Master of Science in Mathematics   College of Arts & Sciences

Spring 2024

An Exploratory Study: Determining Significant Predictors of Academic Success on the Ohio State End of Course Assessment in Algebra 1 for Students with Learning Disabilities and Students Identified as Gifted

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An Exploratory Study: Determining Significant Predictors of Academic Success on the Ohio State End of Course Assessment in Algebra 1 for Students with Learning Disabilities and Students Identified as Gifted

A Thesis

By

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and

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Submitted in partial fulfillment of the requirements

for the degree of

Master of Science, Mathematics

Date

June 18th, 2024

Accepted by the Graduate Department

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Graduate Director, Date

The thesis entitled "An Exploratory Study: Determining Significant Predictors of Academic Success on the Ohio State End of Course Assessment in Algebra 1 for Students with Learning Disabilities and Students Identified as Gifted" **presented by** Nicholas Sesonsky and Jonathan McCullough, **candidates for the degree of** Master of Science in Mathematics, **has been approved and is worthy of acceptance.**
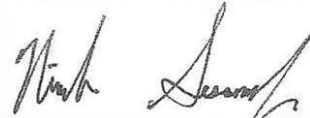
06/18/2024

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ABSTRACT

Since the COVID-19 pandemic, hybrid and online instruction have become more prominent formats in the educational system. This study aimed to focus specifically on students with learning disabilities and students who are identified as gifted. Based on these two subpopulations and prior literature, instructional method, class size, attendance rate, and prior academic performance were selected as potential impactful measures of students' academic success. Academic success for this study was based on the Algebra 1 Ohio State End of Course Assessment while prior academic performance was based on the Seventh-Grade Ohio State End of Course Assessment, and Ohio's School Report Card Data was used for class sizes and attendance rates. Seven Northeast Ohio high schools were involved in the study: four hybrid, one traditional, and two online format schools for a total sample size of 526 students.

The logistic regression analysis results indicated that the Hybrid instructional method was a statistically significant predictor of academic success on the Algebra 1 Ohio State End of Course Assessment. Additional results indicated that class size and prior academic performance were statistically significant predictors of academic success on the Algebra 1 assessment. While attendance rate was found to have no impact on the fit of the model for the data of this study and was therefore removed from consideration. The findings of this analysis contribute to prior literature for both student populations within different instructional methods, class size, and prior academic performance. The researchers acknowledge the limitations of this study, including lack of diversity in school district location, identification of IEP and gifted students, accommodations for both student populations, and instructional method in previously assessed grades. Overall, the results provided implications for Northeast Ohio secondary school districts regarding the most beneficial classroom environment for students with learning disabilities and gifted students.

ACKNOWLEDGMENTS

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CHAPTER I INTRODUCTION

Chapter One will provide the setup and procedures utilized to carry out the research study of this thesis, which analyzed the significance of instructional methods on academic success for two student populations. The main goal of this research was to determine which instructional methods, traditional, hybrid, or online, have the most significant impact on the academic success of students with learning disabilities and gifted students. Additionally, this study included class size, attendance rate, and prior academic performance as other predictor variables. Throughout Chapter One, a brief discussion of prior literature that guided the current study will be conducted including information regarding both student populations, class size, attendance rates, and prior academic performance while considering all instructional methods. Moreover, the significance, aim, and theoretical framework that ushered this research study's layout will be mentioned in great detail. Ultimately, the chapter will conclude with a breakdown of the research questions, variables, data collection, and research design that were crucial to this thesis.

INTRODUCTION

The purpose of this study is to analyze the impacts that instructional methods

(Traditional, Hybrid, Online) have on students with learning disabilities currently on an IEP:

Individualized Education Plan and on students who have been identified as gifted that currently

obtain a WEP: Written Education Plan (i.e students on the accelerated pathway) in terms of

academic success. Students' Ohio State End of Course Assessment Scores in Algebra 1 were

utilized to determine success rates within each instructional method, as well as other predictors,

including attendance rate, class size, and prior performance. Prior performance was utilized as a

covariate by examining Ohio State End of Course Assessment data from third-, fifth-, and

seventh-grade mathematics courses. This was used as a benchmark to help measure success. The

significance of this study is that the results can help the districts involved better prepare teachers

for the instruction of such students. The results provided precise data on which instructional

methods are most effective for students identified in either of the two categories, IEP or WEP,

and how other factors of the classroom environment impact student success. Prior studies have

analyzed the entire student population regarding academic success and the impact of various

factors such as gender, SES, parents' educational background, attendance, class size, etc. The

current study focused on a specific part of the student population and how such factors, as listed

above, affect student academic success.

BACKGROUND OF THE PROBLEM

Over the past several years, much research has been conducted on the impact of

instructional methods on student learning and academic success. During and after the COVID-19

pandemic, academic studies became essential to determine how social isolation and different

instructional methods or platforms affected students and academic performance. According to current research on the impact of instructional methods, "Course design and preparation play an important role in student learning" (Bir 2019, 3). Additionally, current research has indicated "The way in which the course material is presented to the students is an important aspect for student learning" (Bir 2019, 3). However, current research has focused on the student population as a whole with predictive factors such as gender, SES, and class rank to examine the comparison between traditional, hybrid, and online instructional methods. Based on the results of one such study, there was no significant difference in student performance between traditional face-to-face and online instructional methods for the general student population overall when considering predictive variables of gender and class rank (Paul and Jefferson 2019, 1).

The research study of conversation sought to examine subpopulations of the general student body by examining students with learning disabilities currently possessing an Individualized Education Plan (IEP) and students identified as gifted currently possessing a Written Education Plan (WEP) indicating each student's areas of accelerated learning. These two subpopulations are often viewed as the lower achieving population when considering the students with learning disabilities on an IEP and the higher achieving population when considering the students identified as gifted on a WEP. This research aimed to examine the impact of the instructional methods (Traditional, Hybrid, Online) on these two subpopulations' academic success in high school mathematics courses based on the Ohio State End of Course Assessment in Algebra 1. Other predictor variables were incorporated into the study to determine classroom factors that may impact student learning. These predictors included attendance rate, class size, and prior academic performance on Ohio State End of Course Assessments in third-, fifth-, and seventh-grade mathematics.

The following are prior literature resources that examined one or multiple predictors and at least one of the two subpopulations for the current study. The subpopulations are students with learning disabilities and students identified as gifted. The predictors are class size, attendance rate, and prior academic success. These resources have guided the outline for this study and include the significant contributors to the educational research regarding the predictors and subpopulations.

