to the purposeful sampling of this study and the obstacles of student participation, our participants were not as diverse as hoped. While following the main trends of the focus school's demographics, more efforts could have been made to balance male/female numbers and to be more inclusive of various ethnicities/races. A future intervention could control for and be more cognizant of diversity in the intervention.

Implications of the Study

This study suggests targeting students based on math ability and providing interventions could potentially improve economics performance. As seen in Althaser and Hater (2016), Gill and Bhattacharya (2019), Robinson and Lairde-Muriente (2018), using more cross-curricular interventions could benefit students. Math and Economics teachers can use the results of this study to collaborate on interventions help address gaps in math skills for students in Economics courses. Addressing these math skills gaps can help the student understand and perform better in Economics.

These findings integrate with the hierarchical cross-curriculum approach by using one content area to supplement another (Barnes, 2015). For Robinson and Lairde-Muriente (2018) and our current study, we used math to supplement Economics. Gill and Bhattacharya (2019) used financial investing and money management to supplement Economics. Althaser and Hater (2016) used Economics to supplement Math. These studies saw positive outcomes from using a hierarchical cross curriculum model. In addition to the hierarchical cross-curriculum approach, we also discussed Beckmann's (2009) model for cross-curricular teaching in Chapter I's theoretical framework section. Barnes's (2015) hierarchical cross-curriculum approach aligns with Level I in Beckmann's cross-curricular teaching model. At Level I, educators incorporate another subject to expand on current class topic (Beckmann, 2009). We see this in Robinson and Lairde-Muriente (2018) using math software to improve achievement in Economics, Gill and Bhattacharya (2019) teaching about financial investment and money management to improve Economic understanding, as well as Althaser and Hater (2016) using Economics to enhance elementary Math curriculum. This cross-curricular planning builds on a student's strengths in both courses, helps address gaps by providing support in both courses, and allows connections to real world scenarios.

One of the most used teaching strategies in this study was scenario-based questioning. Scenario based questioning was a steppingstone towards problem-based learning. The research wants to develop the intervention to utilize problem-based learning. Problem based learning has been found to be effective in teaching economics (Singh & Bashir, 2018; Maxwell, Mergendoller, & Bellissimo, 2005; Chulkov &Nizovtsev, 2015; Finkelstein, Hanson, Huang, Hirschman, & Huang, 2010). Singh and Bashir (2018) as well as Chulkov and Nizovtsev (2015) found problem-based learning to be more effective than traditional lecture methods in teaching economics.

The methodological contributions include sampling, data collection measures, and data validation. The sample sizes for quantitative participants were robust. Quantitative data collection included a state created assessment for two cohort years, three district created benchmark assessments for one cohort year, and an intervention specific pre-test/post-test assessment. The state and district created assessments were examined to measure overall economic knowledge of both control and experimental groups, while the intervention specific assessment was examined to measure the impact of the intervention on the experimental group. Qualitatively, we adapted the BERI protocol for an online environment (Lane & Harris, 2015). The qualitative measures were cross-checked and validated for inter-rater reliability using Kappa Coefficients (Hallgren, 2012). We had a longitudinal intervention period of three school years (Fall 2018-Spring 2021).

A mixed-methods design was selected for this study to see how student engagement may impact the student outcomes. Through methodological and data triangularization, we were able to link and merge qualitative and quantitative strands to obtain a more holistic picture (Dezin,2012). If we only did a quantitative study, we could see if there is a statistical difference in outcomes between the control group and the experimental group as well as within the experimental group, but it would be difficult to gauge the impact of the intervention without knowing if students were engaged during the sessions or not. If we only did a qualitative study, we could see student behaviors and potentially interview students about how they feel about their math ability in Economics class, but then we would be difficult to measure if the students grew or if there was a statistically significant difference between students that participated in the study and those that did not. With the mixed methods design, we were able to see growth on quantitative measures alongside engagement in intervention sessions. While we cannot definitively say the interventions are the cause of the students' score improvements, their engagement makes it more likely the intervention had an impact. On the other hand, if a study had low to negative growth on the quantitative assessments, observing student engagement in the intervention could indicate there was no growth because students attended but did not engage or students engaged, and the intervention may just not be effective. You need both pieces, the quantitative and the qualitative, to have a fuller picture of what is going on. While there will always be conditions, we cannot account for, a mixed methods study could help eliminate some of the limitations of an only quantitative or only qualitative research design.

Conclusion

This study shows cross-curricular interventions can be successful in improving student performance. Specifically, to improve student performance in Economics, educators can target students who previously struggled in math and provide an intervention which builds on math skills that overlap with Economic concepts. While we used live teaching sessions for our intervention, Robinson and Lairde-Muriente (2018) had success with the Math You Need software. In a virtual environment, students engaged more when the instruction had discussions built into lecture or had scenario-based questions guiding the instruction. Student engagement was mostly written responses in the chat box. Students did use polling tools and feedback emojis, but to a lesser extent. No students volunteered to be on the microphone during the nine intervention sessions. Mixed-methods studies can help provided a fuller picture of what is occurring during cross-curricular interventions.

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Appendices

Appendix A

IRB Application

Human Research Application

SECTION A: PROJECT INFORMATION

1. **Title of Project:** CAN A MATH INTERVENTION IMPROVE STUDENT PERFORMANCE IN HIGH SCHOOL ECONOMICS COURSE? A CONVERGENT PARALLEL MIXED METHODS STUDY MEASURING THE IMPACT OF MATH-ECONOMICS CROSS-CURRICULAR INTERVENTION

2. **Application Type:**

   ☒ New Project

   ☐ Resubmission of Withdrawn Project

   ☐ Continuing Project (Previous IRB number: _____)

3. **Principal Investigator:**
   (There is only one principal investigator. List the primary contact person as the PI. Include a copy of human subjects research training certificate in the addendum.)

   Name: Kelli L. Kelley

   Title: Education Doctoral Candidate

   Department Name: Department of Teacher Education Leadership & Counseling

   Mailing Address: 3300 Stadium Dr. Apt 710, Phenix City, AL 36867

   Phone: 706-358-1063 E-Mail: kkelley@georgiacyber.org

4. **Co-Principal Investigator:**
   (For student project, thesis, or dissertation, the faculty supervisor serves as the Co-PI.

