# THE EFFECT OF INCREASED ALGEBRAIC INSTRUCTIONAL TIME IN A CAREER AND TECHNICAL HIGH SCHOOL

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**Abstract**

Resources that strive to increase academic performance for secondary students is a noble endeavor. One such technique may prove beneficial and does not require additional resources. This resource is to increase instructional time within the classroom. The setting of this research project was at a suburban comprehensive technical high school in the lower Bucks County region of Pennsylvania and the participants were incoming 9th grade students. The purpose of this project was to analyze whether increasing algebraic instructional time would have an effect on academic performance. This project was important because it would provide a justification for the allocation of resources, should the outcome indicate a positive correlation between increased instructional time and academic performance. The research questions involved in this project were to analyze increased instructional time and academic performance as well as differentiating academic performance regarding gender and socioeconomic status. The quantitative design of the project relied on a classroom diagnostic test and a teacher-made assessment. The results from the teacher-made assessments did not demonstrate a statistically significant event for any research question. The classroom diagnostic test did reveal a statistically significant event for the initial assessment as well as the initial and mid-year test regarding socioeconomic status and academic performance. The conclusion was that there was no statistically significant difference in academic performance differentiated by gender and that increasing instructional time did not affect academic performance following an increase in instructional time on both final assessments. There was evidence that non-economically disadvantaged students scored statistically higher on the initial and mid-year classroom diagnostic test.

# CHAPTER I

## Introduction

A comprehensive career and technical center (CTC) is a unique public high school that provides students with traditional academic preparation but also vocational training credentials. Currently, there are less than 20 comprehensive technical high schools out of 500 school districts in Pennsylvania. One of these comprehensive CTCs will be the setting for this action project which is located in the lower Bucks County region, approximately 30 miles northeast of Philadelphia.

This researcher will refer to this CTC as having two sides or houses in the building: academic and technical. The technical side of this specific CTC is taught by experienced tradespeople with knowledge in a skilled profession such plumbing, engineering, electrical, etc. The core academic and elective courses are taught by teachers with the traditional preparation programs found in most colleges and universities in the United States. The vocational instructors have a designated time frame to complete their training and education to remain as full-time instructors.

This researcher asserts that increasing instructional time within an academic classroom will increase academic performance. The output scores on two different mathematical instruments will validate this assumption. While the output scores are important as a validation method, there are two other essential research questions that are being analyzed related to differences in both gender and socioeconomic status, as well as, academic performance within the classroom. The three research questions essential to this action project:

1. In what ways does providing increased instructional time in 9th grade Algebra 1 affect student achievement?
2. What is the correlation with students' gender and Algebra 1 scores given increased instructional time?
3. What is the correlation with socioeconomic status and Algebra 1 scores given increased instructional time?

This project is one way that this researcher can affect change and perceptions within the student body and community by giving students a solid framework in basic mathematics through more enriching algebraic instruction. The logic behind this hypothesis is that additional instructional time devoted to basic algebraic concepts, which may have been missed or glossed over during middle school, will be rectified during the students' freshmen year.

This researcher's role at the CTC is as both the principal and one of the instructional leaders, in conjunction with an assistant principal and special education supervisor. Three supervisors manage and direct the instructional teaching staff.

One of the most difficult tasks in this research process was deciding on the actual framework for the statistical analysis and whether it would be a quantitative, qualitative or mixed-method study. This researcher wanted this project to be not just another academic enterprise but a valuable tool to shape the direction at the CTC. It is this researcher's belief that the outcome will further facilitate a need to enhance the project with additional services at the CTC or revert back to a model that existed nearly 6 years ago which did not include this initiative.

The actions necessary to accomplish this endeavor were to provide the necessary staff resources for this project to be analyzed. This required shifting staff to the 9th grade level at the expense of increasing rosters within the 10th grade classrooms. The staff were well aware of the rationale for continuing with this initiative. Other than utilizing staff to modify their instructional time, there were no financial considerations to implement this project.

The expected outcome was to note whether a change was noted in academic performance not only on the teacher made assessments but also on the state mandated Keystone State Assessment. The potential implication of this project to the school is that it may require additional shifting of resources if the data demonstrated additional instructional time positively benefitted student performance. It will be the decision on the part of senior level administration whether additional staffing and shifting of resources is warranted.

This section has given the necessary background and rationale for this research study. Moving forward, there will be an in-depth analysis of the literature surrounding similar projects regarding instructional delivery models and teaching strategies that affect academic performance. After the literature review, the exact methodology utilized for this analysis will be discussed. The results section includes the statistical analysis based off the summative assessments and diagnostic tools. The final chapter provides recommendations based off the results and for future areas of research.

# CHAPTER II

## Review of Literature

Comprehensive career and technical education centers (CTC) are a unique niche in the public-school arena because they provide the traditional academic structure as a regular high school but also have the facilities for career training. A comprehensive CTC needs to adhere to the same federal and state regulations as their traditional educational counterparts, including the standardized testing requirements. In Pennsylvania, there are three core subject matter exams required for all students unless specifically outlined in a student's individual education plan (IEP). These exams correlate to end of the year content areas of biology, algebra and literature. The exams are primarily taken in the student's 9th or 10th grade years.

The CTC participating in this research project has traditionally underachieved on Pennsylvania's state mandated Keystone scores for algebra. Students perform better on biology and literature, but generally fall short of the mean score for all of Pennsylvania's school districts. Since a solid background and preparation in mathematics is necessary for many of the school's technical occupations, administration at the school continually strive for ways to increase the student's algebra scores. A key component of increasing the algebra scores is focusing on the curriculum and method of delivery for the 9th and 10th grade students.

### Career Technical Education and Algebra

Rote memorization may serve a student well for one type of academic assessment but for demonstrating mastery of material for technical tasks such as wiring a house, overhauling an engine or even cooking up a delicious meal, mastery of the skill

is needed. It is the assertion of this researcher that integration of academics, especially algebra, with real world technical skills will enhance student understanding of both mundane and advanced topics.

Parr et al. (2019) analyzed the results from an experiment where students had a change in their curriculum by integrating algebra as part of their CTC experience. The researchers recruited teacher volunteers from the state of Kentucky for a 10-.day professional development seminar where they would collaborate and draw up lesson plans that integrated technical skills into the existing algebra curriculum. With the newly revised lesson plans, the teachers returned to their respective home schools and taught the new curriculum to a select group of high school students. Since there was no control group assigned to the study, it was a quasi-experimental design using a pre and posttest algebra assessment to measure the amount of growth that occurred throughout the year. A total of 24 teachers and 172 CTC students participated in the integrated curriculum. Using a *t*-test for the statistical analysis of the pre and posttest results, the researchers concluded that a statistically significant increase in algebraic scores had occurred following the integrated curriculum (Parr et al., 2019).

Overcoming the stigmatization that a child entering a CTC will not receive the same academic rigor as a traditional public high school is a challenge for CTC administrators and staff. Indeed, "Career-technical education is not a lesser form of learning; it's a different form of learning" (Michaels & Barone, 2020, p. 3). An interesting and important development occurred nearly two decades ago with regards to career and technical education: the institutions were originally known as vocational school, but in the mid 1990's, the name changed to career and technical education

centers. The name change was a strategic decision to highlight the training of young adults into not only learning a skill but also mastering a profession in order to obtain a career path rather than just a job. However, convincing the general public that their children would receive the same academic level of rigor at a comprehensive CTC required more than a name change but rather real-world state assessments that competed with their traditional public-school counterparts.

Research by Michaels and Barone (2020) was conducted in a western school district in the United States with 1,000 participants: 500 CTC students and 500 regular education students. The purpose of the research was to analyze achievement scores on the nationally recognized ACT assessment for both cohorts of students. The results demonstrated a statistically significant difference in all subject areas and that "CTC curricula influences student achievement in the academic subjects of English, reading, mathematics, and science as measured by national testing" (Michaels & Barone, 2020, p. 12).

**Student Achievement and College Readiness**

This study's CTC is a comprehensive technical high school and its students take mandated state-wide Keystone tests just like any school district. In addition, students earn valuable technical credentials which may include end-of-the-year program assessments and National Occupational Competency Testing Institute (NOCTI) exams. Many students are employed in their field or are in an apprenticeship program before graduation. Even for those earning technical credentials, many students scoff at the notion of taking the Keystones in their sophomore year was valuable to them. Indeed, one issue administrators have at the school is motivating the students to take the Keystones

seriously. This is not a unique issue relegated only to this CTC. Even though the administration tries to instill upon the community, staff, and students that the academic preparation they earned is as valuable as the technical credentials, it remains a consistent challenge.

The role of any public servant is to serve his/her client. Therefore, as an educator, the occupational role and duty should be to prepare not only students for valuable technical credentials but also to focus students on academics. The Keystone standardized tests are a valuable and accurate assessment of how well the school is preparing its students for a future that may lead to college.

Since the CTC is a comprehensive school, some of its students do opt for a four-year college upon graduation. The CTC draws its students from six sending school districts. There are two small districts and four very large districts sending approximately 1500 children every year. The two small districts combined will send less than 100 students; whereas, the larger districts each send approximately 300 to 350 students. As a result of the sending school dynamics, this CTC has a unique challenge educating this multifaceted clientele base.

In addition to preparing for post-secondary education, the data from the Keystones provide the school valuable information as to how well the curriculum performs compared to other schools in the area. The question then becomes: What preparation programs adequately assess the unique needs to be successful in college? "Though a universal definition of critical thinking currently does not exist, many colleges and faculty agree that the ability to think critically is central to success in college regardless of course content" (Zelkowski, 2010, p. 8). A student may pass with a 65% on

any academic test, but the same student in her/his technical class cannot just wire 65% of a disabled electrical circuit or replace 65% of a set of tires. Technical skills require mastery of the material, and as such, this study's CTC does teach skills that go well beyond regurgitation of facts and figures.

The CTC operates on a 90-minute block schedule for its academic classes and according to Zelkowski (2010), "so do the majority of high schools in the country" (p. 11). The central focus of this study is that additional time in algebra will increase academic achievement, but there is a limitation or saturation point when too much time will leave the students disillusioned and bored with the class.

In order to validate that block scheduling is serving students well for algebra, necessary studies need to be conducted. Zelkowski (2010) researched a sampling of secondary schools to ascertain if academic achievement was higher using a 90-minute block compared to a 42-minute period. The results from the study were inconclusive but the author's recommendation was that high schools continue to use block scheduling because the semester ends mid-year which is the case for most college classes, thus the quicker preparation provides a template for students to acclimate themselves for future post-secondary success.

This researcher has made the assumption that students come to the high school with their minds made up whether they are studious or not. The researcher's assumption has not been altered throughout the past two decades in assessing thousands of children either as a teacher or high school principal. Therefore, if students were scoring well in middle school, then the natural translation would be that they would continue this same performance trajectory in high school. If this assumption is valid, then it may be

beneficial in determining academic placement for incoming freshmen every summer across every high school in the United States of America. In other words, one cannot just place students on a whim but should use historical data and previous scores as a critical measure for proper enrollment and class placement.

Temple and Mohammed (2020) studied the effectiveness of various academic scheduling structures, along with academic achievement for middle school students in Nebraska. The comparison was between 7th and 8th graders and their resulting scores on their statewide tests: Nebraska State Accountability in Mathematics (NeSA-M). The participants were further divided by scheduling time and frequency and by classes with co-teachers versus a singular teacher. The results indicated that students who were enrolled in block schedules versus periods revealed a statistically significant improvement on their state-wide assessment, but those results needed to be in combination with a co-taught class. The statistical analysis was an independent samples *t*-test. Of course, scheduling time is not the only factor to consider for academic achievement.

Various factors come into play as educators are dealing with adolescents and adults who teach these students. Ratcliff et al. (2014) also did a study on scheduling time and academic achievement. Their findings, however, suggest that additional class time will not justify an increase in academic achievement if the time within the classroom was not utilized effectively with hands-on assignments, group work and follow-up questions by teachers. In other words, "non-instructional interactions can also have a powerful impact on the dynamics of the learning environment" (Ratcliff et al., 2014, p. 5). This goes without saying that quality is vitally important in many things including academia.

Continuing along with the theme of block scheduling and academic achievement, but also bringing into the dynamic about student teacher relationships, another study by Eineder and Bishop (1997) further expands on this phenomenon. Some teachers have more of an impact on a student's motivation and trajectory in high school and beyond. Often, it's a simple matter of a connection or passing interest the teacher has with the student which can have a lasting impression for years to come. This dynamic is another factor that can influence many students to go well beyond their past limitations and exceed previous state-mandated assessments.

One dynamic that gets overlooked in the discussion of whether block scheduling is advantageous or not for students is the opinions of the educators. One factor continually cited by teachers as a needed improvement in schools is that smaller class sizes and caseloads are needed in reaching challenging students. As Eineder and Bishop (1997) note,

> there are two distinct advantages that await the classroom teacher with a block schedule 1) block classes will result in three or four classes a day for the teacher as compared to six thus, a reduced number of students and papers to grade 2) more time to develop relationships because of the 90-minute block versus a 42-minute period. (p. 48)

Building relationships within the classroom is a critical component for teachers to encourage effort and interest from their more challenging students. This researcher can attest to the challenges that arise from teaching a lower-level class compared to a higher level one. Students who are struggling end up in lower-level classes often without supports and thus end up lashing out at the teacher disseminating the information. Such

boisterous students require teachers to spend more time on discipline at the expense of learning and instruction. The time spent in a 90-minute block of time building relationships ultimately minimizes time on needless distractions from troublesome students; however, the students must believe that the teacher is concerned with their best interests as human beings and not just on academic achievement. Furthermore, "short instructional periods do not allow adequate time for teachers to effectively employ preventive discipline techniques" (Eineder & Bishop, 1997, p. 49). Thus, larger class periods could lead to better relationships if that time is effectively spent within the classroom. This increased time in a block schedule would give the teacher ample resources and time to effectively deal with a challenging student.