Profoundly Gifted Students' Perceptions of Virtual Classrooms

A significant contributor regarding gifted students within the online instructional method is Jessica Allen Potts, whose work has been cited over ninety times in various other studies, as it examined the benefits of online instructional methods for students identified as gifted. The study determined multiple benefits of the online platform for these students, including homogeneous grouping, easily accessible course materials, the ability to challenge students with more complex materials, the ability to work at one's own pace, and rigor of course content. This study identified homogeneous grouping as the most beneficial part of the online instructional method, as gifted students are more capable of being grouped with students of similar ability levels. The second most helpful aspect of the online instructional method for these students was the ease of access to course material and the ability to use the internet to access additional material to challenge one's thinking processes. However, the study also found issues related to gifted students in the online instructional method, which may be alleviated through the traditional or hybrid instructional methods. One of the most notable challenges indicated by gifted students was the difficulty of communication with the instructor. These students identified email communication as unreliable regarding question and answer dialogues as this format often took too long and resulted in frustration. Additionally, the online platform provided opportunities for distraction amongst the

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students, resulting from continuous access to the internet, which led to getting off topic. The primary result of this study was that the instructor played a considerable role in the education of gifted students, and gifted students actually identified a preference for teacher-led instruction.

Factors Affecting Learners With Disabilities–Instructor Interaction in Online Learning

In terms of online instruction for students with learning disabilities, two major contributors are Abdulrahman Alamri and Tandra Tyler-Wood, whose work has been cited over 100 times in a variety of research studies. This study focused on the second population for the current research plan, which is students identified with a learning disability. The study indicated that students with disabilities often learn at slower rates, need additional time to complete tasks successfully and require differentiated material to be successful with content. Within this study, the researchers cite prior research that indicated students with disabilities are more likely to enroll in online courses than other students. A significant reason for the student's decision was the ease of communication via email and chat rooms with instructors and other students. As students with disabilities often struggle to communicate face to face, this option is more beneficial, and this study indicated that it enables these students to control sensory overload and create consistent routines based on course agendas. Within this article, the researchers cite prior literature that found no significant difference between students with disabilities and students without disabilities in terms of academic performance in online courses. This article also indicated that students with disabilities preferred the online platform due to the opportunity to work at one's own pace. However, the article also confirmed that the social interaction between student and teacher was crucial in producing academic achievement. Thus, the issue of interaction between students and teachers in the online platform may be cause for concern as students with disabilities often require intervention. As the online format often reduces the

amount of interaction, this may be cause for concern as students with disabilities often need additional support.

Exploring Online Activities to Predict the Final Grade of Student

Silva Gaftandzhieva and her partners have been extremely influential in examining the impacts of online instruction on students' final grades. This study investigated how lectures, assignments, and attendance affected academic success. The study found that academic performance was significantly related to all of the aforementioned. The study found that students who attended the lecture portion of the lesson obtained a good academic performance rating at an overwhelming rate. Thus, this indicates that the teacher plays a huge role in student learning. As communication within online platforms is oftentimes complicated, the traditional or hybrid methods may be more beneficial for the two subpopulations of the current research study. Additionally, this study investigated the impact that attendance had on academic performance. The findings of this study were that student attendance is significantly related to academic performance, with students attending more than sixty percent of the time achieving the best academic grades.

Class size, class composition, and the distribution of student achievement

With over 120 citations, Ryan Bosworth's study involving class size and the link to academic performance has been a major component of past educational research. This study investigated the impact of class size on academic performance and other classroom factors. As the two subpopulations of the current study often require more attention from the instructor, the case of class size is of utmost importance in this study. Much research has indicated that students identified as gifted find instructor-led courses more challenging and provide a level of complexity that satisfies the student's needs and learning preferences. In terms of students with

learning disabilities, many studies have indicated that these students often require intervention, scaffolding, and differentiation to be successful. Thus, class size could play a huge role in student success for these two subpopulations, as smaller classes allow for more interaction with the teacher. This study found that a one student decrease in class size led to a relatively small increase in mathematics test scores. The study also indicated that class size changes will not benefit all students equally and may benefit the two subpopulations of the study at hand differently. The study found that a decrease in class size had a more profound effect on the standard deviation of student achievement than on average achievement. Overall, the study helps to identify that smaller classes may benefit the current study's subpopulations as the decrease in class size provides more time for interaction, leading to the attainment of material and closure of achievement gaps.

Examining Predictive Factors For Student Success In A Hybrid Learning Course

When discussing the hybrid learning model and factors that may predict student success, Enoch Park and constituents have made a large impact on the field with over forty citations within a multitude of educational studies. This study investigated the impact of prior academic performance on students enrolled in online courses. Based on the results of this study, it was clear that lower-achieving students performed more adequately in face-to-face settings. In contrast, higher-achieving students performed better in a hybrid setting. However, this article cited additional research that indicated lower achieving students showed more growth and gap-closing within the hybrid instructional method. The study conducted a linear regression model which indicated statistical significance at the .05 level for prior academic performance and final grade. However, the study indicated that prior student performance is more relevant in predicting academic success rather than the instructional method in which the success occurs.

This study also investigated the overall participation of lower and higher-achieving students. The study found that even when lower achieving students participated fully, the group was still more likely to be less successful based on final grades than the higher achieving counterparts. Thus, this study is extremely relatable to the study of discussion as prior Ohio State End of Course Assessments were utilized as a covariate regarding academic success.

An Examination Of High School Student Success In Online Learning

Another major contributor to the online instructional method is Gina Eaton, who examined the impact this method had on the student population as a whole. This study explored the impact of online learning for students who reside in Northeast Ohio. Four school districts were examined, with a total of 214 high school students in grades 9-12 creating this research study's population. These students were enrolled in online courses to earn credits toward graduation. The researcher is interested in the association between learner characteristics and student success. Online learning is becoming an increasing presence in the world of academia. Analyzing the effectiveness of online instruction from prior research has given inconsistent results. Therefore, to examine the impact of online instruction, this study explored the course completion rates with various learner characteristics of high school students. The results of the study revealed some significant findings regarding gender, older students (seniors in high school), and grade level (students at grade level, not over age). Students in upper-grade levels and females tend to be more successful in completing online coursework. More tests revealed that students at grade level were about fifteen percent more likely to complete online work. Other findings have shown that Black students were not statistically likely to complete online courses when compared to Non-Black students. These findings also follow students who are over and under-credited. The learner characteristic that was observed in the results pertained to

self-efficacy, as students categorized in the above areas had low self-efficacy, which contributed

to the success rate of completing high school through online coursework. The researcher

concluded that this study could help develop professional training for teaching staff, the

influence of age and gender in online environments, achievement gaps in virtual learning, and

the effectiveness of digital settings on students.

Effective Teaching Strategies for Students with Learning Disabilities in Inclusive Classroom: A Comparative Study

Obaid Sabayleh and colleagues contributed considerably to educational research

regarding students with learning disabilities and classroom strategies for accommodations. This

study examined the effect of two different teaching methodologies on students with learning

disabilities. The two methodologies used in the study are Behaviorism and Constructivism. Both

were used on two groups of students who were identified with learning disabilities. To measure

student success, the researcher used pre- and post-tests. The statistical analysis performed on the

test results involved paired t-tests using SPSS. A quick review of both methodologies, a

Constructivism methodology supports students in using experiences to help construct one's

knowledge. Connecting to the theoretical framework, Connectivism is a branching idea from

Constructivism. Connectivism will allow students to create a network of knowledge using

individual learning experiences. The second methodology, Behaviorism, focuses on students

using behaviors learned and reinforced in class that eventually lead to action. Based on the

study's results, it was concluded that a Behaviorist strategy did not yield beneficial effects for

students with learning disabilities. The students who received instruction with

Constructivism-based strategies had better post-test results. Using real-life exposure as a

teaching strategy yielded a productive classroom. This result supports part of the findings from

the theoretical framework. It can be inferred that students with learning disabilities will learn

concepts more easily when constructivism-based strategies are employed. The alternative to this is traditional pedagogical techniques. These techniques are more teacher-centered and have the teacher being the only source of information. In this study, that approach did not have a large positive impact on test scores.