   If you are not affiliated with CSU, then you must list a faculty member as the Co-PI. Include a copy of human subject's research training certificate in the addendum.)

   Name: Dr. Parul Acharya

   Title: Assisstant Professor

   Department Name: Department of Teacher Education Leadership & Counseling

Mailing Address: _____

Phone: 706-507-8523 E-Mail: acharya_parul@columbusstate.edu

5. **Indicate whether personnel from an approved lab setting will be involved in this research.**

☐ Yes ☒ No

B) If *Yes*, identify the name of the approved lab:

6. **Other Personnel of the Research Team:**
(If additional space is needed, insert more rows in the table. Include a copy of human subjects research training certificates for all listed personnel in the addendum.)

Name	Email
Rebekah Atkinson	Atkinson_rebekah@columbusstate.edu

7. **A) Do any of the Investigators or Other Personnel listed in this application have a real, potential, or perceived conflict of interest associated with this study?** (See the FAQ webpage for more information.)

☐ Yes ☒ No

B) If *Yes*, identify the individual(s) and explain:

(The conflict must be disclosed in the informed consent process.)

N/A

8. **What is the expected duration of the project?**

The expected duration of the project is October 2020 - Spring 2021 for recruitment of participants, implementation of intervention, and collection of data.

SECTION B: PROJECT SUMMARY

Within 100 words, clearly describe the purpose of the study using lay terminology.

The purpose of this study is to examine the impact of a cross-curricular math intervention on 11th and 12th grade high school students' performance in Economics. Economic literacy is important in understanding real-world problems after high school. Previous studies have found a strong correlation between math performance and economic performance. This study aims to improve targeted students' math skills that overlap with Economic concepts in order to increase students' overall Economics academic achievement.

SECTION C: HUMAN RESEARCH PARTICIPANTS

1. **Number (or Range) of Participants Needed:** 130-150

2. **Age of Participants:**

   ☒ under 18 (Specify age(s): 15-17)

   ☒ 18 to 64

   ☐ 65 and older

3. **Identify the criteria for including, or selecting, participants.**

   Participants must be enrolled in Economics during Fall semester 2020. Students must have performed at Beginning (0-67) or Developing Level (68-79) on 2016-2019 Algebra or Geometry End of Course Test and/or be labeled as below grade level on the Northwest Evaluation Association Measure of Performance (NWEA MAP) Math 6+ Growth assessment to be invited to intervention.

4. **A) Are there any criteria for excluding potential participants?**

   ☒ Yes ☐ No

   B) If *Yes*, identify the criteria for excluding potential participants.

Students that performed at Proficient (80-91) or Advanced (92-100) level on Algebra or Geometry End of Course test or on or above grade level on the NWEA MAP Math 6+ Growth assessment will be excluded from potential participants because their math ability indicates that they should perform well in Economics without the math intervention.

5. **A) Indicate whether any of these groups will be targeted participants.** (Check all that apply.)

- ☐ Pregnant women, neonates, or fetuses
- ☐ Prisoners
- ☐ Individuals who are cognitively impaired
- ☐ Individuals who are economically disadvantaged
- ☐ Individual who are mentally ill
- ☐ Individuals who are terminally ill
- ☐ Individuals who have HIV or AIDS
- ☐ Individuals who have limited English proficiencies

B) Explain the justification for targeting the group(s) checked above in this research project.

N/A

C) What additional safeguards will be added to protect the rights and welfare of these groups?

N/A

6. **A) Do you plan to target individuals who belong to a particular gender, racial, or ethnic group?**

☐ Yes ☒ No

B) If *Yes*, specify the targeted group(s) and explain the justification for targeting the particular group(s) in this research project.

N/A

7. What is your current and/or future relationship to the participants?
I supervise the teachers of the participants.

SECTION D: RECRUITMENT PROCEDURES

1. How will the participants be recruited? (Check all that apply.)

☐ In person	☐ Printed Materials	☐ Television/Radio
☐ Phone call	☐ Letters	☒ Listserv/Email
☐ Social Media/Web-based	☐ SONA	☐ Other (Specify:_____)

2. Describe when, where, and how participants will be initially contacted for each method selected in #1 above. (Attach a copy of any printed and/or electronic materials that will be used for recruiting in the addendum.)

Parents/legal guardians of potential participants will be contacted through the school listserv/email during the fall semester of 2020 to recruit their students. The parents/legal guardians will be emailed the initial recruitment letter one to two weeks prior to the start of the intervention to inform them about the study. Parent/legal guardian and student emails are obtained from the school information system (SIS) and provided on a report by the school's data coordinator. Included in the recruitment email will be a link to the Qualtrics informed consent form. If parents select I AGREE in the informed consent form, then the student will be emailed the recruitment letter with the informed assent form to participate in the study.

3. Describe any follow-up recruitment procedures for each method selected in #1 above. (Attach a copy of any printed and/or electronic materials that will be used for recruiting in the addendum.)

A follow up email will be sent within two weeks after the initial email during fall 2020 to parents/legal guardians that have not responded to the initial email. The Qualtrics consent form will be resent within two weeks to families that indicated their students wanted to participate but have not completed the consent form.

4. **A) Will participants receive any incentives and/or compensation for their participation?**

☐ Yes ☒ No

B) If *Yes*, describe amount and quantity:
N/A

SECTION E: INFORMED CONSENT PROCESS

1. **Describe the specific procedures (i.e., how, where, and when) for obtaining informed consent.** (Use provided templates available on the CSU IRB website to create an informed consent form(s) and attach a copy in the addendum. Studies involving minor participants must include parental consent and minor assent.)

A link will be inserted in the initial recruitment email which will take the parent/legal guardian to the informed consent form in Qualtrics. Parents will read the form and select either "I AGREE" or "I DO NOT AGREE" option. Similarly, a Qualtics link for informed assent will be inserted in the initial recruitment email which will take the students (whose parents have provided their consent) to the assent form. Students will read the form and select either "I AGREE" or "I DO NOT AGREE" option.