Gruber and Onwuegbuzie (2001) conducted a study comparing block classes and traditional periods and its effects regarding academic achievement. In a suburban high school in the state of Georgia, 115 high school students in block classes were compared with 146 students in traditional period classes. The researchers used an ex post facto design as they analyzed graduating seniors from various classes in the 1990s. To analyze the results, an independent samples *t*-test was used for the data compilation. The findings did not demonstrate a statistically significant improvement in math or science, but rather, the findings marked improvement in language arts. The recommendations indicated the continued use of block schedules since one core subject matter showed improvement.

The discussion thus far has comprised an analysis of schools on the east coast of the United States of America. It would be prudent to explore the effect on academic achievement and block scheduling looking at other areas of the country as well. In a study conducted by McClure (1999), analyses was done on academic achievement and

the use of block scheduling. This study is particularly interesting for the current research being conducted at the CTC because it directly ties into the achievement of Algebra 1 and scheduling time which is the central theme of this action project. As noted earlier, block scheduling allows for more resource time, but that time needs to be effective. "Instruction should persistently emphasize doing rather than knowing, and curriculum for all students must provide opportunities to develop an understanding of mathematical models" (McClure, 1999, p. 6). Therefore, no amount of increased instructional time can take the place of effective quality instruction. A total of 56 high schools across the state of Texas provided data for research. There was a qualitative analysis of teacher opinions on the use of the block scheduling as well. The results revealed an overwhelming number of teachers supported the continued use of block scheduling (McClure, 1999). As far as the quantified data was concerned, an ANOVA was analyzed with the Algebra 1 end of course score as the dependent variable and the type of schedule time as the independent variable. The findings suggest that no statistically significant increase was found for students taking block scheduling versus students in traditional period classes (McClure, 1999).

In an ex post facto quasi-experiment of graduating seniors from two different high schools in North Carolina, Lawrence and McPherson (2000) analyzed the difference in academic achievement for students enrolled in block scheduled classes and students who took traditional period classes in algebra, biology, U.S. history, and literature. A causal comparative study was used on the students' end of course test scores for all four disciplines. The data was obtained for the years 1992 through 1994. The findings indicated that for all core subject areas there was a statistically significant improvement

in test scores for traditional periods versus block classes. This contradicted the researcher's hypothesis that block scheduled classes would fare much better. Lawrence and McPherson (2000) suggested that block scheduling was a recent phenomenon to the school in question and teachers may not have been accustomed to the scheduling time.

Lewis et al. (2005) also studied academic achievement and various scheduling structures. As noted earlier, block scheduling is not only the most prominent form of scheduling in secondary education, but according to these authors, "During the last two decades, block scheduling has been one of the fastest growing educational reform initiatives in secondary public education" (p. 72). This ex post facto longitudinal research experiment was conducted in order to analyze the results from several buildings at a school district in Northern Colorado. What was intriguing for this study was that the district implements different scheduling formats per building. One building was using alternating classes while the other used a daily block schedule. The middle schools were operating under a traditional 42-minute period schedule. Academic achievement related to scheduling was correlated with both standardized assessment results and the ACT exams during the students' 11th grade school year. A single factor ANOVA test was used for the statistical analysis of the data which demonstrated a statistically significant increase in academic growth for both the ACT and standardized assessments (Lewis et al., 2005).

The previous section reviewed the merits of block scheduling and student academic achievement. An argument in favor of a block delivery format is that it allows the teacher to go into greater detail. The chief argument against this philosophy is that students can only retain a limited amount of material before becoming disengaged.

## Delivery Models

### *Block Scheduling*

The block schedule is a 4 x 4 delivery model where each class is roughly 90 minutes long. There are 4 academic classes each day that conclude half-way throughout the school year resulting in two semesters and 8 classes each year. Teachers are provided a full block to use for lesson preparation, grading, and duty time. Therefore, teachers using block scheduling have a total of 6 classes each year.

Bonner (2012) conducted research on block and traditional schedules. The analysis focused on biology scores for end of the year exams. Forty public high schools in North Carolina were the subject of research- and the data was further aggregated based on race. Archival data was used for a causal comparative analysis. Traditional schedules had been the norm during the early years of public education, but as Bonner (2012) points out, "The teachers found themselves unable to use more effective and active learning models under the traditional schedule because a vast amount of time was fixed on surviving the day" (p. 24).

### *Traditional Scheduling*

The traditional schedule or period structure can be constructed in several ways, but at its core, it is approximately 35-45 minutes each period 6-8 times a day. With Science Technology Engineering and Mathematics (STEM) education playing a larger role in public education, particularly over the past decade, longer instruction times were needed to perform intriguing laboratory activities that fit appropriately into a 90-minute block of time. Some schools will do double block scheduling for science but then make their students return back to 45-minute periods for the other core subjects. While that

may be advantageous for some teachers, it does present issues for students who are accustomed to routines, especially academically challenged students (Bonner, 2012).

Mallory (2007) focused research on block and traditional schedules with analysis of test scores for several North Texas high schools. The counselors randomly placed students in an 8-period day schedule for some of their core classes, and in other high schools, students were scheduled to four 90-minute classes. The Texas Assessment of Knowledge and Skills Test and end-of-year subject scores were triangulated for data analysis. A one-way analysis of covariance through the Statistical Package for the Social Sciences (SPSS) software program analyzed the 2003-2004 Texas Assessment of Knowledge and Skills for both sets of students. Ironically, the end-of-the-year exams demonstrated no statistically significant difference between the groups regarding standardized test scores; there was, however, a statistically significant difference in favor of block scheduling over traditional periods for academic achievement.

Dexter et al. (2006) compared preparation for college and career readiness and analyzed the merits of both traditional and block scheduling with a qualitative survey of more than eight thousand undergraduate students. Several hundred responses were not answered in completion but the total was still over seven thousand. One of the research questions correlated the type of high school schedule with the undergraduates' major. The research demonstrated that there was not a statistically significant difference with longer frequency scheduling and a preponderance of science as a major.

***Hybrid Model***

Another innovative technique that some schools have used in scheduling instruction is the hybrid model. This model is not feasible in all locations because of the

resources and commitment required but in its purest form a hybrid model will have students studying one course per day. McGorry and McGorry (1998) investigated several schools in the northeastern counties of Pennsylvania who had used modified intensive schedules. The six-day intensive schedule offered a full course load but one core subject area per day. There was no data regarding achievement tests that validated the effectiveness in either the high school or middle school; consequently, the pilot program lost interest because of a lack of administrative support.

***Course Progressions***

In a study conducted by Richey (2018), the researcher wanted to see if students' academic achievement for algebra could be affected based on the type of math progression that a student would undertake. Richey (2018) compared students' grades in the progression from 8th to 11th grade from two different high schools at the same district in a rural school district in Alabama. One high school had students taking math every day while the other students went every other day to complete their Algebra 1 to Algebra 2 sequence. The researcher used a mixed method experimental design and the data was derived from using surveys from high school students and teachers. The participants for the study were 218 ninth-grade students who took algebra as part of an Algebra 1A/1B model which was math every other day and another 200 students from the other high school in the district that took algebra every day. Independent samples *t*-tests were used to analyze the data for both groups. The results of the data analysis indicated that there was not a statistically significant variance in the state assessments of algebra scores during the end of the students 11th grade year. Based on the results of this study, modifying the mathematics curriculum

did not have a statistically significant impact on end-of-the-year assessments (Richey, 2018).

In the previous sections, the literature analyzed various scheduling times and characteristics that may have an effect on academic achievement within secondary and post-secondary education. Now, the focus will be on specific teaching techniques' impact, if any, at the secondary level, especially in algebra.

## Instructional Strategies

### *Flipped Classrooms*

The flipped classroom is designed to give more autonomy to students to do the background learning prior to coming to class. An example of a flipped approach would be if students would do research on setting up a laboratory exercise prior to coming into class. While in class, students would then utilize the time on group work instead of the teacher explaining the setup which uses valuable class time. Lo and Hew (2019) analyzed the concept of flipped classrooms and noted the perceived advantages and disadvantages with educators and students. Achievement scores were analyzed and compared with scores from students who took traditional 42-minute class periods in the engineering environment.

The flipped classroom's appeal is that much of the background information or prior learning for a lesson is accomplished the night before coming to class. The class time can then be spent on a short review, while allowing much more time for hands-on activities and group analysis. The major advantage is the increased amount of time in actual constructivist techniques, but the downside is that students who struggle academically or who have little support at home find themselves with a distinct

disadvantage. It is for this reason that flipped classrooms are appealing for engineering and gifted students. The results from Lo and Hew's (2019) findings with over five thousand participants – roughly half on flipped classrooms and half in traditional periods (42 minutes) - was that the flipped classrooms demonstrated a statistically significant positive effect on academic achievement over the traditional model for engineering students.

Since a flipped classroom model requires more autonomy from the student, there has been a greater acceptance at the post-secondary level than the secondary level for young adults. Although change is more prevalent in college, there are some professors who lack the willingness to adopt a newer framework into their classrooms. "There may even be some faculty members who reject the idea that students can learn without actually hearing/seeing the instructor tell them" (Rotellar & Cain, 2016, p. 5).

As noted earlier, a core difference in the flipped classroom model is that students are doing the bulk of the background preparation before entering class. This might be advantageous for students who are motivated for their future career but could also lead to a classroom that is dysfunctional if not all the students are on board with the philosophy. For this reason, flipped classrooms are regulated to Advance Placement (AP) classes; however, even students who struggle can benefit if the background work is structured in a way that is engaging and applies to their interests. As Rotellar and Cain (2016) note, "Time spent in the classroom is an opportunity for students to better understand the reasoning, rather than the means of receiving information" (p. 6).

***Time- Compressed Instruction***

Teachers do not only educate, but they also are required to motivate students who

lose interest and have low attention spans within their classrooms. The increased use of electronic devices and social media exposure may have exacerbated the issue of attention span and student focus. In order to increase student attention span and focus, new methods to retain the students' attention are necessary within the classroom.

Visual aids and time-compressed construction is one method of delivery that seeks to remedy the attention/focus problem. In other words, by utilizing prerecorded lessons, the goal was to utilize a delivery system that would supersede the traditional chalk and talk curriculum format. Pastore (2010) studied 216 undergraduate students from a rural college in central Pennsylvania using diagrams and audio recordings pertaining to the lessons and analyzed the results for academic achievement and cognitive load. A pre- and posttest assessment was administered which "consisted of four tests: drawing, identification, terminology, and compression. Together these tests measure facts, concepts, rules/procedures, and problem-solving objectives" (p. 490). A qualitative assessment was conducted using a Likert scale that rated students preferences following a lesson that contained traditional instructional practices and those with audio, multimedia and time-compressed instruction. The results indicated that the majority of students preferred lessons that involved various modes of multimedia and shortened instruction.

***Double Dose of Algebra***

At one time in the nation's history, America was the educational, industrial and economic powerhouse to the world. America's economic base, however, is losing ground to large powers such as China and India. Some scholars surmise that this decrease is the result of a lack of educated youth studying the hard sciences and mathematics. The answer from some policy makers is to increase academic rigor for the majority of the

nation's students, regardless of their economic status or available supports in their home and school district.

One such technique to increase the rigor without spending resources such as additional human capital, is to introduce a concept called Double Dose of Algebra, which at its core introduces students to algebra at a younger age, and this concept increases the amount and frequency of the algebra sequence. In other words, algebra would not only take place in one semester or year, but be a continuation from the 9th to the 10th grade for the majority of its students who traditionally underachieve in mathematics on state assessments. In addition, the algebra classes are broken into two sections- one half on the algebra content and the other half on the remediation.

The Chicago Public School District initiated this policy for its 40,000 plus students in the early part of the 2000s. The results of the pilot program demonstrated that while a limited amount of exam scores increased, the trajectory did not correlate to standardized test scores (Cortes et al., 2013). However, the academic rigor, established procedures and increased homework had a ripple effect on the students' other academic endeavors besides algebra. As Cortes et al. (2013) state, "the skills gained in double-dose algebra seem to have helped students in other subjects and in subsequent years" (p. 49). In addition, following close analysis of the results, a marked improvement in one area followed as well; traditionally lower performing students that required academic support systems showed an improvement in not only mathematical achievement but also in graduation rates.

### *Adaptive Instructional Approach*

Another technique to reach students is to use more technology and to have the

curriculum be self-paced. This technique is called Adaptive Instructional Approach and it relies heavily on students learning via distance education and through timed computer modules. The downside to this strategy is that some learners do not do well at self-paced instruction: they need daily instruction from a motivated and readily accessible adult.

Traditionally, for students who need some sort of remediation before taking more rigorous mathematics courses, College Algebra or Pre-Algebra is the preferred choice. Kasha (2015) analyzed 56 undergraduate students from a small college in Florida. In this particular college, College Algebra is taken with a software component as a reinforcement. The software package called MyMathLab published by Pearson Publishing provided the traditional framework for the algebra classes. To conduct the study, Kasha (2015) asked the math instructors to use an adaptive instructional approach for a cohort of students. The quasi-experimental study (no random assignment) used an Assessment and Learning in Knowledge Spaces (ALEKS) program to provide quantitative data. The qualitative data for this study involved surveys for undergraduate students.

The ALEKS package is primarily self-taught and instructors are available for office hours much like the other classes. The content is the same as in a traditional format but the curriculum is individualized to meet the pace of the student. A pie chart illustrates students' progress for every stage of the curriculum and what is needed in order to continue. Critics of this approach contend that many students get frustrated because the software does not let a student continue to the next unit until a minimum rating or score is achieved. Advocates argue that mastery of the material, especially in algebra, is necessary for students to progress to more challenging subjects in their college

career.