Online self-paced high-school class size and student achievement

When examining online instruction and the connection to class size, Chin-Hsi Lin and partners have made major contributions to educational research with over thirty-five citations in other studies. This study examined the effect of class sizes on online instruction. The sample size for this study involves 12,032 students in 233 courses in six subjects taught by 155 teachers during the 2013-2014 school year. The school selected for this study was in the Midwestern part of the U.S. The main questions addressed in this research analyzed the optimal class size in each subject and all subjects for self-paced courses at a high school level. In prior research, it has been noted that small class sizes generally lead to a higher level of student-teacher interactions. Student achievement is higher when the average classroom size is small. However, this study addresses that overemphasizing the positive effects of small class sizes is not recommended in prior research. It has been shown that the relationship between class size and student achievement is not always linear. The students enrolled in these online courses had different reasons for attending. Some of the reasons stated in the study pertained to a student's learning preferences, credit recovery, and scheduling conflicts. The study results showed a non-linear relationship between class size and final grade. It was a reverse-U shape relationship. The class size associated with the best student performance was forty-five students. For a math course, the optimal class size was thirty-eight students. If the class size was larger than thirty-eight, the final grades and student performance started to decrease. Relating to the study at hand, the effects of

class size with three different instructional methods were examined. It may be possible that larger class sizes in a traditional instructional method have a negative effect on student achievement. In contrast, the reverse could be said with online schools. Since the study focused on student populations that are on the extremes of academic ability, class size might have a different effect than what was seen in the prior study. Typically, students with learning disabilities will perform better with a smaller class size, which is usually an accommodation.

Summary of the Prior Literature

The above literature has guided the focus of the current study as the results of prior research have indicated many driving factors behind the success of students, specifically students with a learning disability and students identified as gifted when immersed in varying instructional methods. In terms of students with learning disabilities, past research has provided evidence that these students require more intervention to reach success, and these students performed most adequately in the traditional setting. Still, research also indicated that these students preferred online instruction due to the ease of communication when not in a face-to-face setting. With this population in mind, research regarding the impact of class size was inconclusive. Thus, the current study planned to examine how different instructional methods and class sizes would impact students with learning disabilities in terms of academic success, hoping to produce irrefutable results. Regarding the gifted population, prior studies have indicated that these students value the teacher's intellect and prefer teacher-led instruction. Still, additional research concluded that the higher-achieving population performs best in the hybrid classroom. With this population in mind, research has supported both larger and smaller class sizes for various reasons, regardless of instructional format. Therefore, prior research has examined this population with numerous variables, producing mixed results. Thus, the study of

discussion examined the effect that instructional methods and class sizes have on students identified as gifted to produce more consistent results. Additionally, nearly all prior research has supported the conclusion that prior academic performance has a clear relationship with current academic success. Most studies simply identify lower, middle, and higher-achieving students and how each maintains that status throughout each year of education. Thus, the current study planned to specifically address how the two populations, students with learning disabilities and gifted students, prior performance on Ohio State End of Course Assessments related to current performance instead of categorizing these groups as lower and higher-achieving students. Finally, attendance has been a huge topic of many research studies, with nearly all studies concluding that higher attendance leads to greater success. However, most prior research has not discussed the attendance rates when considering student subpopulations. Therefore, the study at hand examined how attendance rates impact academic success for students with learning disabilities and gifted students.

PROBLEM STATEMENT AND SIGNIFICANCE OF THE STUDY

The problem that this research study addressed was the academic success of specific student populations, namely students identified with a learning disability and students identified as gifted, based on instructional methods utilized to present course material. The majority of past research has focused solely on the academic success of the general student population as a whole based on instructional methods while considering factors such as race, gender, and socio-economic status. However, when investigating the general student population, many student subpopulations are often excluded because of identifiers that list such students within a specific population. Therefore, students with learning disabilities and gifted students have

minimal data regarding best practices for academic success. Thus, this thesis sought to specify the impacts of instructional methods on academic success for students with learning disabilities and students identified as gifted while considering additional factors of attendance, class size, and prior academic performance.

This study is significant because the outcomes can provide specific information to the school districts involved and Northeast Ohio schools in general on the best practices for educating the student populations of the learning disabled and the accelerated students identified as gifted. This research can also provide information regarding classroom factors and prior education that could potentially impact student success within the instructional methods. The current study provided meaningful data to school districts located in Northeast Ohio. These districts can use this data to improve pedagogical techniques and intervention strategies that positively impact academic success in these two student subpopulations.

PURPOSE OF THE STUDY

The purpose of the current research was to specify the impacts of instructional methods on academic success for students with learning disabilities and students identified as gifted while considering additional factors of attendance, class size, and prior academic performance. The study sought to determine the instructional method for IEP and/or WEP students that positively impacted academic success on the Algebra 1 Ohio State End of Course Assessment. Academic success for a student identified as gifted was a test score of 725, and academic success for a student with an IEP was a test score of 684 on the Ohio State End of Course Assessment for Algebra 1. These scores were determined based on the threshold scores for levels of proficiency defined by the Ohio Department of Education. The Ohio Department of Education defines a

score of 684 as proficient in the course material, and a score of 725 is defined as accelerated. Additionally, this thesis investigated the potential impact of class sizes and school attendance rates on student test scores. Finally, this study examined if prior proficient test scores on Ohio State End of Course Assessments in third-, fifth-, and seventh-grade mathematics courses were reliable predictors of student test scores on the Algebra 1 Ohio State End of Course Assessment.

PRIMARY RESEARCH QUESTION

Is instructional method (Traditional, Hybrid, Online) a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 when considering students on Individualized Education Plans (IEPs) and students on Written Education Plans (WEPs)?

Secondary Research Questions

1. Is class size a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 for IEP and/or WEP students?

2. Is attendance rate a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 for IEP and/or WEP students?

3. Is prior performance a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 for IEP and/or WEP students?

Variables

The goal of this study was to predict academic success based on the Algebra 1 Ohio State End of Course Assessment from instructional method (Traditional, Hybrid, Online), class size, and attendance rate when controlling for prior academic success on Ohio End of Course Assessments in third-, fifth-, and seventh-grade mathematics. These variables were selected

based on prior research, which indicated inconclusive results regarding the impact of instructional methods, class size, attendance rate, and prior academic performance on current academic success. Based on the assumptions for this study and the largest number of subjects, the Hybrid instructional method was set as the reference category for the instructional methods predictor variable. The assumptions also supported below average as the reference category for the class size predictor variable and met the state criteria, indicating higher attendance rates for the attendance rate predictor variable.