2. **If applicable, provide justification for requesting a waiver to document informed consent.** (*See the FAQ webpage for more information.*)

N/A

SECTION F: OUTSIDE PERFORMANCE SITE

1. **A) Does this project involve any collaborating institution and/or performance site outside of the CSU campus (e.g., local public school, participants' workplace, military base, or hospital)?**

☒ Yes ☐ No

B) If *Yes*, list all institutions and sites involved with this research project.
(If additional space is needed, attach a separate sheet as an addendum. For each listed site, attach a Letter of Cooperation **written on the institution's letterhead** and signed by the appropriate authorized official(s) in the addendum. See the FAQ webpage for more information.)

Name of Institution	Location (City, State)	written permission and/or current IRB approval
Georgia Cyber Academy	Atlanta, GA	☒Attached ☐Pending
		☐Attached ☐Pending
		☐Attached ☐Pending
		☐Attached ☐Pending
		☐Attached ☐Pending

SECTION G: METHODS

1. **Basic Design and Procedures**
   Outline the research project procedures in concise and sequential lay terminology. The outline should include the basic design and the sequence of procedures the participants will follow from their entry through their completion of the project.

   This research project will use a convergent parallel mixed methods design in which the quantitative and qualitative data will be collected simultaneously, analyzed separately, and then interpreted together. Potential participants will be identified by their Algebra or Geometry End of Course test scores as well as their performance on the NWEA MAP Math 6+ Growth assessment. Parents/legal guardians will be sent the recruitment email with the informed consent survey. Once the parent consents, their student will receive an informed assent form as well. The individuals that elect to participate in the intervention with parental consent will be added to the online course and invited to the live sessions. Participants will start by taking a pre-test during the first live intervention sessions. There will be six live intervention sessions, twice a week for 50 minutes, before the mid-test is given then there will be six more live intervention sessions also twice a week for 50 minutes before the post test is given during the final live session. During these sessions, our Math and Economics teachers will review math skills and economic concepts that are shared between the two contents such as graphs, ratios, charts, tables, and rational decision making. Teachers will provide sample problems for students to work out solutions, hold discussions over economic concepts, and relate material to real-world examples. Participants will be observed for student engagement during the live intervention sessions for the qualitative strand of the research project. A secondary researcher will review the recordings of the sessions for interrater reliability. The final summative assessment will be created by the district curriculum coordinators and will be comparable to the state's former End of Course Assessment in Economics through standards and weights of domains.

2. **Description of Data Collection / Instrumentation**
For each item selected, you must address all of the required components. (Check all that apply.)

☐ Physiological, Anthropometric, Specimen, or related Measurements (e.g., EEG, body composition, blood, and urine)

Describe the procedure used to conduct each measurement. For specimen samples (e.g. blood) make sure to include the frequency of collection, amount for each collection, and total volume to be collected.

☒ Document and Artifact Collection

Describe any documents or artifacts (e.g., historical papers, educational records, or student writing samples) that will be collected and used.

Educational records of students enrolled in Economics will be accessed to identify potential participants based on prior 2016-2019 Algebra and Geometry End of Course tests as well as their 2020 NWEA MAP Math Growth 6+ levels. District created pre-test, Interim Assessment 1, and Interim Assessment 2 scores will be collected for intervention (experimental) and non-intervention (control) participants during the study. Students' Economics summative test scores (Interim Assessment 3) will be collected for intervention and non-intervention students. The District generated tests will cover all five economic domains and will measure general economic knowledge for both the experimental and control groups.

☒ Behavioral Observations (e.g., classroom observations)

Describe the

- *focus,*
- *duration,*
- *number of observations,*
- *and how the observations will be recorded.*

Classroom observations will focus on student engagement during the intervention. Observations will last for the 50 minutes of the intervention session. There will be twelve observations, which will be recorded on Observational Protocol Form.

☒ Survey, Interviews, and Questionnaires (Attach a participant copy of each measure in the addendum. If your survey, interviews, and questionnaires will be administered online, you must answer the Internet Surveys and Research section below.)

For each measure, describe

- *setting,*
- *mode of administration,*
- *and anticipated duration.*

Researcher generated questionnaires will be 15 math/economic questions focused on topics covered, specifically in the intervention. These assessments will be online through Illuminate DNA (school testing platform) and given during a live synchronous intervention session. Students will be given 30 minutes to complete. Students with extended time accommodations will receive 45 minutes for time and a half and 60 minutes for double time.

☒ Internet Surveys and Research

Describe the measures

- *that will be taken to ensure security of data transmitted over the internet (e.g., internet surveys)*
- *to remove IP addresses*
- *and to protect from unauthorized access.*

The data collected through Qualtrics is protected within the EAB Student Information System which is maintained and monitored by CSU UITS department. The IP addresses of the participants will not be accessible to Principal Investigator and Co-Principal Investigator. CSU data servers are protected by sophisticated firewall systems and high-tech security scans are performed regularly to ensure that data in CSU servers are secure and only authorized personnel can access the data. In addition, CSU employs a Transport Layer Security (TLS) encryption (also known as HTTPS) for all transmitted data. In addition, all the electronic data (EOC and assessment test scores) data would be stored in password-protected computers within the Principal Investigator's and Co-Principal Investigator's office located in the workplace. All hard copies of the observation forms for student engagement, and other paper documentation will be securely stored and maintained at the Principal Investigator's office within the school premise in a locked file cabinet with sole key access to only the Principal Investigator. Data will be kept secure for one year, and then destroyed by deleting electronic data from the Principal Investigator's and Co-Principal Investigator's hard drive and shredding all hard copies of student engagement forms and paper documentation from any further access after the research project is complete. No personal information (i.e., addresses, phone numbers, email addresses, social security numbers) will be collected. All the data will be aggregated. No individual responses either from quantitative or qualitative analysis will be reported. No school names will be published.

☐ Audio or Video Recording

Describe the setting and anticipated duration.

3. Is it possible for any of the collected data to be used for future research projects?

☒ Yes ☐ No

SECTION H: RISKS AND BENEFITS

1. A) Estimate the level of risk for participants.

Potential Risk	Not applicable	No More than Minimal Risk	Greater than Minimal Risk
A. Physical	☒	☐	☐
B. Psychological	☐	☒	☐
C. Social or Economic	☒	☐	☐
D. Use of deceptive technique	☒	☐	☐
E. Other (Specify: _____)	☒	☐	☐

B) If any of the above risks are greater than minimal risk, describe the severity and likelihood of the indicated risk(s).