A pre- and posttest was assigned for the cohorts and an independent samples *t*-test was used to interpret the quantitative results which revealed that there was not a statistically significant difference between the two delivery approaches.

A critically important factor that impacts every classroom is the amount of time spent on a subject. Research on instructional time within the classroom and student achievement regarding other factors in secondary education is denoted in the following section.

## Instructional Time

### *Increased Instructional Time in Algebra*

In many public schools in the United States of America, students are required to spend a minimum number of days within the classroom. States not the federal government mandate their own requirements. For example, in Pennsylvania, schools must have at least 180 days of instruction. Local jurisdictions place elected school board members within local school districts to carry out the legislation.

In addition, a CTC will have strict limits on the number of hours within a technical shop that a student must adhere to in order to get the necessary credentials for employment. Therefore, time is an important entity in determining how often a student must be in school and within their specific classes.

There are numerous studies for and against increasing instructional time. Yesil (2019) analyzed and reviewed a number of published studies to assess if any determinant effect could be drawn from the available studies. His paper was a culmination of reviewed findings. The supporting evidence is contradictory and advocates can find some

solace in a few of the researched papers but in other scholarly works researched by Yesil (2019), a contradictory finding is made. Yesil (2019) further states,

> In sum, it could be concluded from the reviewed papers that there is evidence that increased instructional time may have effects on academic achievement. However, the evidence is mixed, with some studies showing no benefit and a small minority showing an inverse relationship between instructional time and academic achievement. (p. 514)

As previously mentioned, an increase in the amount of algebraic instructional time was implemented through a pilot program for the school district of Chicago. The research revealed that for lower achieving students, exam scores increased (Yesil, 2019, p. 508).

Tidd et al. (2018) researched the results of 401 students at an urban high school in Florida taking intensified algebra in their 9th grade year, which basically meant longer periods of instruction for this specific discipline. The hypothesis was that an intensified and longer time in algebra would lead to higher Florida state standardized test scores. This intensified approach included literacy and remediation as well as the core algebra curriculum.

The comparison group of students consisted of 27 traditional algebra classes from across the state of Florida. Although the Florida state standardized test scores were not part of the results, the findings focused on the predictability of passing scores from one group of students as compared to the other based on numerous attributes in a child's previous coursework and socioeconomic challenges. Teachers were identified as either being high fidelity instructors or low fidelity. The fidelity of each instructor was based on criteria such as time in the district, use of technology, academic credentials, etc. It was

the use of these high- fidelity instructors that was tailored to the intensified cohort of students in order to aggregate the data. The findings suggest there was a statistically significant likelihood of an increase in algebraic scores for the cohort of students who were in the intensified algebra class with high-fidelity instructors.

There are factors and limitations involved in increasing school time for children that are not so readily visible. These include transportation, staff, child care as well as other factors. Indeed, schools do not operate in a vacuum of only teachers and students and they rely on infrastructure and facilities to play a significant role in maintaining a safe learning environment for all who enter the school's doors. For example, a school could not operate effectively if it lost water supply or busses. Without the requisite infrastructure and facilities, schools would cease to operate.

It is because of these constraints that researchers Kolbe and O'Reilly (2017) conducted research analyzing increased instructional time and the true cost to the district. The focus of research consisted of four public school districts in Massachusetts and the analysis of the true cost of increasing instructional time. Each school added an additional 300 hours of instruction for the year. The length of the day was increased in all cases rather than increasing the school year. The large share of the expenditures included staffing for the longer day, remediation, common planning and enrichment activities for their students. By relying on grants and volunteers for the programs, the schools were able to manage some of the personnel required; yet, the amount of personnel required for the additional time placed a heavy burden on the school districts by increasing the expenditures for overtime (Kolbe & O'Reilly, 2017).

### *Loss of Instructional Time*

Students are not robots, and there comes a time within the classroom that a saturation point is reached where the learning has ceased regardless of the quantity or quality of instruction. Research by Kubitschek et al. (2005) focused on the loss of instructional time due to class changes and scheduling constraints and its impact on the educational environment. The research pertains to a high school in a small midsized city in the central part of the United States. This particular high school had numerous scheduling conflicts each year and due to the lack of resources within the district, counselors routinely alter student choices for the upcoming year. Nearly one half of the students had an error and a change on their first day of classes for the research years 1999 to 2000.

The effect of all these errors and scheduling changes was that students were spending time in classes that were not part of their normal career or chosen path, and they eventually fell behind their peers who had a head start by being in the right class at the appropriate time. Kubitschek et al. (2005) posit that the research indicates there was not a statistically significant impact to academic achievement from prior years, but instead, theorize that the teachers would need to spend more time on review for students who had been misplaced in a class. Thus, although no difference in achievement was realized with their peers within the school, the loss of instructional time may have had an effect if the loss of time was compared to students outside of this chosen district.

Sometimes, procedures become common and accepted as part of the normal routine. The research by Kubitschek et al. (2005) further revealed scheduling issues

most likely are not isolated to one school. This researcher has noticed this same phenomena and issue of scheduling and errors from his own school district and rectified the issue by moving scheduling out of the counselor's hands and into the main office where either the assistant principal or principal makes the master schedule. The logic behind this initiative was that the educational administrators understand the teaching staff and are the instructional leaders who can customize the student schedules to match the needs of all their students. Of course, this has to happen in conjunction with the special education department as well.

The Program for International Student Assessment (PISA) is an assessment that measures students' abilities in math and science every three years. It might be unwelcome news for American students to learn that "Students in the United States spend much less time than do students in most other industrialized nations, and the school year has been essentially unchanged for more than a century" (Marcotte & Hansen, 2010, p. 52). If children in the United States are falling behind other students in the world in academic achievement via standardized test scores, a possible cause could be the lack or loss of instructional time.

Nothing can be done to alter the weather and school children generally have been given the day off when there would be a snow cancellation. The COVID-19 Pandemic of 2020 introduced virtual education to children in a massive way, but prior to this particular epidemic, virtual education in public high schools was a rare occurrence. The research by Marcotte and Hansen (2010) analyzed data on Maryland's state assessments for years when there was a severe disruption in the school year due to the weather and years when it was mild. The results indicate that a statistically significant learning loss occurs from

days due to weather disruptions. In fact, "the percentage of students passing math assessments falls by about one-third to one-half percentage point for each day school is closed" (Marcotte & Hansen, 2010, p. 55).

**Student Perspectives on Instructional Time and Math**

Public elementary and secondary students are not an assembly line of widgets and machinery that can be manipulated at a whim to increase or decrease production. Within the confines of the schools are thousands of children with a range of emotional and physical limitations that often place barriers to academic success. One such barrier that has become more prevalent with each passing year is anxiety. Anxiety is a daily part of human existence that can manifest from work, relationships, money, etc. It can affect any individual for a day or two; however, when anxiety reaches a point where one cannot function, then severe impairments arise, especially in children.

Ditrick (2018) analyzed anxiety in children at the secondary level as it relates to mathematics. Students from two public high schools in the Midwest participated in the research. The study was qualitative involving a survey and interviews with the participants. Surveys included questions such as the amount of anxiety in their lives, causes for anxiety in math, and what coping mechanisms they rely on to control or limit anxious feelings while in math class. The Mathematics Anxiety Survey (MARS) was used as a template for researchers to coordinate the findings. Test taking is the largest source of concern for students followed by receiving the wrong answer in class. Students' anxiety for math varies but a common theme is that this fear has been built up since their elementary experience where undoubtedly, they noticed some of their peers solving basic problems quicker than themselves. This shared helplessness and lack of motivation to

increase their skills remained throughout middle school and into high school.

As a former chemistry teacher who received students who had taken biology the year prior, this researcher noticed how much prior learning in biology was missed by students in just a few short months of summer vacation. Indeed, it was almost as if some students had no prior learning at all, and this was noticed for all levels of students at the school. This phenomenon presents the challenge and supports proponents who wish schooling throughout the entire year. Education should do more than provide facts to students. It should be a continuous process. There will always be more and more information for students to acquire but the method of obtaining that information and the retrieval of information should be in the form of a process.

**Gender and Academic Achievement in Algebra**

Although a number of colleges and universities no longer require the American College Testing (ACT) and/or the Scholastic Aptitude Test (SAT) for admissions either because of a perceived cultural bias or other discriminatory factor hindering minority enrollment, it is still a viable and ubiquitous method used in the college admissions process. With regards to gender and future success in college, there is scant evidence that grade point average is a barometer of future academic achievement. In some cases, it does not correlate whatsoever. In a study by Mattern et al. (2017), research was conducted to determine why current achievement measures did not accurately predict academic success for girls.

ACT Engage is an online program that assesses motivation, social engagements and self-regulation primarily for a college audience. Mattern et al. (2017) used this program to survey and correlate academic achievement for selected students in college.

The theory was that there are other factors that limit academic achievement that are not so clear on admissions tests, or G.P.A. and class rank. Mattern et al. (2017) used regression analysis in their study of two years of ACT scores from across the country (15,000 students and 48 institutions) and correlated those records with ACT Engage scores. The results indicated that girls were underrepresented in future growth based solely on ACT scores. A more accurate barometer of future growth is to take their current ACT Engage score along with their ACT results when they applied to college. The unknown, yet important factors such as homework preparedness, and studying habits correlated more closely for girls than it did for boys. Boys may have been overly generous revealing their answers in social engagement and motivation than the girls. These are important attributes as students mature into adulthood and later college years.

Science, Technology and Math (STEM) are a cohort of disciplines that a person may choose to pursue in life. According to White and Massiha (2016), women make up nearly half the workforce, but are underrepresented in STEM occupations. This inequity has slowly been overcome over the previous generation but a concerted effort to have an equitable workforce in STEM needs to be made.

Using longitudinal studies from 2002 and 2009, Lue and Arbeit (2020) analyzed gender and ethnicity regarding specific career clusters and academies that students were choosing to attend. There were an equal number of boys to girls in the cohorts that were analyzed. The results of the study reealed that more males than females chose a technical education. In addition, "female students were overrepresented in Arts, Education, Health, Hospitality, and Human Services" (Lue & Arbeit, 2020, p. 45). The study revealed that boys chose STEM occupations that were mainly concentrated in finance, manufacturing,

and engineering. It should be noted that the latter STEM occupations require higher-level mathematical computations than their service-orientated counterparts. As a result, if boys are going into the high-tech STEM fields, then it would not be a surprise to predict higher level mathematic courses for students involved in these career paths.

Early predictors of mathematics success and STEM career paths was the focus of a study by Ing (2014). The Longitudinal Study of American Youth (LSAY) facilitated the data regarding students in their middle school years and beyond. The study's research went from 1986 until 2005. For the research, approximately 60 students from 52 schools participated. To correlate the qualitative data needed, students participated in surveys and questionaries.

Although there was not a statistically significant difference with gender and mathematic achievement, Ing (2014) notes that higher math and science achievement does correlate to STEM career attainment for both males and females (Ing, 2014, p. 1232).

Using the Trends in International Mathematics and Science Study (TIMSS) for their platform of research, Reilly et al. (2019) conducted a study on the survey results of thousands of young boys and girls to ascertain why pursuing a STEM field is more prevalent in boys than girls. The qualitative data was derived using a Likert scale rating of favorable attitudes towards science and mathematics. The TIMSS results revealed a divergence from across the globe with no statistically significant difference between boys' and girls' attitudes towards mathematics.

With regards to science and mathematics in the United States, there was a slight deviation of science attitudes for boys over girls. Ing's 2014 research may suggest if boys

are favoring science over girls. If mathematics education is a prerequisite to many science professions, the consequence would be more boys pursuing STEM than girls.

**Socioeconomic Status and Academic Achievement in Algebra**

In order to take more challenging classes in high school, students need to have advanced coursework in their late middle school years and into their 9th grade year. Indeed, if a student does not have algebra well versed by their 9th grade year, chances are that he/she will not have the foundation to take calculus, statistics or other higher-level coursework needed for advanced standing in college. Therefore, it is important that barriers to classwork be removed early in a child's life so as to level the playing field for all.

Ricciardi and Winsler (2021) conducted longitudinal research on nearly 32,000 students who were predominantly low income in the Southeast section of the United States. The researchers tracked each student by their unique identification number and by using state assessments were able to formulate predictors and barriers to academic success for the students. The results and conclusion from the research are profound. In disseminating the results, Ricciardi and Winsler (2017) state,

> Those who received reduced price lunch were 82% more likely than those who received free lunch to enroll in an advanced course, while those who did not receive lunch aid were 45% more likely to enroll in an advanced course than those who received free lunch. This suggests that even slight income differences produce meaningful differences in advanced course access. (p. 307)

The research also included variations such as ethnicity, disability status, and gender; however, the underlying theme of poverty as a barrier to future success and a predictor of advanced coursework was most notable.

Paschall et al. (2018) conducted research that tracked mathematics and reading achievement between poor and non-poor white, black and Hispanic children. The longitudinal study differentiated children based on three different age groups using various instruments such as surveys and interviews for the qualitative data and the Peabody Individual Achievement Tests (PIAT) as one of the quantitative assessments.

The results from their research revealed that there was a closing of the achievement gap between poor and non-poor whites and Hispanics, but the gap became larger for both non-poor and poor whites versus blacks. The study further revealed that there was a statistically significant difference in academic achievement among all black children compared to all whites, primarily in later age groups. There was not a reference nor demographic data on single-parent households which may provide a significant variable. In addition, the results demonstrated that the achievement gap between poor and non-poor whites remained relatively unchanged over the age groups, but that the difference between poor and non-poor Hispanics and blacks widened by a statistically significant degree, especially as the children matured.

The problem of low socioeconomic status and academic achievement is not only confined to the United States, but exists in other countries as well. Zhang et al. (2020) conducted a longitudinal study with 829 participants and reflected on the correlation between achievement and their low socioeconomic status as children.