Thus, the variables for the study were as follows:

Dependent (Response) Variable:

(Y): Algebra 1 Ohio State End of Course Assessment

Independent (Predictor) Variables:

(X1): Instructional Method (Hybrid, Traditional, Online)

(X2): Class Size (Below Average, Above Average)

(X3): Attendance Rate (Met State Criteria, Did Not Meet State Criteria)

Covariate Variables:

(X4): Third Grade Math Ohio State End of Course Assessment

(X5): Fifth Grade Math Ohio State End of Course Assessment

(X6): Seventh Grade Math Ohio State End of Course Assessment

RESEARCH DESIGN

Data Collection

The research for this study was conducted based on data collected from seven school districts in Northeastern Ohio. The districts involved in the study included a mixture of

traditional, hybrid, and online platforms. Additionally, the school districts included a wide range

of characteristics from rural to suburban and high SES to low-middle SES. Within this study,

there was one school district with a traditional format and four school districts with a hybrid

format. These schools were Austintown School District, Beaver Local School District, Canfield

School District, Columbiana Exempted Village School District, and Southern Local School

District, all located within Mahoning and Columbiana Counties in Northeast Ohio. There were

two online schools located in Northeast Ohio, namely Virtual Learning Academy in Jefferson

County and Utica Shale Academy in Columbiana County. The researchers contacted each district

involved in the study to receive approval for the requested data. Each district provided the data

based on the Ohio Department of Education's released information. The data was collected from

each school district involved for the 2022-2023 school year's data release provided by the Ohio

Department of Education for eleventh and twelfth-grade students during the current 2023-2024

school year. School districts listed in the research design collected data from the Algebra 1,

third-, fifth-, and seventh-grade mathematics assessments for the aforementioned student

populations. Data was collected from Access, a data acquisition site that collects assessment data

and student demographic information. It also lists students who were identified as gifted or

having a learning disability. Any student identifiable information was deleted from the data

before it was collected, and no student educational records were released as part of the study.

In addition to Ohio State End of Course Assessment Scores, each school district's class

size and attendance rate were collected from Ohio's School Report Cards. School data from these

reports was from the 2022-2023 school year.

The sample population for this research study was students identified with a learning

disability who tested under Ohio State Tests standard conditions based on each Individualized

Education Plan (IEP) and disability codes. Additionally, the sample population included students identified as gifted who currently possess a Written Education Plan (WEP) indicating the areas of accelerated learning. The students were current eleventh and twelfth-grade students from a school district located in Northeastern Ohio. The sample size was n = 526 students from the seven school districts. The data for this sample population was from the 2022-2023 school year. Using the previous year's data ensured that all students involved had taken all Ohio State End of Course Assessments that were analyzed within this study. This study examined the Ohio State End of Course Assessments for the following mathematics courses: Algebra 1, Seventh Grade, Fifth Grade, and Third Grade.

Thus, this study sought to generalize to the entire population of high school students identified with a learning disability who currently possess an Individualized Education Plan (IEP) that test under standard conditions for standardized mathematics testing and students identified as gifted who currently possess a Written Education Plan (WEP) for school districts located in Northeastern Ohio.

Reliability and Validity

The research proposed for this study utilized a state-recognized assessment device, the Ohio State End of Course Assessments. The following describes the reliability and validity of those assessments.

The reliability of the Ohio State End of Course Assessments goes back to the adoption of Ohio's Learning Standards in English and Mathematics in 2010 as part of a multi-state effort. These tests are designed to measure the progress of student achievement toward the Ohio Learning Standards. These standards are addressed and tested in grades three to eight and high school. Each grade a student is tested in will have a subscore representing each subject's learning

standards. For example, eighth-grade math subscores will target Expressions and Equations, Functions, Geometry, The Number System, and Modeling and Reasoning. These assessments are fixed and administered in an online format (Paper format as an accommodation for special circumstances). Each question pertains to the individual subject and is then connected to Ohio Learning Standards.

Regarding the validity of the Ohio State End of Course Assessments, the Ohio Department of Education created Content Advisory and Rubric Validation committees. These committees include educators, content specialists, and other stakeholders in the education of Ohio students to ensure that Ohio State End of Course Assessments are valid forms of assessment for each student. There is a committee responsible for each assessment, and the members of each committee include a majority of classroom teachers from a wide range of school districts across the state of Ohio. These committees meet regularly to examine new test questions for the assessment bank and materials associated with specific test questions or content. The committee members examine these test questions to ensure each accurately assesses Ohio's Learning Standards for each grade level and subject area. Additionally, the committee members report to the Ohio Department of Education to ensure that every assessment question has appropriate Depth of Knowledge (DOK) for the grade level of each assessment and to ensure that the content that is assessed is accurate for the subject as well as clearly written for ease of understanding based on grade level abilities. After state testing, the committee reconvenes to examine the students' responses from the machined scored test items embedded in the online field test for each assessment year. This meeting is designed to ensure that the machine accurately scores test items. If any issues arise, the committee has the right to change the field test scoring rubric to clarify certain test items and ensure the validity and reliability of each

field-tested question.

Data Analysis and Software

This study used multiple regression techniques to analyze the data collected from the seven school districts. The data was organized using zeros and ones to indicate if a student had achieved or met the criteria for a particular variable. Students who achieved academic success based on the cutoff values of 684 and 725 are coded as one. Any student with a zero value indicates failure of academic success as it pertains to the response variable, Y. Additionally, Hybrid was set as the reference category for the instructional method variable, X1. Students identified as having an IEP or WEP were coded as YES. Any student coded as NO indicates that the student did not match this criteria. Class sizes and attendance rates for each school district were obtained from Ohio State Report Cards for the 2022-2023 school year. Furthermore, class size was categorized into two levels: below average and above average, while attendance rate was categorized into two levels: met the state criteria and did not meet the state criteria. With these categorizations, below average was set as the reference category for the class size variable, X2, and met the state criteria was set as the reference category for the attendance rate variable, X3. School districts were lettered A - G. Any student data with two or more missing test scores from third, fifth, and seventh grades were excluded from the data set. For any student with one missing test score, a mean from the other two test scores was used to calculate that missing value.

All statistical calculations performed in this study were computed with the statistical package R, version 4.3.0 (2023-04-21). These calculations included descriptive statistics, logistic regression models, graphs, and tables.

R Core Team (2023). R: A Language and Environment for Statistical Computing. R

Foundation for Statistical Computing, Vienna, Austria.

https://www.R-project.org/.

A multiple regression analysis was used to decide if traditional, hybrid, or online instructional methods impact student academic success. Descriptive statistics are given for each student population (students with an IEP or WEP) and instructional method associated with each school district. The quantitative variables, which have either been dichotomized or categorized, in the model were from third-grade math, fifth-grade math, seventh-grade math, and Algebra 1 test scores on Ohio State End of Course Assessments, class size, and attendance rate. The categorical variables in the study were instructional methods (traditional, hybrid, online), student population (students with an IEP or WEP), and school districts (lettered A- G). The sample size for the study was n = 526 students. The predictors for the model were traditional, hybrid, and online instructional methods, class size, and attendance rate. The covariates for the model were student test scores on third-, fifth-, and seventh-grade Ohio State End of Course Assessments in mathematics. A 95% confidence interval was calculated for each student population. Any statistical result was considered significant for p-values below .05.