N/A

2. Explain what steps will be taken to reduce the impact of the indicated no more than minimal and/or greater than minimal risks and protect the participant's welfare.

Participants will be identified in live synchronous intervention sessions only by their first name and last initial. Confidentially of student participants will be maintained. Recordings of sessions replace student names with Participant numbers.

3. Describe the potential benefits to the participants as a direct result of this research project. (*Note:* Compensation is not considered a benefit).

Participants should see improvement in their math and economic skills as direct result in participating in this research.

4. **Describe the potential benefits to research or practitioner community a direct result of this research project.**
The potential benefit to the practitioner community as a direct result of this research project is educators will see if math interventions for Economic courses are beneficial. The potential benefit to the research community is a mixed methods study addressing Economics education for a fuller understanding of student engagement and the connection between math ability and economic academic achievement.

SECTION I: CONFIDENTIALITY OF DATA

1. **A) Will demographic information be collected?**
   ☒ Yes ☐ No

   B) If *Yes*, list all demographic information that will be collected. (Check all that apply.)

   ☒ gender ☒ racial classification ☐ age

   ☐ education level ☐ employment status ☐ Other (Specify:_____)

   C) If *Yes*, describe how the information will be used.
   Demographic information will be used to analyze trends among groups.

2. **A) Indicate the degree of confidentiality.** (See the FAQ webpage for more information.)

   ☐ De-identified

   ☐ Anonymous

   ☐ Coded – Indirect

   ☒ Coded – Direct

   ☐ Data will not be confidential.

   B) If the *data will not be confidential*, explain the rationale.
   N/A

   C) If the *data will be de-identified*, explain the procedures for completing that process.

   N/A

   D) If *indirect or direct coding*, indicate
   - **in what format (e.g., paper or electronic files) will the data be kept,**
   - **where will the data will be stored,**
   - **how long will the data will be stored,**
   - **and how the data will be destroyed.**
     Student identification numbers will be used for tracking the data in the quantitative and qualitative phase of the study. The Algebra and Geometry End of Course test scores, NWEA MAP Math 6+ Growth scores, and the Economic

assessment test scores will be stored in password-protected computers within the Principal Investigator's and Co-Principal Investigator's office located in the workplace for up to one year after the data is collected. Observation forms and paper documentation will be stored in a locked storage cabinet in the Principal Investigator's office at the workplace for up to one year after the data is collected. Data will be kept secure for one year and kept on the Principal Investigator's and Co-Principal Investigator's password protected computers. The data will be destroyed by deleting all the past educational data and the assessment tests from the Principal Investigator's and Co-Principal Investigator's hard drive. All hard copies of student engagement forms and any other paper documentation will be shredded from any further access after the research project is complete.

E) If *indirect or direct coding*, explain why it is necessary to keep indirect or direct identifiers.

We are using student identifiers to keep the student identity participants confidential. Direct coding is required to track student performance across the three 15-question intervention assessments and three Economic interim assessments, which will be administered in fall 2020, as well as the retrospective Algebra End of Course test scores, Geometry End of Course test scores, and NWEA MAP Math 6+ Growth scores used to identify math ability. Additionally, qualitative data from observation forms will be linked to the assessment data. This would allow us to integrate the quantitative assessment test scores with the qualitative observation data and also protect the student identity.

F) If *indirect or direct coding*, identify who will have access to the coding and/or individually identifiable information.

Only the principal investigator, co-principal investigator, and other research personnel will have access to the data. The researcher being used as a second observer for interrater reliability will only has access to the recordings, which replace the students names with participant numbers (Ex: John S in the live session will be Participant 1 in the recording).

SECTION J: ELECTRONIC SIGNATURES

The Research Team, including the Principal Investigator, Co-Principal Investigator, and other personnel, must read and comply with all Columbus State University Institutional Review Board (IRB) Policies and Procedures. In addition, they must abide by all federal, state, and local laws regarding protection of human subjects in research. As the Principal and Co-Principal Investigators, if applicable, you agree to follow these governing guidelines that include, but not limited to, the following policies and procedures. Failure to follow these guidelines may result in delays with the processing of this application and/or future applications.

1. Complete the Human Subjects Research training and submit a training certificate as an addendum.
2. Merge all addendums into one file.
3. Begin recruitment and data collection after receiving notification of final IRB approval.
4. Obtain approval from the IRB prior to instituting any change in project protocol.

5. Obtain informed consent from all participants, and legal parent or guardian, prior to commencing this research study when applicable.
6. Maintain copies of all records and signed consent forms, if required, from each participant for the duration of the project.
7. Notify the IRB regarding any adverse events, unexpected problems, or incidents that involve risks to participants and/or others.
8. Submit the Final Report Form within 12 months from the date of IRB approval using the template available on the CSU IRB website (if applicable).

If this research study is a student-led project, the Co-Principal Investigator, the student's faculty supervisor, must agree to complete the following tasks prior to the submission of the Human Research Application:

- Collaborate with the student to develop the research study.
- Read and review this application with its addendums for content and clarity.
- Guide and oversee the procedures outlined in this application.
- Ensure that all of the Research Team responsibilities are fulfilled.

Principal Investigator's Email Address as an electronic signature. (For authentication purposes, the email address must match the email address on file with Columbus State University.)

Email Address: kelley_kelli@columbusstate.edu Date: 10/09/2020

Co-Principal Investigator's Email Address as an electronic signature. (For authentication purposes, the email address must match the email address on file with Columbus State University.)

Email Address: acharya_parul@columbusstate.edu Date: 10/09/2020

Appendix B

Observation Protocol

Observation Protocol Data Collection													
Date of Observation:					Instructor(s):			Est Attendance:					
Time Stamps (Minutes)	Teacher Instruction					Student Actions							Additional Comments
	Lecture	MultipleChoice	ScenarioBasedQuestions	Polling	Other	WrittenResponse	AskQuestion	PollingResponse	VerbalResponse	Off-TaskBehavior	Non-Responsive	Other	
0-2													
2-4													
4-6													
6-8													
8-10													
10-12													
12-14													
14-16													
16-18													
18-20													
20-22													

Appendix C

Intervention Specific Assessment Instrument

1. Use the budget to answer the question.

Earnings	Salary	$3,000
Earnings	Rent	$1,200
	Food	$1,000
	Car payment	$150
	Auto insurance	$50
	Entertainment	$550
	Savings	$50

Ramy is seeking to purchase his first home. How could Ramy best revise his budget to enable him to meet his goal?