The participants, two rural schools in China agreed to be a part of the research. The study included taking a questionnaire home to be filled out with their parents. The families' education and occupation were also used in the analysis. The span of years for the longitudinal study was only two years and the I.B.M. SPSS program was used to analyze the results from their math scores in high school. The results of the study demonstrated that a statistically significant effect of socioeconomic status and academic achievement are correlated further demonstrating that poverty is a barrier to academic success.

**Summary**

The preceding literature review provided a background on academic achievement, scheduling types, techniques, socioeconomic barriers and gender disparities within the United States related to academic achievement in mathematics. It was the intention of this researcher to correlate some of that knowledge from the literature and relate it to the research project at the CTC. The research at the CTC is concerned with academic achievement in a career and technical environment and the specific method to achieve that goal while at the same time aggregating data between gender and socioeconomic status for the students at the school.

The following section will describe the methods and participants used to fulfill the action project at this particular CTC. The action project will concentrate on the impact of increased instructional time and student achievement.

# CHAPTER III

## Methodology

This chapter describes the design and the method of data collection used for the CTC research project. Through a series of pre and post-test teacher-made assessments, in addition to classroom diagnostic tests, the assessments' raw data were quantified and stored for analysis. The collection of data was used for a true experimental design studying the effect on the dependent variable which was analyzed through a series of independent samples t-test results.

### Purpose

This research project's primary rationale was to ascertain whether increasing the amount of algebraic instructional time would have an effect on academic performance for students at the CTC. Throughout the literature review, various studies highlighted the effectiveness of increasing instructional time in order to increase academic performance. For example, Temple and Mohammed (2020) pointed out that the increased time spent in class correlated to increased scores in statewide assessments for their 8$^{th}$ grade students. In addition, Cortes et al. (2013) posited that the rigor established with increased instructional time led to students taking more advanced classes as they maneuvered their way through upper-level grades at the secondary level.

Increasing academic performance is one of the strategic goals for this specific CTC but this endeavor also has practical applications for its students. As an administrator at the CTC for over eight years, this researcher has had many discussions with not only faculty from the mathematics' department but also the technical instructors. One of the core concerns is the lack of basic mathematical ability of students in their respective

technical career programs. Without a solid foundation in basic mathematical computations such as multiplication, fractions, etc., students struggle to perform both the mundane and advanced required academic tasks. This academic deficiency then leads to the technical instructors spending time remediating math concepts that students should have acquired prior to their entry into the school.

Three essential questions to be answered in this research study were:

1) In what ways does providing increased instructional time in 9th grade Algebra 1 affect student achievement?

2) What is the correlation with students' gender and Algebra 1 scores given increased instructional time?

3) What is the correlation with socioeconomic status and Algebra 1 scores given increased instructional time?

**Setting and Participants**

***Setting***

The setting for this research project was at a comprehensive technical high school located approximately 30 minutes north of Philadelphia, PA. The high school was comprised of a little less than 1,500 students who were selected using a lottery system for enrollment. Six public school districts provided the clientele for the student body. There were approximately 380 students enrolled in the freshmen year and 11% participated in this study.

Each district sends a certain number of students based upon an agreed upon formula by the joint board committee. There were approximately 240 full and part-time staff that worked at the school. This specific CTC has been incorporated since 1958 with

a significant upgrade in the year 2000. The upgrade converted the school from a shared-time model to a full-time comprehensive high school. This was a fairly unique entity as most CTCs in Pennsylvania provide career training services to students on a half day basis, while the other half of the day students take their academic classes at their sending or home district.

At the CTC, there were 26 technical programs. A total of 35 technical instructors provide services for its high school students in 9th through 12th grade. The chosen technical career path for a student is determined by how well they do academically as they traverse through each technical shop during the first two semesters of their freshmen year. This process is called "Explorer" at the CTC. Students spend two days in each technical career area on a half day basis. The other half of the day students take elective classes. After visiting all 26 technical areas, students choose their top three choices for a career path or technical shop.

According to the pupil services supervisor at the school, 75% of the freshmen students were granted their first technical career area choice. In early spring, students were placed into their permanent technical shop. The vast majority of the students spend their time in that specific shop until graduation; however, there is some attrition as a few students will choose to return to their home school over the next 3 years.

As noted earlier, academics were also provided at the school which were delivered in a 4 x 4 block format for the majority of its classes. A few select electives were delivered in 42- minute sections, primarily at the 9th grade level. The school did not provide some of the more traditional electives such as music and art. Sports and other extracurricular activities were confined to the sending districts. Although the CTC did not

have its own buses for transportation, the sending districts provided transportation for student athletes. Less than 10% of the student body at the CTC participated in athletics offered by their sending school districts.

***Participants***

The participants in this action project and experimental study were selected from the incoming 9th grade student class. The students for both the control and experimental groups were randomly assigned during the summer months preceding the school year. This researcher set out to have a homogenous mixture of students in both the control and experimental groups based on academic ability. Academic ability was ascertained by using students' middle school final grades as well as guidance counselor recommendations. In addition, prospective students submitted a short essay as part of their application packet.

The gender and socioeconomic status of the student body for both the control and experimental groups was also an area of study as it pertained to the academic achievement scores for this research project.

Table 1 is a list of the students in the control group. To protect the anonymity of each student, random identification numbers were given and are listed in the first column. The B1 after the name of the class in the second column stands for block 1 which was a combination of two 42- minute periods totaling approximately 88 minutes. The last column in the Table 1 lists whether the student was economically disadvantaged or non-economically disadvantaged.

**Table 1**

*Control Group of Students*

| ID | Class | Gender | Economically Disadvantaged (Y/N) |
|---|---|---|---|
| 6 | Algebra1 Acad B 1 | F | N |
| 11 | Algebra1 Acad B 1 | F | N |
| 15 | Algebra1 Acad B 1 | F | N |
| 19 | Algebra1 Acad B 1 | F | N |
| 1 | Algebra1 Acad B 1 | M | N |
| 2 | Algebra1 Acad B 1 | M | N |
| 4 | Algebra1 Acad B 1 | M | N |
| 5 | Algebra1 Acad B 1 | M | N |
| 7 | Algebra1 Acad B 1 | M | N |
| 12 | Algebra1 Acad B 1 | M | N |
| 17 | Algebra1 Acad B 1 | M | N |
| 20 | Algebra1 Acad B 1 | M | N |
| 8 | Algebra1 Acad B 1 | F | Y |
| 9 | Algebra1 Acad B 1 | F | Y |
| 10 | Algebra1 Acad B 1 | F | Y |
| 14 | Algebra1 Acad B 1 | F | Y |
| 16 | Algebra1 Acad B 1 | F | Y |
| 18 | Algebra1 Acad B 1 | F | Y |
| 3 | Algebra1 Acad B 1 | M | Y |
| 13 | Algebra1 Acad B 1 | M | Y |

Table 2 is a listing of the students in the experiment group. There were 24 participants. The female population was 38% and the overall economically disadvantaged segment of the group was 42%.

**Table 2**

*Experimental Group of Students*

| ID | Class | Gender | Economically Disadvantaged (Y/N) |
|---|---|---|---|
| 29 | Algebra 1 Acad Daily B 3 | F | N |
| 31 | Algebra 1 Acad Daily B 3 | F | N |
| 32 | Algebra 1 Acad Daily B 3 | F | N |
| 34 | Algebra 1 Acad Daily B 3 | F | N |
| 36 | Algebra 1 Acad Daily B 3 | F | N |
| 22 | Algebra 1 Acad Daily B 3 | M | N |
| 23 | Algebra 1 Acad Daily B 3 | M | N |
| 28 | Algebra 1 Acad Daily B 3 | M | N |
| 33 | Algebra 1 Acad Daily B 3 | M | N |
| 37 | Algebra 1 Acad Daily B 3 | M | N |
| 38 | Algebra 1 Acad Daily B 3 | M | N |
| 39 | Algebra 1 Acad Daily B 3 | M | N |
| 41 | Algebra 1 Acad Daily B 3 | M | N |
| 42 | Algebra 1 Acad Daily B 3 | M | N |
| 24 | Algebra 1 Acad Daily B 3 | F | Y |
| 25 | Algebra 1 Acad Daily B 3 | F | Y |
| 30 | Algebra 1 Acad Daily B 3 | F | Y |
| 43 | Algebra 1 Acad Daily B 3 | F | Y |
| 21 | Algebra 1 Acad Daily B 3 | M | Y |
| 26 | Algebra 1 Acad Daily B 3 | M | Y |
| 27 | Algebra 1 Acad Daily B 3 | M | Y |
| 35 | Algebra 1 Acad Daily B 3 | M | Y |
| 40 | Algebra 1 Acad Daily B 3 | M | Y |
| 44 | Algebra 1 Acad Daily B 3 | M | Y |

The students attended four academic classes throughout their instructional day with a 30 minute break for lunch. The other academic classes at the CTC represent science, language arts and social studies. The current delivery model did not allow for

any open periods or study halls throughout the day. Students at the CTC took technical career classes all day but at the 9th grade level their technical career classes were half day. The other half of a student's day primarily consisted of business, literacy, health, foreign language and reading electives.

Students were told of their involvement in the beginning of the year by this researcher and also by their instructor. If students chose to have their data analyzed for this research study, they were asked to either sign electronically or to fill out a paper and pencil consent form. The informed consent form is listed in Appendix A. One hundred percent participation was given by the student body for both the control and experimental groups. As noted in Appendix A, their names were not to be shared by anyone other than this researcher and their mathematics instructor.

**Research Plan**

***Action***

Much of the discussion and research regarding the literature review in Chapter II focused on the delivery models and instructional strategies to increase academic performance, primarily at the high school level. Although no consensus was given as to a definitive format that would lead to academic growth, the majority of the literature that this researcher reviewed reflected a bias towards block scheduling. This happened to be the current format that was used at this CTC.

The CTC operates as a comprehensive technical high school that had students attending their academic classes for 6 days followed by 6 days of their technical instruction. For this action project and research design, these particular students in the experimental group spent 12 days in the same mathematics class. Students in the control

group took Spanish classes for the additional time the students in the experimental group received the added mathematics instruction. Both sets of students were at the same academic level but differed in the amount of time spent in their algebra class. No other variable other than instructional time differentiated the control and experimental group of students. Every day math was compared to math that was one-half of the time. The students for both the control and experimental groups were randomly assigned to each group and were taught by the same teacher. Their academic abilities were measured prior to the placement and all were deemed to be at the same academic level. For this experimental design, instructional time was the independent variable and the mathematical scores on the teacher-made assessments and CDTs was the dependent variables.

The experimental group in this research study received 135 hours more instructional time over the course of the school year than their counterparts in the control group who were participating under normal circumstances. The objective of this added instructional time was to serve two purposes. First, the added instructional time allowed for the instructor to remediate basic mathematical concepts such as multiplication and factoring that the students lacked prior to their entry into the school. Second, the added time allowed for the instructor to provide enrichment activities and cooperative learning projects that were not utilized in the control group.

There were two sets of data instruments used throughout the year for this action research. First, a baseline was established with a teacher-made pretest. This pretest was given to both the control and experimental groups. This same pretest was analyzed by the instructor who performed specific actions to remedy deficiencies that were noted in both

the control and experimental groups. Since the remediation was applied to both experimental and control groups, there was a consistency to this action project. In addition to the teacher-made pre and posttest, a classroom diagnostic test (CDT) was used to further validate and triangulate the data. The CDT is a set of online assessments that track academic deficiencies in algebra and other core subject areas. The CDT was given in October, December and April.

In order to validate the data being analyzed, it was necessary to ensure that the same instructor be used for both the control and experimental group for this research. The current instructor for this study has taught at the CTC for over 20 years and was well versed in pedagogy and remediation of academic deficiencies for students. There was to be no change in the approved mathematics curriculum but the instructor would remediate the class as a whole and this applied to both groups of students.

The data analyzed for this study was measured in several ways. First, classroom diagnostic tests gave detailed information on specific mathematical standards that were key to academic success in algebra and higher-level mathematics. Second, a posttest assessment by the teacher validated whether the increased algebraic instructional time resulted in a deeper understanding of the mathematics curriculum at the high school. Both mathematical instruments used in the experimental design were necessary in order to adhere and align to the state mandated Keystone assessments in algebra which demonstrate proficiency and advanced standing.

Table 3 lists a typical schedule for a student taking math for six straight days during periods 3 and 4. This example schedule for this particular student will be repeated for six days. The last column denotes the day or rotation that the student is on: Day 1

being academic and Day 2 denoting technical classes. If you follow the third column in Table 3 to the bottom it changes to 2. Day 2 indicates that the student was now on his/her technical rotation and did not take math for Days 7 through Day 12. This is further illustrated by noticing that there is no additional algebra class when the day changes to 2. This block of time is now occupied by Spanish in periods 7 and 8.