ETHICAL CONSIDERATIONS

An exempt IRB application was completed and approved by Shawnee State University's Institutional Review Board for this study. Both researchers completed PHRP, Protecting Human Research Participants, training as part of the IRB application process, ensuring that the researchers understood the obligations for research involving human subjects.

As no student-identifiable information was obtained or released during this study, there are no ethical issues involving the two subpopulations. Additionally, as no student-identifiable

information was obtained or released during this study, there are no ethical issues involving the educational standing of any student. Regarding the school districts involved in the study, the district name was not associated with any student in the release of the data analysis. Thus, the reputation of each school district was not harmed as a result of this analysis. The researchers have identified the district from which each student was from as a means to report the findings of the study to each district, but a district comparison was not conducted to alleviate ethical concerns regarding district reputation.

THEORETICAL FRAMEWORK

Situated Cognitive Learning Theory (The Cognitive Apprenticeship Model)

One theoretical framework for this study was the Situated Cognitive Learning Theory, developed by Brown, Collins, and Duguid, which states that students must be presented with problems from an expert and work through the problems together as if the students were experts. The teacher, or expert, acts as a coach to facilitate the lesson instead of a lecturer. However, the teacher is still responsible for scaffolding the materials to meet all students' needs. The classroom environment must provide reflection, discussion, and critical thinking opportunities to enable active student engagement. This form of instruction is difficult to achieve for all lessons, but technological advancements have broadened the opportunities for this type of instruction. Situated Cognitive Learning Theory focuses on the classroom environment and the method by which students acquire information. This theory indicates the importance of the situations surrounding knowledge development in the classroom, which ultimately results in academic success based on understanding. The theory defines cognitive knowledge as a set of tools that students can acquire but may only be fully understood once the knowledge is used. According to

Brown, Collins, and Duguid, "Instead, it may be more useful to consider conceptual knowledge as, in some ways, similar to a set of tools. Tools share several significant features with knowledge. They can only be fully understood through use, and using them entails both changing the user's view of the world and adopting the belief systems of the culture in which they are used" (Brown et al. 1989, 303). Therefore, the theory focuses on student interaction with the cognitive knowledge and with other students to become experts in understanding the content, leading to academic success with increasingly more complex problems involving the application of such knowledge. Situated learning supports the questions of the current study as it focuses on multiple formats of learning material, from teacher presentations to student collaboration with technology and other students to student discovery through individual investigation.

Situated Cognitive Learning Theory also has a component that focuses on the interactions and relationships that students build with each other to develop an understanding of the material. Students must work together through collaboration with one another and with prior material to develop the knowledge required to master the lesson material. Situated learning requires all students to engage in group collaboration utilizing prior knowledge and requires each student to create differentiated thinking to consider the knowledge of others. This theory supports the selection of the two student populations, students with disabilities (IEP) and students identified as gifted (WEP), because oftentimes students with disabilities struggle to work within group settings, and students on the accelerated path often are unengaged when group members lack a higher level of understanding.

The Cognitive Apprenticeship Model, developed by Collins and Brown, is an application of the Situated Cognitive Learning Theory. The Cognitive Apprenticeship Model indicates the importance of both parts of learning: practical instruction and active engagement with presented

material through meaningful activities wherein students apply the content. According to Collins, Brown, and Holum, "Teaching methods should be designed to give students the opportunity to observe, engage in, and invent or discover expert strategies in context. Such an approach will enable students to see how these strategies combine with their factual and conceptual knowledge and how they use a variety of resources in the social and physical environment" (Collins et al. 1991, 13). This model has key strategies in terms of instructional methods. First, cognitive knowledge must be modeled by an expert, and in terms of education, that comes in the form of a licensed teacher. This modeling could be lecture-based, guided examples, video tutorials, etc. Next is the coaching strategy, where the expert encourages students to perform a task utilizing the cognitive knowledge or content. During this strategy, the expert pushes students to find alternative problem-solving methods to deepen overall understanding. The previous strategy is followed by the scaffolding strategy, where the expert implements specific supports based on students' performance with the material. Such tasks may include group activities or games where students establish specific roles and provide individualized information based on the assigned role in developing an understanding of the knowledge. Following this phase, the articulation and reflection strategies take place. During these strategies, students present an understanding of the knowledge and reflect upon how such knowledge can be applied in different contexts. Lastly, the students enter the exploration phase, which can occur again in a group or individual setting. Still, in either case, the students engage in discovery learning, where each will apply the knowledge presented to specific tasks and develop strategies to solve problems in various contexts. This approach allows students to learn, practice, and apply knowledge to ensure complete understanding and enhance academic success throughout each course. Once again, the Cognitive Apprenticeship Model is an application of the Situated Cognitive Learning Theory, and this

supports the questions of the current study as it emphasizes the importance of instructional techniques, classroom engagement, and student collaboration to further student understanding leading to academic success.

The Situated Cognitive Learning Theory and the Cognitive Apprenticeship Model are utilized in a 2016 article by Kelley and Knowles entitled "A Conceptual Framework for Integrated STEM Education" in the *International Journal of STEM Education.* These researchers use the Situated Cognitive Learning theory and Apprenticeship Model to confirm the conceptual framework for how STEM material is presented, learned, processed, and understood.

This theoretical framework supports the development of the current study as the goal was to determine which instructional method, traditional, hybrid, or online, led to the most impact on student success for students with learning disabilities and gifted students.

Connectivism Learning Theory

Another theoretical framework for this study was the Connectivism Learning Theory. It was first introduced in 2005 by two theorists, George Siemens and Stephen Downes. This theory suggests that students should combine thoughts, theories, and general information in a useful manner. Part of the process will incorporate the use of technology. It acknowledges that technology allows students to connect with others and provides opportunities to make learning choices. Both theorists take different standpoints on this theory. Siemens focuses on the social aspects of Connectivism, while Downes focuses on non-human appliances and machine-based learning. The basic framework of this theory is broken down into principles. Some principles are: Learning and knowledge rest in a diversity of opinions, learning is a process of connecting, learning is more critical than knowing, and decision-making is a learning process. Connecting involves students acting as "nodes" in a network. The nodes (students) will connect through

different experiences that help maintain connections to form knowledge. The benefits of Connectivism seen in the classroom are support for collaboration, diversity, and empowerment of students and teachers. The benefits are, essentially, creating a learning community. The technology aspect of the theory can be seen through social media, gamification, and simulations.

This framework extends the concepts of constructivism. Constructivism promotes the idea that learners are active participants in the learning journey. This relates to the technology component of Connectivism. Online schools rely heavily upon social networking and creating online activities that promote students to be actively engaged in one's learning. In addition, students are encouraged to communicate with each other through collaboration. Students benefit from this collaboration and communication by learning from different perspectives. As a result, this can help decision-making, problem-solving, and comprehension of complex concepts.