A. by cutting his food budget in half
B. by demanding a raise at his job
C. by reducing his entertainment budget
D. by getting rid of his auto insurance

2. Use the table to answer the question.

Currency Exchange Rates - November 2019			
US dollar	Euro	British pound	Canadian dollar
1.00	1.10	0.86	1.32

Which currency was worth the least in November 2019?

A. the British pound
B. the Canadian dollar
C. the Euro
D. the US dollar

3. Use the news headline to answer the question.

MILITARY TRIBUNE

NAVY ORDERS TWO FORD CLASS AIRCRAFT CARRIERS FOR $26 BILLION

How will this development affect the gross domestic product?

A. It will rise due to increased government spending.
B. It will fall due to increased government spending.
C. It will rise due to increased consumer spending.
D. It will fall due to increased consumer spending.

4. Use the scenario and the table to answer the question.

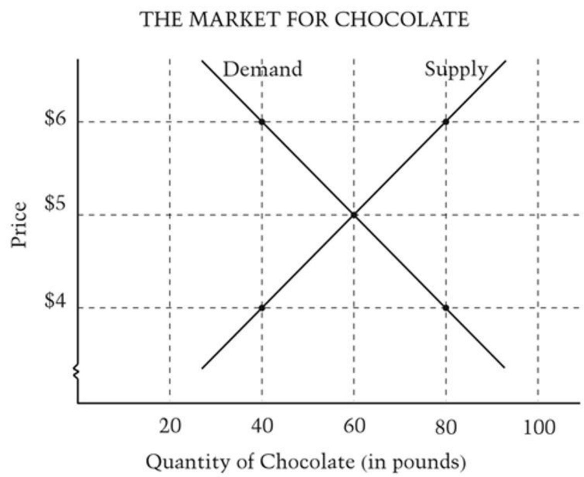
> John is a junior at a high school in Georgia and is preparing to decide what to do after he graduates. He wants to take over managing his family's restaurant. John's father is set to retire soon, but he wants John to attend either culinary school or get a business degree and work for three years before taking over the restaurant. If John goes to college for business, he would want to attend the same school that his parents attended, which is out of state. Culinary programs are offered in a nearby city, so John would not have to leave home to attend. John would like to live somewhere new or be in school a shorter amount of time; however, it is more important that he be able to save money before returning home to the restaurant. John has made a table to help with his decision.

Criteria	Culinary Arts Program	Business Program
Number of Years of School	4	6
Location of School	In-State	Out-of-State
Total Cost for Schooling	$120,000	$150,000
Number of Years Working	3	3
Projected Annual Income	$40,000	$100,000

Based on the table and the scenario, which program is best aligned with John's preferences and why?

A. the business program, because John wants to move and be away from home as long as possible
B. the business program, because John will make more money working and be able to save
C. the culinary arts program, because John will spend less on schooling and be able to save
D. the culinary arts program, because John wants to stay at home and be in school as little as possible

5. Suppose that the government set the price of chocolate at $6 per pound. Which of the following statements best describes an effect of this price control?



A. There would be a surplus of 40 pounds of chocolate
B. Less chocolate would be demanded at $4 than at $6
C. Producers of chocolate would want the price set at $4
D. There would be a shortage of 20 pounds of chocolate

6. Over these three months, the company has experienced:

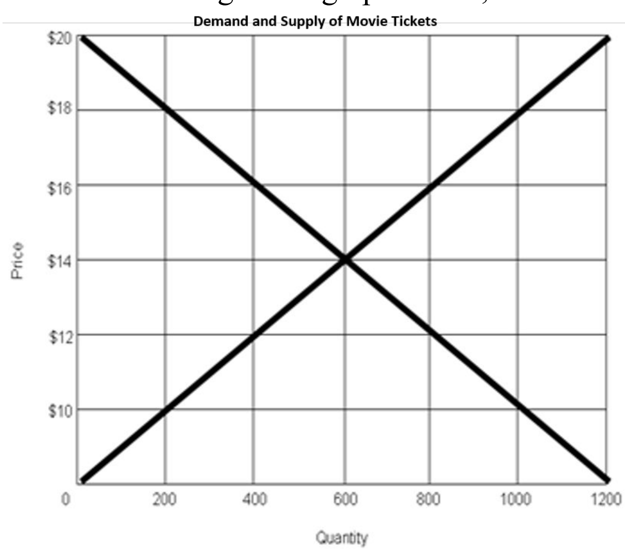
	Month 1	Month 2	Month 3
Pencils Produced	3,000	3,000	3,000
Hours of work required to produce the pencils	100	95	90

A. an increase in its number of employees
B. a decrease in its number of employees
C. an increase in productivity through a decrease in input
D. a decrease in productivity through an increase in input

7. A new bank attracts customers by not charging any fees and paying an average of 2 percent on deposits. To ensure that it will have customers for years to come, the bank is charging 1 percent on loans. What is the bank's financial outlook?

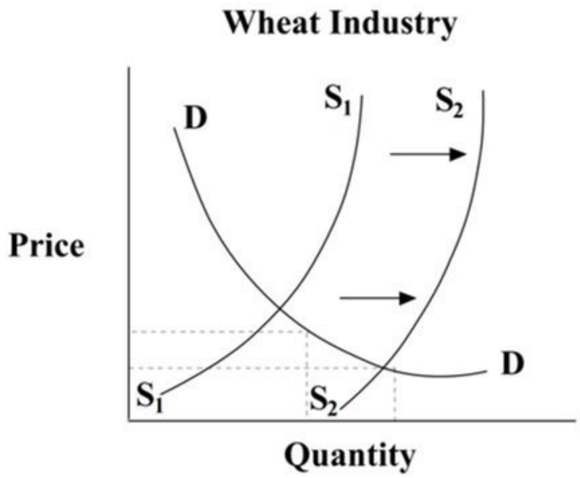
   A. The unfavorable spread between the interest charged and interest earned will cause the bank to lose money.
   B. The high interest on deposits and absence of fees will secure new customers and the bank will earn money.
   C. The low interest charged on loans will cause the bank to loan too much money and the bank will lose money.
   D. The favorable spread between the interest charged and interest earned will cause the bank to earn money.