**Table 3**

*6 Day Math Schedule*

| Period | Description | Days |
|---|---|---|
| 01 | HON GLOBAL STUD | 1 |
| 02 | HON GLOBAL STUD | 1 |
| 03 | **ALG 1 9 ACAD.** | **1** |
| 04 | **ALG 1 9 ACAD.** | **1** |
| 05 | PHYSICAL SCIENCE 9 ACAD | 1 |
| 06 | PHYSICAL SCIENCE 9 ACAD | 1 |
| 07 | HON. LANG. ARTS | 1 |
| 08 | HON. LANG. ARTS | 1 |
| 09 | LUNCH 1 | 1 |
| 01 | CAREER EXPLORER | 2 |
| 02 | CAREER EXPLORER | 2 |
| 03 | CAREER EXPLORER | 2 |
| 04 | CAREER EXPLORER | 2 |
| 05 | PE/HEALTH | 2 |
| 06 | COMPUTER TECH | 2 |
| 07 | SPANISH 1 9th | 2 |
| 08 | SPANISH 1 9th | 2 |
| 09 | LUNCH 1 | 2 |

Table 4 illustrates a typical schedule for a student taking a 12- day math rotation. During periods 5 and 6, this student took Algebra1 Academic Daily. The number 1 in the third column indicates that the student took academic classes and that the schedule repeated for Days 1 through Day 6. In addition, by following the last column labeled

"Days" until it changes to the number 2, there is a repeated Algebra1 Academic Daily class. This is a continuation of the same class that the student is taking for periods 5 and 6 with the same teacher. The number 2 under the Days column indicates that the student schedule switched to the technical rotation. However, unlike the 6- day math schedule in Table 3, there is an additional block of math time that was taken which is denoted in periods 03 and 04 when the last column labeled "Days" switches to the number 2. And unlike the 6- Day math schedule, there is no Spanish class.

**Table 4**

*12 Day Math Schedule*

| Period | Description | Days |
|---|---|---|
| 01 | GLOBAL ST. ACAD | 1 |
| 02 | GLOBAL ST. ACAD | 1 |
| 03 | LANG. ARTS 9 AC | 1 |
| 04 | LANG. ARTS 9 AC | 1 |
| 05 | **Alg1 ACAD DAILY** | **1** |
| 06 | **Alg1 ACAD DAILY** | **1** |
| 07 | PHYSICAL SCIENCE 9 ACAD | 1 |
| 08 | PHYSICAL SCIENCE 9 ACAD | 1 |
| 09 | LUNCH 1 | 1 |
| 01 | PE/HEALTH | 2 |
| 02 | COMPUTER TECH | 2 |
| 03 | **Alg1 ACAD DAILY** | 2 |
| 04 | **Alg1 ACAD DAILY** | 2 |
| 05 | CAREER EXPLORER | 2 |
| 06 | CAREER EXPLORER | 2 |
| 07 | CAREER EXPLORER | 2 |
| 08 | CAREER EXPLORER | 2 |
| 09 | ACADEMY LUNCH | 2 |

In order to differentiate the academic students at the CTC, it was necessary to determine which students wish to take Spanish in their freshmen year. This is important because if a student chooses Spanish, they will not be able to take math every day.

Students who were selected to take math everyday do not have an opportunity to take a foreign language because that block of time is allocated to another block of math at the expense of the foreign language class. This lack of a foreign language elective for students taking math every day in 9th grade is rectified at the CTC by allowing students to take Spanish during their sophomore or junior year.

Following the instruction of the CDT and pretest in the fall of the year, the mathematics instructor analyzed the results for both groups of students and rectified any academic deficiencies that were prevalent within the classes. The data from both groups were shared with this researcher. In order to triangulate the results, the CDT was compared to the teacher-made tests for both the pretest and posttest results.

***Research Design***

This experimental design was a quantitative analysis of the data derived from two sources: teacher-made tests and CDTs. The comparison of mean scores for both control and experimental groups were analyzed using an independent samples *t*-test. In addition to the comparison of scores for both groups, the data were further aggregated based on gender and socioeconomic status.

The key variable that differentiated the control and experimental group was the amount of instructional time delivered to the students. Specifically, students in the experimental group received twice as much instructional time as students in the control group. In doubling the amount of instructional time, one may surmise that twice the amount of curriculum was being delivered. However, this researcher has discussed this topic with the instructor many times and it should be noted that although the time was longer in the experimental group, the curriculum was consistent. The logic underlying

this approach was that the experimental group would receive more enrichment and gain deeper understanding through activities, cooperative learning and remediation of foundational concepts. Therefore, no change was noted at the end of the year in terms of material or assessments but theoretically a more robust understanding of the curriculum was received. The independent samples *t*-test validated whether this intervention led to higher mathematical scores or not. The statistical analysis was analyzed for both the teacher-made assessments as well as the CDTs.

Growth over the course of the school year was assessed based off the pre- and posttest results. This growth was also analyzed via the CDT results which were given in the beginning, middle and end of the year. It will be noted in the results section if any correlation exists between individual student scores as they progressed throughout the school year on both types of assessments.

The end - of - year teacher-made assessment mean scores were compared for both control and experimental groups in order to analyze whether increasing the instructional time had any effect on academic performance. This same technique was used on the output mean scores of the CDTs. The independent samples *t*-test differentiated the mean scores for students classified as being economically disadvantaged versus students who were non-economically disadvantaged. Lastly, any differentiation that may have existed in academic performance with respect to gender for both the experimental and control group was analyzed.

***Data Collection***

The data collection was fairly similar for both experimental and control groups. The teacher-made pre- and post-test results were given in their respective classrooms for

each group. Since administration of the CDTs was a normal part of the curriculum and standard practice at this CTC, all students who were taking algebra were subjected to these assessments. Although there are various methods to assess academic performance such as project-based assessments and portfolios, for this action project grades and scores generated on the teacher-made assessments and CDTs were the primary assessments used for analysis. As Brookhart (2015) notes, "Grades are important to study because they are ubiquitous, are widely perceived to be the measure of a student's achievement, and have pervasive influence on students and schooling" (p. 269).

The CDTs were given in the fall, winter and spring of the school year but were done electronically with each student using their school issued chrome book. The teacher-made assessments were paper and pencil format and the instructor provided the results on a shared Google drive document with this researcher. The results from the CDTs were also uploaded as soon as the students concluded with their assessments. Because of absenteeism, the data were not translated to the shared drive until all students took the assessments. This shared drive consisted of demographic data such as gender and socioeconomic status. It is the contention of this researcher that the data collected for both types of assessments were sufficient to answer the three essential research questions for this study. The testing environment for the CDTs and teacher-made assessments were conducted within the existing mathematics classroom. The teacher-made assessment consisted of 30 questions in algebra.

The data for both the teacher-made assessments and also the CDTs were analyzed using the SPSS software program developed by the I.B.M. corporation. After the data was generated by the students, it was shared and downloaded to this researcher's desktop

as an excel file. The excel file was uploaded to the SPSS software program. The independent samples *t*-test compared the mean scores for both the control and experimental groups. As noted earlier, a comparison was made not only by gender but also with students who were economically disadvantaged and students who were non-economically disadvantaged at the school. Lastly, the teacher-made posttest results and the CDTs were compared to see if any correlation existed between the output data sets.

***Potential Financial Implications***

There were no additional fiscal constraints or requirements to perform this research project. Since students were taking mathematics every day in the experimental group, this required the same instructor to be furnishing instruction for all 12 days of the rotation. Without this mode of delivery, this particular mathematics instructor could be utilized to teach upper grade level courses. Thus, there is a constraint to the mathematics department in terms of increasing the number of students for other instructors while this particular instructor was teaching 9$^{th}$ grade classes.

A larger financial but also human implication may result if the analysis of the data correlated to an increase in student performance. If it was determined that a positive correlation existed between increased instructional algebraic time and academic performance, administration may increase the scope of this research to include more sections of math every day at the 9$^{th}$ grade level. This would increase staff for the mathematics department but could have unintended consequences for personnel in other departments.

Students who take mathematics on the 12- day schedule do not take a foreign language class. If more students were to take a mathematics class on a 12- day rotation,

there would be a decrease in the number of students taking the Spanish foreign elective class. The decrease in the number of students taking Spanish may necessitate a decrease in personnel teaching that elective.

At the CTC, students automatically are enrolled in Spanish at the 9th grade level if they are in Algebra 2 or Algebra 2 Honors. This constitutes approximately 20% of the student body. The majority of the students at the CTC were categorized at the academic and lower academic level. Students at the academic level may choose to take Spanish in their freshmen year. If they do not chose to take Spanish, they are automatically enrolled in a 12- day mathematics class.

***Timeline***

Since this research project tracked the progress of students in their freshmen year, the analysis and research concluded at the end of the traditional school year in June. The initial stages to differentiate the control and experimental groups was done in August of 2021. The teacher-made benchmark assessments were given in the fall of 2021and spring of 2022. The CDTs were given in the fall, winter of spring.

The winter CDT assessment followed remediation by the same teacher for both the control and experimental groups. This remediation was needed as part of the action project to rectify academic deficiencies that were present for both groups of students. There was to be no additional revisions to the existing mathematics curriculum at the school but rather reinforcement of key areas that align to the standardized test given in the spring. In addition, the last CDT was given in April of 2022. The timeline for the battery of tests administered in this research study is listed in Table 5.

**Table 5**

*Research Project Timeline*

| Research Questions | Types of Data | Data Sources | Timeline |
|---|---|---|---|
| 1. In what ways does providing increased instructional time in 9th grade Algebra 1 affect student achievement? | Quantitative | 1) teacher-made pre and posttests<br>2) classroom diagnostic test | 1) September 2021, May 2022<br>2) October, December 2021, April 2022 |
| 2. What is the correlation with socioeconomic status and algebra 1 scores given increased instructional time? | Quantitative | 1) teacher-made pre and posttests<br>2) classroom diagnostic test | 1) September 2021, May 2022<br>2) October, December 2021, April 2022 |
| 3. What is the correlation with students' gender and algebra 1 scores given increased instructional time? | Quantitative | 1) teacher-made pre and posttests<br>2) classroom diagnostic test | 1) September 2021, May 2022<br>2) October, December 2021, April 2022 |

## IRB Approval

The Instructional Review Board (IRB) approved this research project and the email demonstrating acknowledgement is listed in Appendix B. The required training and certifications were accomplished in the summer of 2021. The data were analyzed and comprised of two distinct aggregate sets. In addition to comparing the results for the control and experimental groups as a whole, further analysis by this researcher focused on differences between gender and socioeconomic status.

**Validity**

Validation of the data is crucial in order to form a reasonable conclusion for this research project. The interpretation of the data and the method of collection should be free from any type of bias on the part of the researcher. This researcher has no vested interest in the outcome of the project other than an academic endeavor to prove whether this experiment demonstrated any type of effect on student achievement and if there is a differentiation among gender and socioeconomic within the experimental and control group with regards to academic scores.

To ensure the fidelity of the data and the interpretation of the results be as transparent as possible, it's necessary for the data or content being analyzed to be as uniform and random as possible. This researcher contends that that the content validity is accurate and uniform since the randomization and distribution of the students for the control and experimental groups were done without any constraints and based solely on academic ability. The randomization of students was implemented prior to the school year. Careful attention to gender distribution throughout the process was achieved without altering the student's entire schedule. The same teacher was used for both control and experimental group which prohibited any deviation in teaching styles that might be introduced by another professional. The distribution of socioeconomic status was achieved with a deviation of 8%.

Since this research was done using an experimental design, the degree to which the dependent variable is impacted by the independent variable is critical for the analysis of the results. By using various mathematical instruments such as the CDTs, teacher-

made assessments and the SPSS statistical package measuring a series of independent samples *t*-tests, this researcher is confident that internal validity of the study was robust.

The external validity or the replication of this study in any other setting could be generated provided that the randomization of students be accomplished with fidelity and the distribution of students based on academic ability is accurate. This research was conducted at a CTC but any secondary school could further demonstrate or replicate this research by increasing algebraic instructional time with a randomized control and experimental group of students.

Quantified results of data are either going to demonstrate a correlation and cause and effect or no impact to the dependent variable. This research was a true experimental design analyzing various outputs for achievement scores on two different sets of assessments. The statistical validity is free from bias and is derived solely on the outputs from the various independent samples *t*-tests using the SPSS mathematical instrument.

**Triangulation**

The CDTs were developed by the Data Recognition Corporation (DRC) as a benchmark that would align to the Pennsylvania Department of Education's (PDE) Standard Aligned System (SAS). By using the SAS portal, which can be freely accessed, educators can monitor fidelity to Pennsylvania's standards and assessments.

The SAS portal was designed by PDE as a resource to support educators in their effort to increase student achievement. The portal has several categories to assist educators in that endeavor. Specifically, the SAS portal lists standards, assessments, curriculum framework, instruction, materials and resources and safe and supportive schools. The standards section lists the Pennsylvania standards for each Keystone discipline ranging

from elementary to the high school level. Educators can also find the academic anchors aligned to each standard.

The curriculum framework is a bridge to each standard aligning each of them to specific modules assessed on the Keystone exams. The materials and resource category is a section that will uses existing resources by educators which exemplify specific standards that should be taught across the state of Pennsylvania. These resources can be anything from actual science labs, lesson plans, or enrichment activities. An example of an enrichment activity can be found by searching for the word "mole" in the materials section; whereby, one will find an article titled "Chemistry Calculations Using the Mole." This researcher along with several other colleagues provided PDE with this science activity that integrates literacy and science standards.

One area of particular importance, especially for this researcher, was the section embedded within the Assessment category labeled CDTs. The CDTs were an instrumental factor for the research design and were given three times in this research project. This section will give pertinent information for any educator or researcher wishing to use a diagnostic tool within a school setting. There are pamphlets, parent resources, metacognition templates, and assessment resources that will aid in the understanding and distribution of the CDTs.

The specific benchmarks incorporated in the algebra section of the CDTs align to standards in the SAS portal and also to the modules on the Keystones exams. If students are increasing their CDT output scores through early intervention and remediation, then the expected outcome is that their respective algebra Keystone scores will also increase. Furthermore, the end of the year assessment given by the instructor aligns to specific

benchmarks in not only the CDTs but also the Keystone exams. Therefore, both sets of data correlate with each other and the increased growth or regression should be seen in both assessments.

**Summary**

This section has given the necessary background explaining the research design, implications of the research, and data collection methodology used for this study. Since this research was purely an experimental design, the data was quantified and aggregated based upon the three essential research questions. The primary instruments for data representation include both the teacher-made tests and the CDTs. Moving forward into the results and discussion section, the essential questions as well as the outputs generated from the statistical software package for both the control and experimental groups were analyzed and graphically displayed. The SPSS software program was the statistical instrument for the mathematical analysis.