Transitioning to the structure of Connectivism, nodes, and links are terms used to describe and frame this theory. A node is defined as a source of information. Information can be from individuals, organizations, databases, or any resource that can generate or process information. Links connect these nodes like bridges. Through online learning, this can be seen as discussion groups, digital hyperlinks, or social and networking ties.

Creating instruction using Connectivism can be accomplished by aligning with four philosophies and practices that follow from metaliteracy.

1. Learning requires diverse information resources, including collaborative Web 2.0 resources, user-generated content, and library and scholarly literature.
2. Acknowledging that these resources are part of a student's learning networks.

3. Students possess transferable skills that enable each to learn across a broad range of media. These skills can help encourage students to view libraries and library resources as part of the learning network.

4. Learning involves the critical evaluation and synthesis of concepts, opinions, and perspectives that are embedded in diverse nodes.

Relating to the current study, students are given more of a choice when researching for information pertaining to a particular lesson concept. The teacher is not necessarily the only source of knowledge from which students obtain information. The proposed study focused on two specific student populations: gifted and students identified with a learning disability. Online schools can differentiate instruction by providing a variety of resources that can match the individual learning needs of a student, which can be beneficial in creating multiple nodes in a network. Students will then contribute to this network and learn from various perspectives. The desired result from this network is to provide support and guidance for a student's learning needs. In contrast, traditional pedagogy is limited in resources. Technology is considered an additional tool but not a central component in instruction. The concept of a learning community is limited. As a result, there are more academic challenges that most students, specifically the two groups in this study, will not overcome.

A case study that utilized this theoretical concept is a journal article by Elaine Garcia, Mel Brown, and Ibrahim Elbeltagi in "Learning Within a Connectivist Educational Collective Blog Model: A Case Study of UK Higher Education." In this article, the authors examine the implications of Connectivism and its role in higher education by observing the collective blog usage of students at an HE Institution in the United Kingdom. The article concluded that this

learning theory is still relatively new, but its concepts are seen in many activities and are worth considering.

This framework relates to the current study by helping to determine which instructional method positively impacts students' success on end-of-course assessment exams. The current study examined academic success for students identified as gifted or with a learning disability.

ASSUMPTIONS, LIMITATIONS, AND SCOPE

Assumptions

Based on the review of prior literature, three assumptions were developed for the data analysis. First, from prior research, it appeared that hybrid instruction allowed for more differentiated instructional practices and helped teachers meet the academic needs of each student. Thus, hybrid instruction seems to provide a better opportunity for the students in the current study to achieve academic success.

Second, based on the majority of prior research, small class sizes seem to allow teachers to give students better-quality instruction and attention. The findings have not been conclusive in prior research, specifically regarding the ability level of student subpopulations. Still, it appears that for the current study, small class sizes may increase academic success.

Additionally, examining prior research studies and national statistics showed a clear connection or association between a higher attendance rate and academic success. Once again, this has not been conclusive, especially when considering the subpopulations of this study, but for the general student population, it appears that higher attendance rates will lead to an increase in academic success.

Lastly, based on prior research, it can be assumed that prior academic success on previous

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end of course exams can indicate success on the Algebra I Ohio State End of Course assessment.

Limitations

Considering the current study's population, one limitation would be the sample size and the lack of diversity in the school districts' locations. Since the study only examined school districts in Northeast Ohio, the sample size may be small when considering the generalizability for high schools in the state of Ohio and across the United States. The small sample size might affect the analysis of test data. Additionally, the sample might have a small subpopulation of traditional or online schools, which can affect the significance of the predictors and variables of this study. Therefore, this limitation prevented the study from generalizing to a larger population and forced the study to provide valid information only for Northeast Ohio high schools.

A second limitation involves the learning-disabled population, as the study did not consider when and how long each student had been on an Individualized Education Plan (IEP). The study only examined whether a student was currently on an IEP and not the dates when the IEP was issued, so there may be a problem generalizing based on the years when these students took the state assessments and whether or not each had an IEP at that time. Additionally, this study limited data to students without Significant Cognitive Disabilities, as this was necessary because of testing standards, which may impact the generalizability of students with learning disabilities. Lastly, for the subpopulation of students with learning disabilities the study analyzed all students even when an IQ was lower than average. If the study had identified IQ before data collection, then only students with an IEP that had been identified with an IQ of at least average could have been selected. Considering all students regardless of IQ level may create a skewed data analysis due to students with lower than average IQ scores.

A third limitation involves the gifted population, as this study did not consider when and

how the students were identified as gifted. The study only examined whether a student was currently on a WEP and not the dates when the WEP was issued, so there may be a problem generalizing based on the years when these students took the state assessments and whether or not each had a WEP at that time. Additionally, this study considered all WEP students regardless of whether or not the student was identified as gifted in mathematics. Thus, students identified as gifted in this study may not have been identified in mathematics. Instead, identifications of acceleration could have been in reading, science, social studies, superior cognitive ability, or creative thinking. If the study had identified gifted mathematics students before data analysis, then the study could have specifically determined success for gifted mathematics students.

A fourth limitation involves the method of instruction during the prior academic years, as this study only examined the type of instruction a student received during the high school years. Thus, the student's current instructional method for the high school educational years, which represents the instructional method for the Algebra 1 Ohio State End of Course Assessment and the instructional method for this study, may have been different when each student took the Ohio State End of Course Assessment in third-, fifth-, and seventh-grade mathematics. Thus, students identified in each instructional method for this thesis may have been in a different instructional method for all of the Ohio State End of Course Assessments. Therefore, the data analysis may be skewed when examining prior academic success as a covariate for current academic success, as the student's instructional method could have changed throughout the tested years.

Lastly, there is a limitation as to how online schools service students who are identified as gifted or with a learning disability. All students with an IEP have specific accommodations determined by school district members, including the intervention specialist, special education coordinator, general education teacher, and the student's parents and/or guardians. These

accommodations indicate how each student on an IEP is serviced during the school day. The accommodations for students with learning disabilities can range from video chat rooms where the teacher/aid provides intervention to scaffolded assignments that meet accommodations or read-aloud instructions for assessments. Additionally, all students with a WEP have specific goals established by school district members, including the gifted coordinator, the general education teacher, and the student's parents and/or guardians. These goals dictate how each student on a WEP is to reach growth during the year for each identified subject of acceleration. These accommodations can range from independent studies to stretch cognitive abilities to challenge assignments that extend in-class content. Therefore, as this study did not examine the accommodations for the subpopulations, the data analysis may be skewed based on the types of accommodations each student in the sample received during the instructional period.

Therefore, future research may consider how students are identified with a learning disability, IQ levels at the time of the assessment, and when the student was provided with an IEP. These identifications will ensure that all findings are driven toward mathematical results and guarantee that students with learning disabilities have been accurately defined to make conclusions about academic success. Additionally, future research may consider how students are identified as gifted, when the student was provided with a WEP, and what tests are used to evaluate giftedness. The above will ensure that all results are driven towards mathematical findings and guarantee that students identified as gifted have been accurately defined to make conclusions about academic success. Future research may also examine the accommodations that students with learning disabilities and students identified as gifted received during instructional time to ensure that the accommodations were not the influential factor in terms of academic success but rather the type of instruction each student received within the general education

classroom. Finally, future research may consider the instructional methods for each subject in the study during all years of testing to ensure that the instructional method remains consistent throughout the testing period. Identifying the instructional methods will provide more firm results on whether the method was associated with the student's academic success, specifically when examining prior academic success based on standardized test results in previous grades.