8. According to the graph below, what is the price of movie tickets at equilibrium?



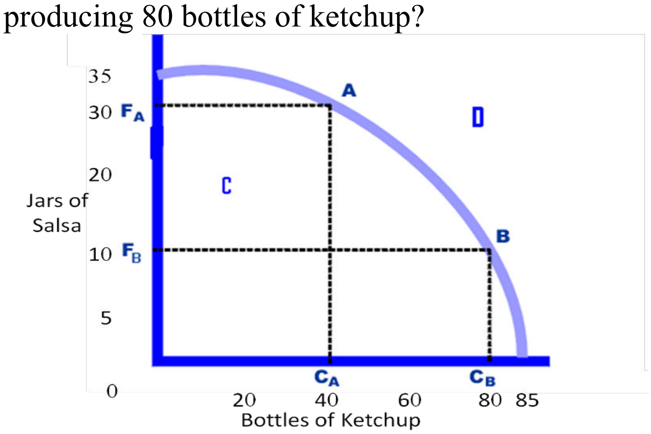
   A. $10
   B. $600
   C. $14
   D. $20

9. Of the following, which situation would cause the shift of the supply curve from $1 to $2?



A. The government reduces subsidies to wheat farmers.
B. New fertilizers increase wheat crop yields.
C. Firms exit the wheat industry.
D. Drought reduces industry output by 25%

10. For Hunts Inc., assuming production began at point A, what is the opportunity cost of producing 80 bottles of ketchup?



A. 10 jars of salsa
B. 80 bottles of ketchup
C. 20 jars of salsa
D. 40 bottles of ketchup

11. Use the table to complete the task.

Personal Income Tax Rates in Four Countries				
Income Bracket	Country W	Country X	Country Y	Country Z
$1–$40,000	25%	5%	15%	35%
$40,000–$100,000	20%	15%	15%	20%
$100,000–$250,000	15%	25%	15%	10%
$250,000+	10%	35%	15%	5%

Match each country to the correct description of its tax system

Web-Only Interaction

12. Look at the formula below.

Expenditure Model

W = consumer spending + government spending + X + (Y–Z)

Correctly match each letter to the variable it represents.

Web-Only Interaction

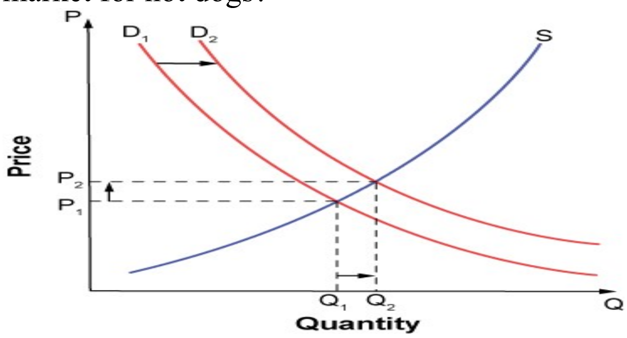
13. Which statement about the production advantages of Canada and the United States is correct?

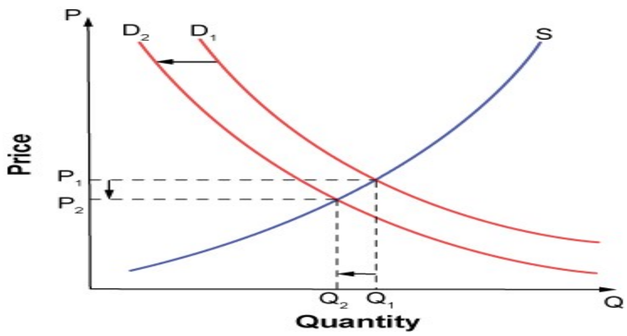
A. Canada has an absolute advantage over the United States in producing both Product X and Product Y.
B. The United States has an absolute advantage over Canada in producing both Product X and Product Y.
C. Canada has a comparative advantage over the United States in producing both Product X and Product Y.
D. The United States has a comparative advantage over Canada in producing both Product X and Product Y.

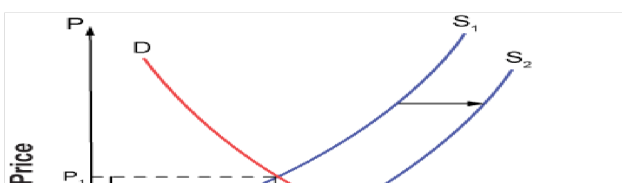
14. Read the passage. Then answer the question that follows.

> During the week before Memorial Day, a supermarket chain begins a new set of sales. The prices of grilling products such as charcoal briquettes and lighter fluid are significantly discounted. Condiments such as mustard, ketchup, and relish have been put on sale as well.

Which graph represents how the Memorial Day sale will MOST LIKELY affect the market for hot dogs?







15. Use the table to answer the question.

Country	Blenders (per day)	Sweaters (per day)
Country A	4,000	8,000
Country B	2,000	7,000

This table shows the daily economic output of two countries

Directions: Answer the following question(s). Suppose Country A decided to produce only sweaters. What is the opportunity cost?

A. 2,000 sweaters
B. 4,000 blenders
C. 7,000 sweaters
D. 8,000 blenders

Appendix D

Samples of Intervention Discussions and Questions Tied to Math Topics

Number Sense

Rational Decision Making

Joey has been saving up for a car for the last few years. He currently has $5,000 for a vehicle. He is trying to decide if he should pay cash for an older used vehicle or use the $5,000 as a down payment on a new vehicle. He will be going to a college about an hour away, but he will not have to drive much once on the college campus. He found a newer vehicle for that would be $475 a month for 60 months after applying his $5000 down payment (there is also interest as well as tag and title fees).

How can Joey use the table to help him make a rational decision?