# CHAPTER IV

## Data Analysis and Results

The purpose of this project was to ascertain whether increasing the amount of instructional time within a 9th grade mathematics classroom would improve students' academic performance. A statistical analysis was performed using an independent samples *t*-test on output scores generated from both the teacher-made assessments and on the CDTs. The SPSS statistical software package furnished the necessary data for analysis.

The entire project was predicated on a quantifiable experimental design in which an experimental group was compared to the control group. As noted in the methodology section, the independent variable in this project was the increased instructional time. No other variables were introduced into the experimental design. In addition to analyzing the scores for both the control and experimental group, the SPSS software program compared mean scores for gender and socioeconomic status within both the experimental and control group.

### Data Analysis

This researcher received both the initial and final scores for each mathematical instrument: teacher-made assessments and CDTs. Each test was given at a predetermined point in the school year. The data was then shared via a Google drive and downloaded to an excel file on this researcher's desktop. The data was then uploaded to the SPSS software package.

The essential research questions that were analyzed using the SPSS software program were:

1. In what ways does providing increased instructional time in 9th grade Algebra 1 affect student achievement?
2. What is the correlation with students' gender and Algebra 1 scores given increased instructional time?
3. What is the correlation with socioeconomic status and Algebra 1 scores given increased instructional time?

The first analysis compared the mean scores for both the experimental group and the control group. This provided the results for research question #1. For research questions #2 and #3, an independent samples t-test was again used for differentiating gender and then socioeconomic status within the control and experimental group.

**Results**

By using the SPSS software program, an initial baseline generated a series of output scores for both the control and experimental group. The output charts were then compared to the output data charts generated at the end of the year for the teacher-made tests. The CDTs were administered three times during the school year. The same computational analysis was run for each scenario: independent samples t-test. The key criteria for each output was designated under the Levene's Test of Variance, specifically the Significance (Sig.) value. If the Sig. value was less than 0.05, then there was a statistically significant difference in the output mean scores for any of the quantified measurements. In Table 6, the Sig. value listed under the Levene's Test for Equality of Variances is .242. Since this value is above the 0.05 threshold, this revealed that there was not a significantly significant variance or difference with gender for the teacher-made pretest scores in the experimental group.

**Table 6**

*Teacher-Made Pretest Scores Differentiated by Gender for the Experimental group*

**Group Statistics**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Teacher-Made Pretest | Male | 13 | 34.08 | 12.107 | 3.358 |
| | Female | 9 | 30.78 | 8.657 | 2.886 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Teacher-Made Pretest | Equal variances assumed | 1.452 | .242 | .701 | 20 | .492 |
| | Equal variances not assumed | | | .745 | 19.949 | .465 |

In addition to analyzing the mean scores differentiated by gender, research question #3 focuses on the socioeconomic differences in output scores for both the experimental and control group.

Table 7 represents the output scores comparing students who were economically disadvantaged at BCTHS and students who were non-economically disadvantaged within the experimental group for the teacher-made pretest. As in Table 6, the focus will be under the Independent Samples Test- Levene's Test for Equality of Variances, specifically the Sig. value which is noted to be 0.056. Since this value is over the 0.05 threshold, this revealed that there was not a statistically significant difference in output

scores between students who were economically disadvantaged and students who were non-economically disadvantaged on the initial teacher-made test within the experimental group.

**Table 7**

*Socioeconomic Difference within the Experimental Group for the Teacher-Made Pretest*

**Group Statistics**

| | Lunch Status | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Teacher-Made Pretest | Free and Reduced Lunch | 8 | 30.38 | 7.405 | 2.618 |
| | Regular Lunch | 14 | 34.07 | 12.288 | 3.284 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Teacher-Made Pretest | Equal variances assumed | 4.117 | .056 | -.770 | 20 | .450 |
| | Equal variances not assumed | | | -.880 | 19.870 | .389 |

Table 8 lists the output mean scores for the initial teacher-made test. The Sig. value listed under the Levene's Test for Equality of Variances is .890. Since this value is over the 0.05 threshold, this revealed that there was not a statistically significant variance

in output mean scores for the control and experimental group on the teacher-made pretest in the experimental group.

**Table 8**

*Control and Experimental Group Mean Score Results for Teacher-Made Pretest*

**Group Statistics**

| | Class Type | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Teacher-Made Pretest | Control Group | 19 | 35.59 | 10.475 | 2.403 |
| | Experimental Group | 23 | 32.91 | 10.518 | 2.193 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Teacher-Made Pretest | Equal variances assumed | .019 | .890 | .824 | 40 | .415 |
| | Equal variances not assumed | | | .824 | 38.575 | .415 |

**Data Triangulation**

For a research study to be robust, several sources of data should be incorporated in the analysis. The teacher-made assessment was one method to address the remediation and academic performance over the course of the school year. The other source of data in this study was the CDT which was analyzed three times during the school year: initial

(September), mid-year (December) and final (May). For each CDT assessment, the gender and socioeconomic differences were analyzed as well the comparison in mean output scores for both the control and experimental group. Table 9 represents the output score results for the initial CDT regarding the control and experimental group. The Sig. value listed under the Levene's Test for Equality of Variances is .027. Since this value is under the 0.05 threshold, this revealed that there was a statistically significant difference in output scores for the control and experimental group on the initial CDT.

**Table 9**

*Initial CDT Mean Score Comparison for the Control and Experimental Groups*

**Group Statistics**

| | Class Type | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Initial CDT Scores | Control Group | 19 | 997.26 | 72.590 | 16.653 |
| | Experimental Group | 23 | 943.65 | 120.296 | 25.083 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Initial CDT Scores | Equal variances assumed | 5.248 | .027 | 1.701 | 40 | .097 |
| | Equal variances not assumed | | | 1.781 | 36.905 | .083 |

Table 10 lists the output results for the initial CDT scores within the experimental group differentiated by gender. The Sig. value listed under the Levene's Test for Equality of Variance is .298. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by gender in the experimental group.

**Table 10**

*Initial CDT Scores Differentiated by Gender for the Experimental Group*

**Group Statistics**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Initial CDT Scores | Male | 13 | 959.38 | 141.049 | 39.120 |
| | Female | 9 | 928.00 | 93.644 | 31.215 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Initial CDT Scores | Equal variances assumed | 1.144 | .298 | .582 | 20 | .567 |
| | Equal variances not assumed | | | .627 | 19.990 | .538 |

Table 11 represents the baseline output scores differentiating economically disadvantaged students and non-economically disadvantaged students in the experimental group on the initial CDT. The Sig. value listed under the Levene's Test for Equality of

Variances is under 0.05. Since this value is under the 0.05 threshold, this revealed that there is a statistically significant difference in output scores comparing non-economically disadvantaged students and economically disadvantaged students on the initial CDT in the experimental group.

**Table 11**

*Socioeconomic Difference within the Experimental Group for Initial CDT Scores*

**Group Statistics**

| | Lunch Status | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Initial CDT Scores | Free and Reduced Lunch | 8 | 897.00 | 160.239 | 56.653 |
| | Regular Lunch | 14 | 974.86 | 89.242 | 23.851 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Initial CDT Scores | Equal variances assumed | 5.337 | .032 | -1.476 | 20 | .155 |
| | Equal variances not assumed | | | -1.267 | 9.540 | .235 |

The CDTs were distributed three times during the school year for this study. The mid-year CDT results are listed Table 12 and reflect the remediation that was done by the teacher for both the control and experimental group. This action project consisted of

remediation by the teacher after identifying specific areas of academic weakness noticed on both the CDTs and teacher-made assessment. The Sig. value listed under the Levene's Test for Equality of Variances is .728. Since this value is over the 0.05 threshold, this revealed that there was not a statistically significant difference between the control and experimental group on the mid-year CDT.

**Table 12**

*CDT Mid-Year Results for the Control and Experimental groups*

**Group Statistics**

| | Class Type | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| CDT Mid-Year | Control Group | 19 | 995.16 | 112.676 | 25.850 |
| | Experimental Group | 23 | 1006.57 | 112.905 | 23.542 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| CDT Mid-Year | Equal variances assumed | .123 | .728 | -.326 | 40 | .746 |
| | Equal variances not assumed | | | -.326 | 38.546 | .746 |

Table 13 lists the output score results differentiated by gender within the experimental group. The Sig. value listed under the Levene's Test for Equality of

Variances is .760. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by gender on the mid-year CDT in the experimental group.

**Table 13**

*CDT Mid-Year Results Differentiated by Gender in the Experimental Group*

**Group Statistics**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Mid -Year CDT | Male | 13 | 1004.3846 | 127.36400 | 35.32442 |
| | Female | 9 | 1002.3333 | 100.71619 | 33.57206 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Mid -Year CDT | Equal variances assumed | .096 | .760 | .040 | 20 | .968 |
| | Equal variances not assumed | | | .042 | 19.547 | .967 |

Table 14 lists the output score results differentiated by socioeconomic status within the experimental group on the mid-year CDT. The Sig. value listed under the Levene's Test for Equality of Variances is 0.044. Since this value is under 0.05, this revealed that there was a statistically significant difference between students who were

economically disadvantaged and students who were non-economically disadvantaged on the mid-year CDT in the experimental group.

**Table 14**

*CDT Mid-Year Result Differentiated by Socioeconomic Status in the Experimental Group*

**Group Statistics**

| | Lunch Status | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Mid -Year CDT | Free and Reduced Lunch | 8 | 949.5000 | 141.28795 | 49.95283 |
| | Regular Lunch | 14 | 1034.4286 | 87.43148 | 23.36705 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Mid -Year CDT | Equal variances assumed | 4.619 | .044 | -1.753 | 20 | .095 |
| | Equal variances not assumed | | | -1.540 | 10.137 | .154 |

The instructional time that students encountered within the experimental group was twice as long as in the control group. After over 80 days of instruction, the final CDT results as well as the final teacher-made test results were analyzed. Table 15 represents the final CDT output scores comparing the control and experimental group. The Sig. value listed under the Levene's Test for Equality of Variances is .745. Since this value is

above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores between the control and experimental group on the final CDT.

**Table 15**

*Final CDT Results for the Control and Experimental Group*

**Group Statistics**

| | Class Type | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| CDT Final | Control Group | 19 | 1072.0526 | 95.29572 | 21.86234 |
| | Experimental Group | 23 | 1046.2609 | 114.52559 | 23.88024 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | |
|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference |
| CDT Final | Equal variances assumed | .107 | .745 | .783 | 40 | .438 | 25.79176 |
| | Equal variances not assumed | | | .797 | 39.994 | .430 | 25.79176 |

In order to triangulate the data and increase data reliability for this study, the final teacher-made assessment was analyzed and compared to the final CDT results. Table 16 represents the differentiation between the control and experimental group on the teacher-made posttest. The Sig. value listed under the Levene's Test for Equality of Variances is .282. Since this value is above the 0.05 threshold, this revealed that there was not a

statistically significant difference in output mean scores between the control and experimental group for the post teacher-made assessment in the experimental group.

**Table 16**

*Teacher-Made Posttest Results for the Control and Experimental Group*

**Group Statistics**

| | Class Type | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Teacher-Made Posttest | Control Group | 19 | 55.6105 | 14.00781 | 3.21361 |
| | Experimental Group | 23 | 55.8000 | 9.22575 | 1.92370 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Teacher-Made Posttest | Equal variances assumed | 1.188 | .282 | -.053 | 40 | .958 |
| | Equal variances not assumed | | | -.051 | 30.054 | .960 |

The two other essential research questions for this study were academic performance differentiated by gender and socioeconomic status within the control and experimental group.

Table 17 lists the output results differentiated by gender in the experimental group. The Sig. value listed under the Levene's Test for Equality of Variances is .816.

Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by gender in the experimental group.

**Table 17**

*Final CDT Results Differentiated by Gender in the Experimental Group*

**Group Statistics**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| CDT Final | Male | 13 | 1061.6923 | 98.79725 | 27.40143 |
| | Female | 9 | 1020.0000 | 141.79386 | 47.26462 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | |
|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference |
| CDT Final | Equal variances assumed | .108 | .746 | .816 | 20 | .424 | 41.69231 |
| | Equal variances not assumed | | | .763 | 13.281 | .459 | 41.69231 |

Table 18 lists the final CDT output results differentiated by socioeconomic status in the experimental group. The Sig. value listed under the Levene's Test for Equality of Variances is .757. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by socioeconomic status on the final CDT in the experimental group.

**Table 18**

*Final CDT Results Differentiated by Socioeconomic Status in the Experimental Group*

**Group Statistics**

| | Lunch Status | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| CDT Final | Free and Reduced Lunch | 8 | 1032.0000 | 90.89554 | 32.13643 |
| | Regular Lunch | 14 | 1051.8571 | 132.25201 | 35.34584 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | |
|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference |
| CDT Final | Equal variances assumed | .098 | .757 | -.375 | 20 | .711 | -19.85714 |
| | Equal variances not assumed | | | -.416 | 19.116 | .682 | -19.85714 |

Table 19 lists the output results on the teacher-made posttest differentiated by gender in the experimental group. The Sig. value listed under the Levene's Test for Equality of Variances is .456. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by gender on the teacher-made posttest in the experimental group.

**Table 19**

*Teacher-Made Posttest Results by Gender in the Experimental Group*

**Group Statistics**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Teacher-Made Posttest | Male | 13 | 53.8538 | 10.16912 | 2.82041 |
| | Female | 9 | 57.4000 | 7.42041 | 2.47347 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Teacher-Made Posttest | Equal variances assumed | .578 | .456 | -.892 | 20 | .383 |
| | Equal variances not assumed | | | -.945 | 19.900 | .356 |

Table 20 lists the output results on the teacher-made posttest differentiated by socioeconomic status in the experimental group. The Sig. value listed under the Levene's Test for Equality of Variances is.778. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by socioeconomic status on the teacher-made posttest in the experimental group.