Scope

The results of this study can be extended to all school districts located in Northeast Ohio. If the results were to be generalized to the larger population of Ohio school districts, this study would need a larger sample from schools across Ohio. Data from multiple states would need to be accessed if the results were to be generalized to schools across the country.

DEFINITION OF TERMS

DOK: Depth of Knowledge measures the level of critical, cognitive, and conceptual thinking required for students to know, understand, and answer a question. It does not characterize the difficulty of a question.

Hybrid Instruction: Instructional materials were presented face-to-face with digital supports (Google Classroom, Edpuzzle, digital textbook, online instructional videos) or a model of two days in person and three days remote.

IEP: Individualized Education Plan developed for every student identified with a learning disability to specify classroom and testing accommodations.

Ohio State End of Course Assessments (EOC): State assessments that are given at the end of specific grades during the elementary school years and at the end of specific high school courses.

Online Instruction: All students learn instructional material through a digital medium.

Traditional Instruction: In-person instruction. All instructional materials were presented

face-to-face.

WEP: Written Education Plan developed for every student identified as gifted to specify the content areas of acceleration and goals to help the students stretch learning.

SUMMARY

Based on previous literature, the primary focus of this thesis analyzed the factors that have the most significant impact on student academic achievement. To measure student academic achievement, Algebra 1 EOC test scores of 684 and 725, respectively, according to the student populations, indicate success for an individual student. This thesis aimed to demonstrate the instructional format that best achieved this result. The instructional formats used in this study were traditional, hybrid, and online. In addition, other factors were considered, including class size, attendance rate, and prior performance on math end of course exams in third, fifth, and seventh grades. This study categorized student performance in the previously mentioned grades as covariates. Class size and attendance rate are other predictors that impact a student's educational success.

The reason for conducting this study stems from the theoretical ideas of Situated Cognitive Learning Theory and Connectivism Learning Theory. Situated Cognitive Learning Theory suggests teachers facilitate classroom learning rather than being the sole expert. This theory breaks away from the traditional approach to classroom discussion. Scaffolding and differentiation are vital components that require the teacher to facilitate while properly using technology as an implementation tool. Connectivism Theory focuses on discussing and connecting ideas that originated within the classroom. It requires students to seek knowledge through personal connections with peers using technology. This study used both theories to

explain the variance in academic success along with instructional format within two population groups. The populations were students identified as having a learning disability and students identified as gifted. The conclusion of the analysis explained the instructional method that increased the likelihood of students within each population succeeding on the Algebra 1 Ohio State End of Course Assessment.

The sample size for this study included seven school districts in Northeast Ohio. The number of students collected from these districts was n = 526. The descriptive statistics provide each student's information pertaining to all variables measured in the study. A logistic regression methodology was used to support the conclusion of the study. The statistical package R was used for all calculations in this thesis's regression analysis, descriptive statistics, and graphs. From the literature review, the main assumptions of this research study state that students attending a school district with a hybrid learning format with a small class size ratio and high attendance rate should have a more significant probability of students achieving academic success.

CHAPTER II LITERATURE REVIEW

OVERVIEW

The purpose of this chapter is to present relevant literature related to the topics of this study, including the impacts instructional methods have on students identified as gifted (WEP), students with learning disabilities (IEP), attendance rate, class size, and prior academic performance on standardized tests as well as to the theoretical framework that guided this study. This was accomplished by searching for major contributors in each field, analyzing current journal articles, searching the references of major contributors, and analyzing all findings to make connections to this study and the limitations that this current study will potentially address. The goal of this review process was to collect information to conduct a study with a more well-rounded and comprehensive background of the above categories.

RELEVANT LITERATURE

The literature review process was conducted by searching Google Scholar and the Shawnee State University Library research catalog for journal articles related to mathematics instruction, instructional methods/formats, students identified as gifted, students with learning disabilities, attendance rate, class size, and prior academic performance on standardized tests. The years of focus for these articles ranged from 2005 to 2023 to ensure the most relevant and up-to-date research results were utilized to guide the current research study. The results of each piece of relevant research and the references of major contributors were examined to identify additional literature, pertinent results, and educational theories that could further guide this study.

INTRODUCTION

In recent history, much research has been conducted on the impact of instructional methods on student learning and academic success. With the COVID-19 pandemic impacting students across the US, academic studies were conducted to determine the effects of social isolation, varying instructional methods or platforms, and changing classroom environmental factors had on students' academic performance. Current research on instructional methods indicates that "Course design and preparation play an important role in student learning" (Bir 2019, 3). Additionally, current research found that "The way in which the course material is presented to the students is an important aspect for student learning" (Bir 2019, 3). However, most current research has focused on the student population as a whole with predictive factors such as gender, SES, parents' educational backgrounds, and class rank to examine the comparison between traditional, hybrid, and online instructional methods. One such study indicated there was no significant difference in student performance between instructional methods of traditional face-to-face and online platforms for the general student population when considering predictive variables of gender and class rank (Paul and Jefferson 2019, 1).

As the bulk of prior research has focused solely on the general student population, the current study saw vital importance in investigating specific student populations that are often excluded from research or lumped into a general category without regard for specific characteristics. The research study of conversation sought to examine subpopulations of the general student body by examining students with learning disabilities currently possessing an Individualized Education Plan (IEP) and students identified as gifted currently possessing a Written Education Plan (WEP) indicating each student's areas of accelerated learning. When considering the students with learning disabilities on an IEP, these students are often viewed as

the lower-achieving population and are generally expected to need specific accommodations to succeed. When considering the students identified as gifted on a WEP, these students are usually viewed as the higher-achieving population and are usually expected to succeed regardless of the type of instructional format. The primary research goal of this study was to examine the impact that instructional methods (Traditional, Hybrid, Online) have on these two subpopulations' academic success in high school mathematics courses based on the Ohio State End of Course Assessment in Algebra 1. Other predictor variables were included in the study, based on the findings from the following recent research studies in the literature review, to determine classroom factors that may impact student learning. The predictors included attendance rate, class size, and prior academic performance on Ohio State End of Course Assessments in third-, fifth-, and seventh-grade mathematics.