	Newer Vehicle	Older Vehicle
Cost	$28,500	$5000
Mileage	40,000	100,000

Absolute Advantage

The chart below and to the right shows the maximum number of each type of vehicle each country can make.

Which statement is true?

	Cars	Trucks
USA	30 million	10 million
Japan	25 million	2.5 million

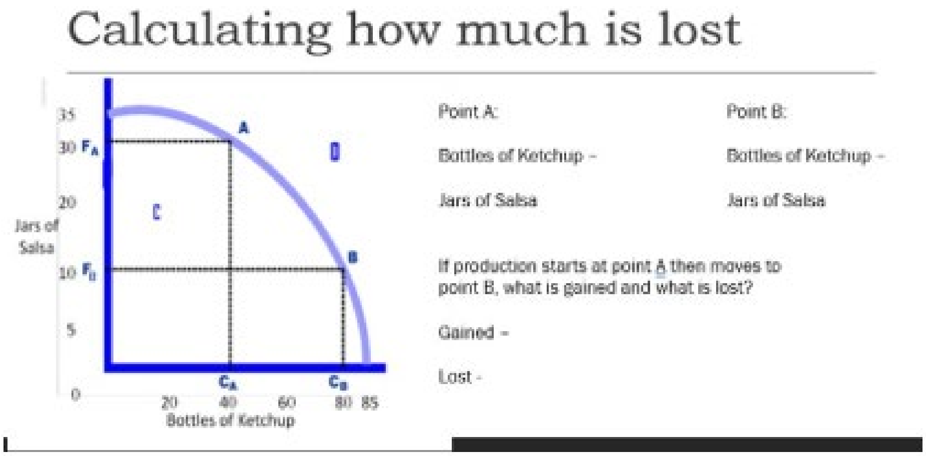
The USA has an absolute advantage in making both cars and trucks.

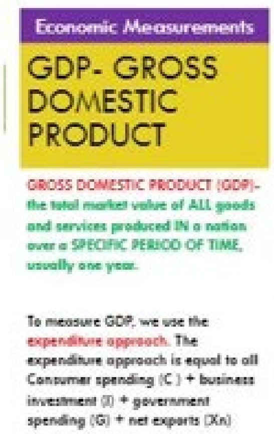
Japan has an absolute advantage in making cars while the USA has an absolute advantage in making trucks.

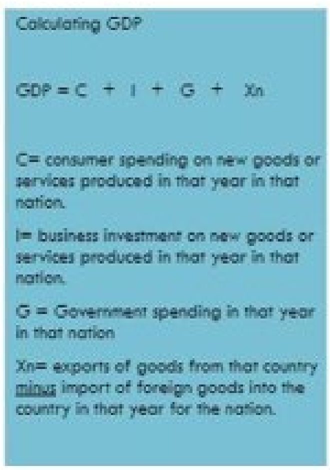
Japan has an absolute advantage in making trucks while the USA has an absolute advantage in making cars.

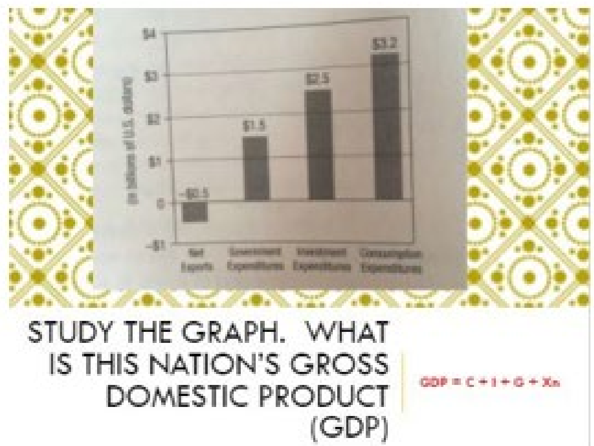
Japan has an absolute advantage in making both cars and trucks.

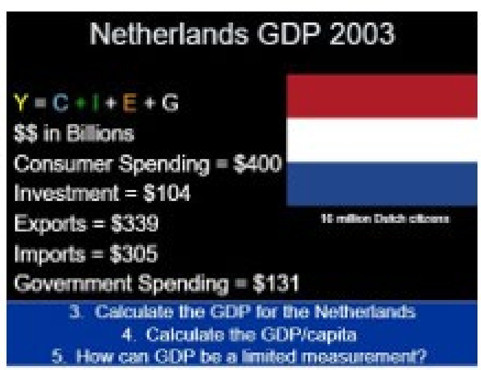
Computation











Fractions, Decimals, and Place Values

Comparative Advantage

Since the United States can produce 30 million cars or 10 million trucks:

30 million cars = 10 million trucks

Since Japan can produce 25 million cars or 2.5 million trucks:

25 million cars = 2.5 million trucks

	Cars	Trucks
USA	30 million	10 million
Japan	25 million	2.5 million

Exchange Rates

The **exchange rate** can be best thought of as the cost to buy a unit of one country's currency given in the units of another country.

Exchange rates are often given in terms of a table, like this:

Currency Exchange Rates - November 2019			
US dollar	Euro	British pound	Canadian dollar
1.00	1.10	0.86	1.32

Often one currency is given a value of "1" (here, the United States Dollar), and other currency values are given in relation to that. So looking at this table, 1 dollar = 1.10 Euros = 0.86 British pounds = 1.32 Canadian dollars.

Since every entry in this table "buys" an equivalent amount, **lower numbers correspond with more valuable currencies**. A lower number means that it takes less of that unit of currency to buy a unit of the "host" currency".

Did the U.S. Dollar appreciate ↑ or depreciate ↓ vs. each other currency?