**Table 20**

*Teacher-Made Posttest Results by Socioeconomic Status in the Experimental Group*

**Group Statistics**

| | Lunch Status | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Teacher-Made Posttest | Free and Reduced Lunch | 8 | 57.5000 | 10.19496 | 3.60446 |
| | Regular Lunch | 14 | 54.0500 | 8.59407 | 2.29686 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Teacher-Made Posttest | Equal variances assumed | .081 | .778 | .847 | 20 | .407 |
| | Equal variances not assumed | | | .807 | 12.711 | .434 |

Table 21 lists the output score results differentiated by gender on the final CDT assessment in the control group. In Table 21, the Sig. value listed under the Levene's Test for Equality of Variances is .508. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by gender on the final CDT in the control group.

**Table 21**

*Final CDT Results Differentiated by Gender in the Control Group*

**Group Statistics**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| CDT Final | Male | 9 | 1037.0000 | 98.99495 | 32.99832 |
| | Female | 10 | 1103.6000 | 84.36192 | 26.67758 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| CDT Final | Equal variances assumed | .457 | .508 | -1.583 | 17 | .132 |
| | Equal variances not assumed | | | -1.570 | 15.855 | .136 |

Table 22 lists the output score results differentiated by socioeconomic status on the final CDT in the control group. The Sig. value listed under the Levene's Test for Equality of Variances is .773. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by socioeconomic status on the final CDT assessment in the control group.

**Table 22**

*Final CDT Results Differentiated by Socioeconomic Status in the Control Group*

**Group Statistics**

| | Lunch Status | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| CDT Final | Free and Reduced Lunch | 8 | 1097.6250 | 99.38660 | 35.13847 |
| | Regular Lunch | 11 | 1053.4545 | 92.34865 | 27.84416 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| CDT Final | Equal variances assumed | .086 | .773 | .997 | 17 | .333 |
| | Equal variances not assumed | | | .985 | 14.538 | .341 |

Table 23 lists the output score results differentiated by gender for the post teacher-made assessment in the control group. The Sig. value listed under the Levene's Test for Equality of Variances is .205. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in output scores differentiated by gender on the teacher-made posttest in the control group.

**Table 23**

*Teacher-Made Posttest Results by Gender in the Control Group*

**Group Statistics**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Teacher-Made Posttest | Male | 9 | 49.2667 | 9.68427 | 3.22809 |
| | Female | 10 | 61.3200 | 15.25151 | 4.82295 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Teacher-Made Posttest | Equal variances assumed | 1.740 | .205 | -2.028 | 17 | .058 |
| | Equal variances not assumed | | | -2.077 | 15.394 | .055 |

Table 24 lists the output score results on the teacher-made posttest differentiated by socioeconomic status in the control group. The Sig. value listed under the Levene's Test for Equality of Variances is .289. Since this value is above the 0.05 threshold, this revealed that there was not a statistically significant difference in scores differentiated by socioeconomic status on the teacher-made posttest in the control group.

**Table 24**

*Teacher-Made Posttest Results by Socioeconomic Status in the Control Group*

**Group Statistics**

| | Lunch Status | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Teacher-Made Posttest | Free and Reduced Lunch | 8 | 63.3250 | 15.42111 | 5.45219 |
| | Regular Lunch | 11 | 50.0000 | 10.22204 | 3.08206 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Teacher-Made Posttest | Equal variances assumed | 1.198 | .289 | 2.271 | 17 | .036 |
| | Equal variances not assumed | | | 2.128 | 11.375 | .056 |

**Discussion**

For both the mid-year and final CDT as well as the initial and final teacher-made assessments, there was not a statistically significant difference in output mean scores between the control and experimental group. The initial CDT result did demonstrate a statistically significant difference in mean scores comparing the control and experimental

group. In that particular case, the control group scored higher than the experimental group.

Within the experimental group, there were two output score results that demonstrated a statistically significant difference regarding socioeconomic status. The students who were non-economically disadvantaged scored higher than students who were economically disadvantaged on the initial and mid-year CDTs but not on the final CDT results. The initial and final teacher-made assessments did not show a statistically significant difference in socioeconomic status.

There were no statistically significant differences on any assessment used throughout this research project regarding gender in either the control or experimental group.

Table 25 is a compilation of the CDTs and teacher-made assessments that were analyzed and discussed in this research study. The individual table numbers are listed for ease of reference on the first column followed by the type of assessment that was demonstrated in the second column. The key criteria for all of these CDTs and teacher-made assessments was the Sig. value which is listed in the third column. If the Sig. value was under 0.05 in any assessment, then that would demonstrate a statistically significant event.

**Table 25**

*Summary Results for the CDTs and Teacher-Made Assessments*

| Table | Administration | Significance Value | Statistically Significant for this Assessment? |
|---|---|---|---|
| Table 6 | Teacher-Made Pretest Scores Differentiated by Gender for the Experimental group | 0.242 | No |
| Table 7 | Socioeconomic Difference within the Experimental Group for the Teacher-Made Pretest | 0.056 | No |
| Table 8 | Control and Experimental Group Mean Score Results for Teacher-Made Pretest | 0.89 | No |
| Table 9 | Initial CDT Mean Score Comparison for the Control and Experimental Groups | 0.027 | Yes |
| Table 10 | Initial CDT Scores Differentiated by Gender for the Experimental Group | 0.298 | No |
| Table 11 | Socioeconomic Difference within the Experimental Group for Initial CDT Scores | 0.032 | Yes |
| Table 12 | CDT Mid-Year Results for the Control and Experimental groups | 0.728 | No |
| Table 13 | CDT Mid-Year Results Differentiated by Gender in the Experimental Group | 0.76 | No |
| Table 14 | CDT Mid-Year Result Differentiated by Socioeconomic Status in the Experimental Group | 0.044 | Yes |
| Table 15 | Final CDT Results for the Control and Experimental Group | 0.745 | No |
| Table 16 | Teacher-Made Posttest Results for the Control and Experimental Group | 0.282 | No |
| Table 17 | Final CDT Results Differentiated by Gender in the Experimental Group | 0.746 | No |
| Table 18 | Final CDT Results Differentiated by Socioeconomic Status in the Experimental Group | 0.757 | No |
| Table 19 | Teacher-Made Posttest Results by Gender in the Experimental Group | 0.456 | No |
| Table 20 | Teacher-Made Posttest Results by Socioeconomic Status in the Experimental Group | 0.778 | No |
| Table 21 | Final CDT Results Differentiated by Gender in the Control Group | 0.508 | No |
| Table 22 | Final CDT Results Differentiated by Socioeconomic Status in the Control Group | 0.773 | No |
| Table 23 | Teacher-Made Posttest Results by Gender in the Control Group | 0.205 | No |
| Table 24 | Teacher-Made Posttest Results by Socioeconomic Status in the Control Group | 0.289 | No |

**Summary**

This section provided the analysis for the initial, mid-year and final CDTs regarding the control and experimental groups' mean scores. In addition, both the initial and final teacher-made assessments compared output mean scores for both the control and experimental group. Finally, the gender and socioeconomic status and their associated output scores were analyzed for both the control and experimental groups using CDTs and teacher-made assessments.

Moving into the next chapter, a number of conclusions will be drawn from the output score results derived from this section. The necessary recommendations regarding the practical implications of this project for the school will be outlined for consideration as well as a discussion on the limitations and future research within this field of study.

# CHAPTER V

## Conclusion and Recommendations

Since this project consisted of a quantitative study between two groups of students (control and experimental) there were numerous output results to analyze throughout the action timeline. Essential question #1 was whether instructional time increased academic performance. The data was triangulated on both teacher-made tests and on the CDTs. The two corollary questions this researcher analyzed related to gender and socioeconomic status and their respective academic scores for both sets of students.

Mathematics is a tool and a complex system used to justify real world scenarios and a proposed hypothesis. Probability is the projected outcome received for a specific set of occurrences. In all cases for this project, it was decided to use the independent samples *t*-test as the measure for probability and accuracy. The significance value listed under the Levene's Test needed to be under 0.05 indicating a high probability of variance between the two measurements or scores. Another way to state this fact is to declare that the outcome has more than a 95% probability of varying in output scores between the two data sets in question.

### Conclusion

For the difference in academic performance between the control and experimental group, the significant value was over 0.05 for both the final CDT test and the teacher-made posttest results. This indicates with a high degree of probability that there was not a statistically significant difference in the mean scores between the control and experimental group despite the latter having twice the instructional time. Therefore, the increased instructional time did not produce enough of a variance to declare that the

essential question was statistically significant and valid. In other words, increased instructional time does not lead to increased academic performance on both the teacher-made assessment and on the CDTs over the course of the school year as demonstrated in this particular research study. The one anomaly in comparing the control and experimental group results was in the initial CDT result which listed a Sig. value of .027 indicating that for the initial CDT the control group scored higher than the experimental group by a statistically significant degree. The mid-year and final CDT in addition to every teacher-made assessment did not show a statistically significant variance in output scores.

Research question #2 focused on the differences in academic performance differentiated by gender within a specific group of students. The distribution of gender within the experimental group was nearly uniform and was differentiated by this researcher prior to the start of the school year. The results from the SPSS program had a significant value greater than 0.05 on every teacher-made assessment as well as every CDT that was administered regarding output scores differentiated by gender. The conclusion from this researcher is that gender has no statistically significant factor in determining output mean scores for 9$^{th}$ grade students taking Algebra 1 at the CTC. No statistically significant variance in mean scores differentiated by gender was noticed in any assessment for the control group.

Research question #3 focused on the socioeconomic difference within a group of students and their academic performance. The baseline battery of tests that were run on the experimental group differentiated by socioeconomic status illustrated two instances where a statistically significant event had occurred. The first instance was noticed on the

initial CDT for the experimental group. The initial CDT results listed a Sig. value of .032 which revealed a statistically significant difference in output scores differentiated by socioeconomic status and that students who qualified as non-economically disadvantaged scored higher than students who were classified as economically disadvantaged in the experimental group. This correlation was not noted in the control group for any of the output scores.

The second instance was on the mid-year CDT result which listed a Sig. value of 0.044 indicating that there was a statistically significant difference in output scores differentiated by socioeconomic status in the experimental group and that students who were classified as non-economically disadvantaged scored higher than students who were classified as economically disadvantaged.

The output results from both the final CDT and final teacher-made assessment did not demonstrate a statistically significant difference differentiated by socioeconomic status. In other words, the significance value under the Levene's Test of Variance were all over 0.05 on both the final CDT and teacher-made posttest results. This was also consistent within the control group of students. Since there were conflicting output results regarding socioeconomic status and academic performance, no definitive conclusion can be delineated by this researcher.

**Recommendations**

Research Question #1: In what ways does providing increased instructional time in 9th grade Algebra 1 affect student achievement? This project demonstrated with a high degree of probability that increased instructional time does not increase academic performance for students in a 9th grade Algebra 1 class. The implication to the CTC and

upper level management is whether the use of instructional staffing for this initiative should continue or revert to a time when certain mathematical teachers did not teach math every day.

The academic growth for the experimental group over the course of the school year is demonstrated in Table 26. The initial mean score is listed at 946.6 and the final mean score was 1044.6. The percentage increase from the initial score to the final score is an increase of 10.3 % over the course of the school year.

**Table 26**

*Output Scores for the Initial and Final CDT in the Experimental Group*

**One-Sample Statistics**

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Initial CDT Scores | 22 | 946.55 | 122.305 | 26.076 |
| Final CDT Scores | 22 | 1044.6364 | 116.94913 | 24.93364 |

**One-Sample Test**

Test Value = 0

| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference Lower | Upper |
|---|---|---|---|---|---|---|
| Initial CDT Scores | 36.300 | 21 | .000 | 946.545 | 892.32 | 1000.77 |
| Final CDT Scores | 41.897 | 21 | .000 | 1044.63636 | 992.7840 | 1096.4887 |

In Table 27, the mean scores for the initial and final CDT tests is listed for the control group. The initial mean score is 997 and the final mean score is 1072. This is a percentage increase of 7.5 %. The difference between the experimental and control group in terms of raw mean score percentage is 2.8%.

**Table 27**

*Output Scores for the Initial and Final CDT in the Control Group*

**One-Sample Statistics**

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Initial CDT Scores | 19 | 997.26 | 72.590 | 16.653 |
| Final CDT Scores | 19 | 1072.0526 | 95.29572 | 21.86234 |

**One-Sample Test**

| | Test Value = 0 | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | |
| | t | df | Sig. (2-tailed) | Mean Difference | Lower | Upper |
| Initial CDT Scores | 59.884 | 18 | .000 | 997.263 | 962.28 | 1032.25 |
| Final CDT Scores | 49.037 | 18 | .000 | 1072.05263 | 1026.1216 | 1117.9837 |

Since this researcher has triangulated the data with all three essential research questions, it would be useful to continue this validation with the teacher-made assessments regarding academic growth. This would be analyzed by comparing the initial and final teacher-made assessments for both the experimental and control groups.

Table 28 lists the output score results comparing the initial and final teacher-made assessments in the experimental group. Under the One-Sample Statistics column, the mean scores are listed for both the initial and post teacher-made tests. The initial mean score is 32.73 and the final output score is 55.3. This is an increase of 69% in academic performance in the experimental group.