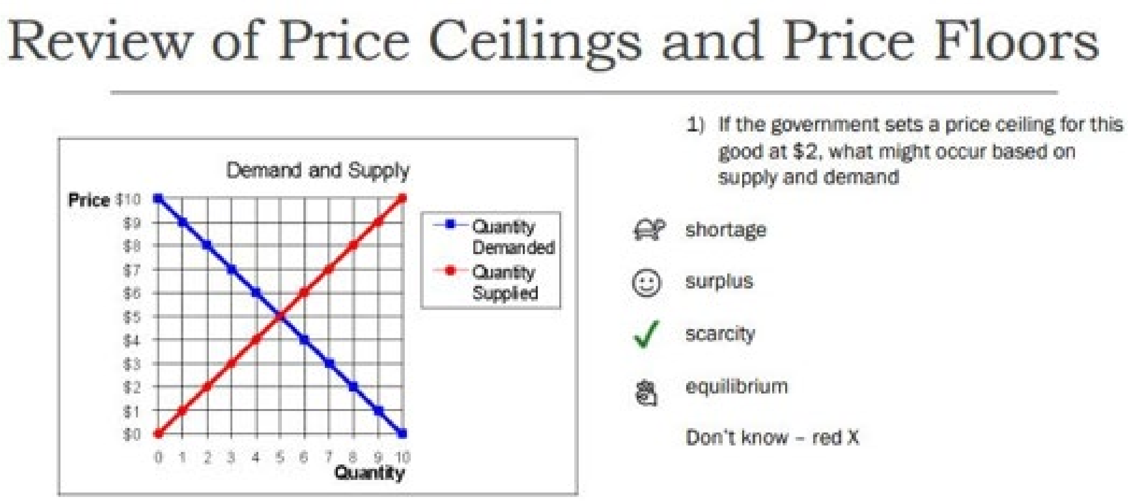
U.S. Dollar, end of Year 1

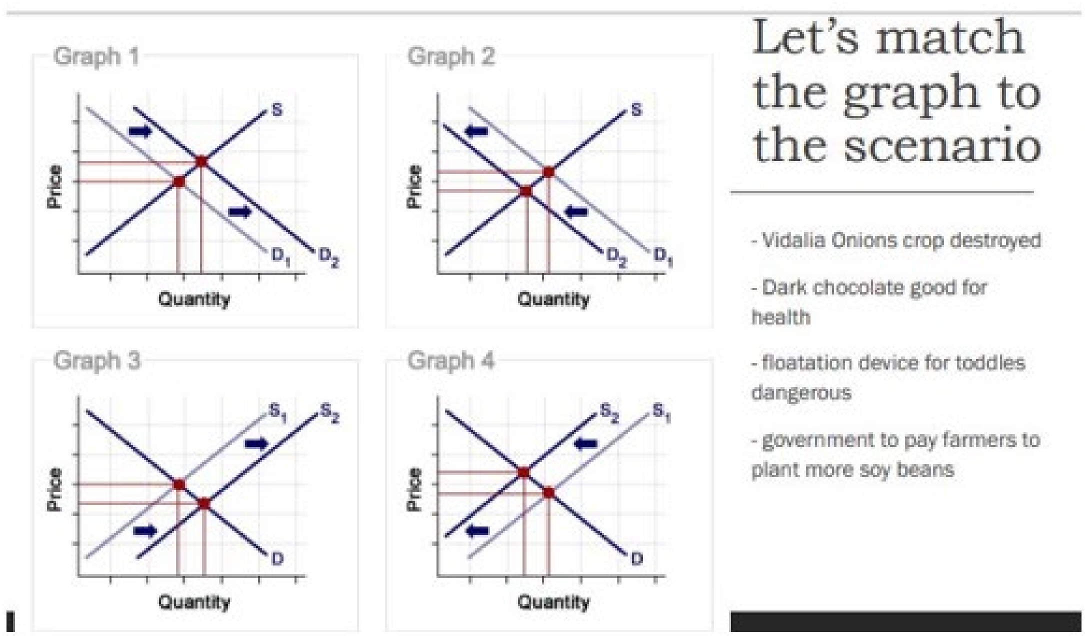
	One U.S. dollar	in U.S. dollars
British pound	0.49	2.06
Danish krone	5.17	0.19
Euro	0.69	1.44
Japanese yen	114.69	0.0087
Mexican peso	10.71	0.093
Swiss franc	1.17	0.86
Thai baht	31.7	0.03

U.S. Dollar, end of Year 2

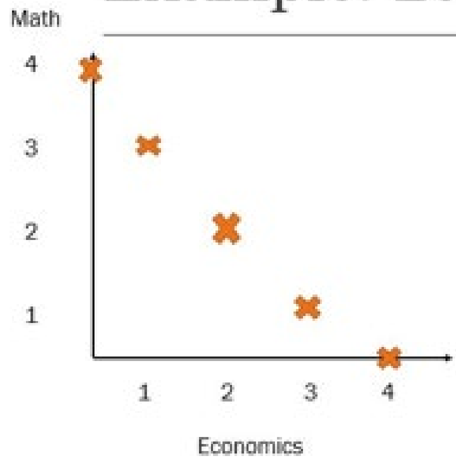
	One U.S. dollar	in U.S. dollars
British pound	0.52	1.92
Danish krone	4.83	0.21
Euro	0.67	1.49
Japanese yen	121.3	0.0082
Mexican peso	15.02	0.067
Swiss franc	1.06	0.94
Thai baht	36.8	0.027

Problem Solving





Example: Let's look at the graph



All points are if you used all 4 hours efficiently –either studying math or economics or a combination of both

What happens if you decide to play xbox for an hour instead?

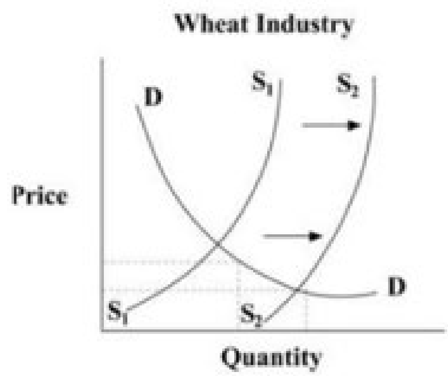
What happens if you were supposed to spend 2 hours on each but you have gone over on Math and studied for 3 hours for math instead?

What happens or could happen if one of your obligations gets cancelled (say plans with a friend)?

What happens if something other than studying takes longer (like chores or work ask you to pick up an extra shift)?

For each option below the question, lets figure out the following

- Which determinant is being addressed?
- Will this cause an increase or decrease in supply?
- Which option best matches the graph?



Of the following, which situation would cause the shift of the supply curve from S1 to S2?

The government reduces subsidies to wheat farmers.

New fertilizers increase wheat crop yields.

Firms exit the wheat industry.