**Table 28**

*Output Scores for the Initial and Post Teacher-Made Test in the Experimental Group*

**One-Sample Statistics**

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Teacher-Made Pretest | 22 | 32.73 | 10.727 | 2.287 |
| Teacher-Made Posttest | 22 | 55.3045 | 9.12430 | 1.94531 |

**One-Sample Test**

| | Test Value = 0 | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | |
| | t | df | Sig. (2-tailed) | Mean Difference | Lower | Upper |
| Teacher-Made Pretest | 14.310 | 21 | .000 | 32.727 | 27.97 | 37.48 |
| Teacher-Made Posttest | 28.430 | 21 | .000 | 55.30455 | 51.2591 | 59.3500 |

Table 29 lists the output scores for the initial and post teacher-made tests in the control group. The initial mean score is 35.59 and the final mean score is 55.6.This is an increase of 56% in academic performance over the course of the school year.

**Table 29**

*Output Scores for the Initial and Post Teacher-Made Test in the Control Group*

**One-Sample Statistics**

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Teacher-Made Pretest | 19 | 35.59 | 10.475 | 2.403 |
| Teacher-Made Posttest | 19 | 55.6105 | 14.00781 | 3.21361 |

**One-Sample Test**

Test Value = 0

| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference Lower | Upper |
|---|---|---|---|---|---|---|
| Teacher-Made Pretest | 14.811 | 18 | .000 | 35.595 | 30.55 | 40.64 |
| Teacher-Made Posttest | 17.305 | 18 | .000 | 55.61053 | 48.8590 | 62.3621 |

The increase in academic performance in favor of the experimental group to the control group is less than 3% regarding the initial and final CDT results and 13% on the teacher-made assessments. This fact coupled with no statistically significant difference in mean scores comparing both the control and experimental groups leaves this researcher to recommend discontinuation of the double dose algebra at the CTC.

Research Question #2: What is the correlation with student's gender and Algebra 1 scores given increased instructional time? The results from the CDTs and the teacher-made tests demonstrate that there was not a statistically significant difference in academic

performance with increased instructional time regarding gender for both the control and experimental group. This researcher has no recommendation to implement a change in policy regarding academic performance differentiated by gender in any of the classes at the CTC.

Research Question #3: What is the correlation with socioeconomic status and Algebra 1 scores given increased instructional time? This essential research question was consistent throughout the initial and final teacher-made assessments for both the experimental and the control group: there was no statistically significant difference in mean score results differentiated on socioeconomic status. However, as noted in the results section, the initial and mid-year CDTs did denote a statistically significant difference in socioeconomic status within the experimental group and that students who were classified as non-economically disadvantaged scored higher than students who were classified as economically disadvantaged.

The fact that economically disadvantaged students scored lower on several of the assessments (initial and mid-year CDT) given throughout this action project is a serious consideration for educators not only at this CTC but across the educational spectrum. The CTC as well as countless other school districts receive federal and state subsidies for food and wellness nutrition and there are strict guidelines that must be adhered to for full compliance.

Since some of the output results indicated lower academic performance in relation to students classified as economically disadvantaged, ensuring that all of the students at the CTC receive a quality lunch may help close the academic achievement gap. However, as this researcher has personally seen over numerous years overseeing students at the

cafeteria, a large minority of students do not actively participate in the free/reduced lunch program even though they were classified as economically disadvantaged students. The belief on the part of this researcher was that it was sheer embarrassment that led many students who were economically disadvantaged to not participate in the lunch program. However, during the COVID-19 pandemic for the years 2020-2022, the opposite was proven to be true. Every child was entitled to receive a free lunch at the school yet anecdotal and visual evidence by this researcher had demonstrated that numerous students were not engaging in the nutrition program at the CTC.

This researcher had personally questioned numerous students who either ignore or obfuscate their answers when questioned as to why they would not eat their free lunch at school. A few students would state the quality of the food was not to their liking. Since this pattern has continued over the course of several years, the conclusion from this researcher was that there must be an embedded reluctance on the part of a number of students to not utilize the program whether through embarrassment or another reason. This is perplexing since students only need to reveal their identification number to acquire the meal and no other qualifier will distinguish their entrance in the program. This issue also translated into the breakfast program. Only a limited number of students were actively participating in the breakfast program whether they were economically disadvantaged or non-economically disadvantaged.

The implication for the CTC is profound and this researcher would recommend that upper-level management remove whatever barriers exist to increase the participation in the nutrition program. Whether this entails altering or enhancing the program, closing the academic achievement gap is a stated goal of all educators and if providing a

nutritious meal would help students academically, it should be a stated goal at the CTC and has this researcher's highest recommendation. There is not much that the school can do for dinner at a child's household but the other two meals are within the domain of the school and its personnel.

**Financial Implications**

The results from the initial research question #1 regarding academic performance with an increase in instructional time did not demonstrate a statistically significant difference on the final CDT nor on the post teacher-made assessment. As noted earlier, the recommendation from this researcher is to discontinue the action project and this policy.

The current financial implication to the CTC is null. In fact, there may be an added benefit in utilizing the staff members who were teaching the classes with increased instructional time to teach other classes which may save the school from hiring a math teacher in the future.

There were no financial implications regarding research question #2 to the CTC since gender had no statistically significant impact on academic performance as indicated on either set of output scores. This fact was demonstrated on both the experimental and control group and on every type of assessment used throughout this research project.

Students who were identified as being non-economically disadvantaged had a higher probability of receiving improved algebra scores at the 9$^{th}$ grade level compared to students who were identified as economically disadvantaged on the initial and mid-year CDTs. The financial implication to the CTC was negligible since students who were classified as economically disadvantaged generally received the federal nutritional

subsidy. As noted earlier, the issue is not documenting eligibility into the program but rather ensuring 100% active participation within the program at the CTC.

**Implications for Future Research**

This project lasted approximately 10 months in duration, which included the initial baseline, remediation and post analysis. The results demonstrated that there was not a positive correlation between increased instructional time and academic performance. In addition, supplying all children with a well-balanced lunch and breakfast may enhance or close the achievement gap between students who were non-economically disadvantaged and students that were economically disadvantaged. More research could be followed up with students who were identified as economically disadvantaged among other factors that could be limiting their academic growth such as discipline, health care, parental involvement, etc.

Since no statistically significant difference was found regarding gender and academic performance in either the experimental or the control group, continued research with that variable would most likely be unproductive.

Research that focuses on academic performance in relation to the time of the day would be a worthwhile endeavor. In a study performed by Williams and Shapiro (2018), the researchers noted significant variances in academic achievement for students attending afternoon classes compared to students attending classes in the morning. The researchers further posit that "classes starting 9 am or later are more favorable to student learning than earlier ones" (p. 169).

It would make an interesting longitudinal study to track students who were identified as economically disadvantaged as they traverse over the next three years at

high school. For example, examining whether students who were economically disadvantaged continue along the same trajectory or whether they move to a lower or higher academic level could be a worthwhile research study.

Further research that tracks and differentiates academic performance with students from specific school districts could also be worthwhile. Recall that this CTC has six sending school districts for the student body. There were four large districts and two smaller ones. A short-term study and a longitudinal experiment could be made on the different levels of mathematics that the various students from each sending district opt to take in the upper-level grades.

Lastly, the cohort of students in the control group were already exposed to a higher-level elective: Spanish, in their 9th grade year. It would be interesting to note if these same students proceeded with Spanish 2 in their 10th grade year in addition to other higher-level academic classes. The comparison could then be extended to the students in the experimental group who did not have Spanish and track what upper-level electives, if any, they would eventually take.

**Implications for Practice**

Since the recommendation from this researcher was to not continue or implement this project, there was no implication to the CTC. There may be a morale issue within the math department which were evenly divided on implication of this double dose of algebra when it was first introduced into the school. Some members of the math department were strongly opposed to the implication because it would require utilizing staff to instruct 9th grade algebra classes. The effect of this policy resulted in larger 10th grade classes for specific disciplines such as geometry and honors geometry. A stated goal of the math

department was to increase the state mandated Keystone scores. It was the belief that the additional instructional math time in 9th grade would benefit the students as they prepared to take the exams in late May. The conclusion and output data results was shared with the members of the math department who would form their own judgement as to practical implications for continuing or halting this policy.

**Limitations**

No experimental study is without some cause for concern or issue that may have tainted the results. As this researcher reflects upon the previous year and this project, several issues come to mind. First, the differentiation between the groups of students was done in a pandemic year. In prior years, administration relied on a battery of tests that incoming 9th grade students would come to the school and take. The tests were a strong indicator of where these 9th graders would be placed. For the 2021-2022 school year, administration relied on the students' prior school work, grades and counselor recommendations. Since this was consistent for all incoming students, the rationale was that it was uniform enough to be applied for this experiment.

Upon reflection, this researcher realized that to ensure data reliability a standardized test could have been performed prior to the start of the school year. At that point, the students could have been placed in a more homogenous mixture of control and experimental groups. The downside to attempting that policy would have been to alert all parents as to why the shuffling of classes was occurring for their children at the beginning of the school year and getting the required consent forms returned in a reasonable amount of time. It should be noted that it took a month in the beginning of this project to obtain 100% parental consent. Differentiating the students using a standardized test prior to the

school would be ideal but due to time constraints, it was not feasible. If this project took place during the students' 10th grade year, obtaining consent forms and a standardized assessment could have been implemented since the students would have been identified in advance by not only the 9th grade teachers but also their guidance counselors.

Another possible limitation for this study was in the timing of the control and experimental group throughout the school day. The control group was in the morning and the experimental group took place exactly after lunch. Whether or not the lunch time could have affected academic performance is debatable but it is reasonable to assume there may have been a contributing factor to the results, especially since the initial CDT results demonstrated a statistically significant difference in mean scores favoring the control group over the experimental group. In an ideal scenario, this researcher would have both groups instruct at the same time of the day. Since it was more important to have the same instructor, it was not feasible to process both classes at the same time.

In addition, the sample size for the control and experimental groups were not exact. This was a limitation on the delivery model at the school and much care was put into making the distribution as equitable as possible but a more robust sample would have the gender and sample size equitable and larger.

Lastly, to be truly consistent and equitable between the control and experimental group, the battery of exams such as the CDTs and teacher- made tests should be given in the same day. As this researcher analyzed the results and identified the timeline, there was considerable difference, often weeks, that separated the administration of these assessments to the students.

**Summary**

This project was instrumental in answering some of the questions that this researcher sought regarding increased algebraic instructional time and academic performance as well as differences in socioeconomic status and gender at the 9th grade level.

Prior to the start of the year, the overwhelming consensus from this researcher and his fellow administrators was that there would be a positive correlation with increased algebraic instructional time and academic performance. The fact that this did not prove to be a statistically significant event after academic remediation was perplexing. The two cases where the output results demonstrated a statistically significant difference in favor of socioeconomic status was not surprising and reinforces the concept that children need to be nourished in order to focus on academics.

The only way to be confident that a credible conclusion is reached when conducting a quantitative research study is to ensure the experiment was conducted with data reliability, triangulation and validity. This researcher is confident all those metrics were met during the research project, and the conclusion and recommendations arise from a source of credible data and analysis.

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# APPENDICES

## Appendix A

Parental or Guardian Permission Form for Research Involving a Minor

**Title of Project:** The Effect of Increased Algebraic Instructional Time in a Career and technical High School

**Researcher(s):** Robert S. Azar – Principal, Bucks County Technical High School

**Purpose of the research:** The purpose of this study is to explore the effectiveness of having mathematical instruction on both sides of our rotation- technical and academics for students in their freshmen year taking Algebra 1.

**Procedure to be followed:** The procedure is to give students who are in Alg 1 daily and students in Alg 1 Academic a pretest in the beginning of the year and then a posttest and diagnostic test at the end of the year. Then, we will analyze whether increased instructional time for the students in Alg 1 daily resulted in higher scores compared to students in Alg 1 Academic.

**Discomforts/risks:** The risks in this study are minimal, no greater than those ordinarily encountered in daily school life or the routines of the average high school student. There are no foreseeable discomforts or dangers to your child in this study.

**Incentives/benefits for participation:** There is no direct benefit to the student from being in this study, but the analysis of their assessment data may help the researcher and district personnel better understand what methodology and resources best fit the learning styles of our 9th grade students taking algebra and if a modification needs to be made for future students.

**Time duration of participation:** Participation for the students require no additional time than normally spent during class.

**Statement of Confidentiality:** All records are kept confidential and will be available only to professional researchers and staff. If the results of this study are published, the data will be presented in group form and individual children **will not** be identified.

**Voluntary participation:** Your child's participation is voluntary. If you feel your child has in any way been coerced into participation, please inform the faculty advisor.

Questions regarding participation and/or research should be directed to: **Robert S. Azar-Principal**, BCTHS 215-949-1700

**Parent Signature Box**

I, the parent or guardian of _____, a minor _____ years of age, permit his/her participation in a program of research named above and being conducted by Robert S. Azar.

_____ _____

Signature of Parent or Guardian Date

_____

Please print your name here

**Student Signature Box**

I, _____, agree to participate in the program of research named above and understand that my participation is voluntary.

_____ _____

Signature of Student Date

_____

Please print your name here.

Signature of Investigator _____ Date_____

## Appendix B

IRB Approval Letter

Institutional Review Board
California University of Pennsylvania
Morgan Hall, 310
250 University Avenue
California, PA 15419
instreviewboard@calu.edu
Melissa Sovak, Ph.D.

Dear Robert,

Please consider this email as official notification that your proposal titled "The Effect of Increased Algebraic Instructional Time in a Career and Technical High School" (Proposal #20-048) has been approved by the California University of Pennsylvania Institutional Review Board as submitted. The effective date of approval is 8/23/21 and the expiration date is 8/22/22. These dates must appear on the consent form.

Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)

(2) Any events that affect the safety or well-being of subjects

(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).

(4) To continue your research beyond the approval expiration date of 8/12/22 you must file additional information to be considered for continuing review. Please contact instreviewboard@calu.edu

Please notify the Board when data collection is complete.

Regards,

Melissa Sovak, PhD.

Chair, Institutional Review Board