GIFTED STUDENT POPULATION (WEP: WRITTEN EDUCATION PLAN)

The first of the two subpopulations within this study was students identified as gifted, indicating that the student possesses a current Written Education Plan (WEP), which identifies each student's areas of accelerated learning. When considering this subpopulation regarding instructional methods, it was vital to implement past research results and how such research has identified the importance of homogeneous groupings for gifted students. Homogenous groupings signify that students of similar abilities are grouped to foster intellectual development and critical thinking skills. However, such groupings for these students are sometimes met with the challenge of numbers, meaning that not all school districts have a large number of gifted students. Thus, it may be challenging to create homogeneous groupings consisting of all gifted students or students of similar ability levels. Therefore, the instructional method of online learning could be a

significant benefit for this subpopulation as students could access other gifted learners from other grade levels within the district, from nearby school districts, from across the state, or even from across the country. One recent qualitative study by Potts (2019) investigated the perceptions of gifted students when immersed in virtual learning platforms. The students were observed during synchronous platforms, where instructors and students met together, and asynchronous platforms, where students engaged with material individually. The results of this study indicated that gifted students preferred interaction with instructors and classmates but also found that gifted students did not perceive a lack of rigor or complexity with course material within the virtual environment. Based on this study, "One of the most obvious benefits of online learning for gifted students is the ease with which they can be homogeneously grouped with their intellectual peers" (Potts 2019, 61). Additionally, this study determined that, in particular, when gifted students are placed in specified groups, these students profited from the like-minded students' intellect and exponentially advanced in educational settings compared to students of similar intelligence (Potts 2019, 61). The online learning instructional method also provided gifted students with challenging opportunities and the ability to work independently with the wealth of information that is available through the internet. Gifted students often search for additional material on a given topic to foster challenges, and the online instructional method provides these students instant access to course material. With an online method of instruction gifted students have the opportunity to work ahead or at one's own pace, which could benefit the overall understanding of the material. According to these gifted students regarding the online platform, "the course was both rigorous and helpful" (Potts 2019, 72).

Conversely, a more recent study indicated that gifted students often felt online instructional methods were inferior, insufficient, and led to greater difficulty in overall

understanding of course material (Alshehri 2022, 861). The qualitative study by Alshehri (2022) explored the impact that distant learning had on the attitudes of gifted students. The results of this study indicated that gifted students developed a lack of motivation for learning during virtual classroom instruction and found the instruction insufficient and inadequate in terms of meeting this group's rigorous depth of knowledge. Thus, gifted students face challenges within the online learning instructional method, including a lack of communication with an expert teacher and inadequacies with specific learning style preferences. When considering the challenges gifted students may face in an online instructional method, it was crucial to examine the group's views on the traditional and hybrid methods. Based on current research, gifted students identified a primary concern with online learning as the time it takes for communication between student and instructor and the excess of time between multiple question and answer dialogues (Potts 2019, 69). Even though gifted students seek independence when learning, these students often believe that instructor interaction is vital to learning. Additionally, "All the participants touted the importance of an instructor in an online course, and they agreed that there were enormous benefits to having an instructor who could personalize both instruction and feedback" (Potts 2019, 69). Thus, research confirms that no matter the form of instruction, the teacher's presence was vital in intellectual development and overall understanding of course material. Traditional and hybrid methods of instruction for gifted students provide the benefit of an expert teacher who is available instantly and can provide assurance of correct understanding, leading to student satisfaction. The study by Alshehri (2022, 863) on online instructional methods found that gifted students "indicated that it was often inadequate, difficult, and not their preferred learning style," indicating that gifted students seek instructional methods aligned with particular learning methods. As traditional and hybrid methods of instruction can provide instant teacher interaction,

student interaction, reflection, and feedback, gifted students may also benefit from these methods. Gifted students also identified a concern with distractions within online instruction and often felt that supervision from an instructor was vital in terms of learning. The presence of an instructor provides a means for coaching, reflection, and assurance of correct understanding. One prior study mentioned above indicated that "all the students also voiced a preference for an instructor-led learning environment over the more autonomous environment of online learning systems" (Potts 2019, 74). Therefore, the online instructional method provided certain benefits for gifted students regarding specific groupings and ease of access to challenging course material. However, as current research indicated, traditional and hybrid instructional methods provide certain benefits, including instantaneous communication with an expert teacher, lack of distractions within the classroom, and the ability to interact with other students socially.

Another aim of this literature review was to examine the instructional methods and the impacts on each of the student populations in this study. A dissertation by Eaton (2020) examined the academic success of students learning in an online environment. This dissertation was of interest since it examined a student population in Northeast Ohio. The study was interested in the association learner characteristics had with student success. These characteristics were then compared to high school students' online course completion rates. The characteristics that were focused on in the study were gender, race, grade level, and grade level as it pertains to expected age and course completion rates.

The results of this study concluded that students in the upper-grade levels and females were more likely to complete online coursework than those students at grade level. Race did play a factor, and the results indicated that an achievement gap existed for Black students. This group was less likely to obtain academic success. Despite the student population not focusing on

students with learning disabilities and those identified as gifted, this study's outcome does support Connectivism. For example, as stated in the study, online educational formats are used for advanced placement courses, honors courses, and dual credit classes. Additionally, credit recovery through an online format has become an option for many students lacking or requiring additional credits. The students in this study used online learning to achieve this requirement. In this thesis, the sample population was similar in having students enrolled in an online school for some of the above reasons.

One of the major learner characteristics seen in the results pertained to self-efficacy. Informal learning was a major contributor to many students' educational experiences. Learning is now seen through communities of practice, personal networks, and the completion of work-related tasks (Siemens 2005, 5). Self-efficacy is "a construct affecting one's accomplishment, learning, behavior, feeling, and cognition in life" (Ozcan et al. 2021, 85). The previous study mentioned that students with low self-efficacy were less likely to complete online coursework. To use the Connectivism Learning Theory effectively, educators need to be mindful of a student's self-efficacy and create a network of learning that fosters a higher level of self-confidence.

Foundationally, this learner characteristic was essential to gifted learners. A study done by Ozcan et al. (2021) examined the sources of mathematics self-efficacy (SMS) for gifted and non-gifted students after controlling for mathematics achievement. In this study, the sources of self-efficacy that were examined are mastery experience, vicarious experience, social persuasion, and physiological state. The research study consisted of 106 gifted and 118 non-gifted students. The Sources of Mathematics Self-Efficacy Scale was used to collect data, and these students self-reported previous fall mathematical grades. Gifted learners tend to be highly motivated,

obtain self-confidence, and have high self-efficacy. Additionally, these students have great

analytic abilities and high memory capacity compared to non-gifted students. Due to these

characteristics, online learning can be less daunting and difficult for gifted students.

The study found that when controlling for mathematics grades, SMS was higher for

non-gifted students. Whereas with gifted students, all of the sources of SMS listed above tend to

decrease. When comparing the unadjusted mean scores of the SMS, mastery, social, and

physiological scores were higher for gifted students. Controlling for mathematics achievement

showed that gifted students had a decrease in the adjusted mean for SMS versus non-gifted

students. The authors of the study contributed this to perfectionism. Gifted students strive for

high grades and are self-motivated towards higher achievement. Thus, controlling for

mathematics achievement eliminated the characteristic of perfectionism, which could be the

result of the decrease seen in the data. The authors concluded that academic achievement was a

good predictor of SMS. Additionally, mathematics grades should only be used as a reinforcer for

gifted students. It can be concluded that self-efficacy is an aspect that educators should consider

when designing lessons, regardless of the type of instructional format.

To summarize the previous two studies. Online learning can benefit gifted students due to

the high levels of self-efficacy, which can drive gifted students self-motivation. Self-efficacy was

not necessarily a given for students who have a learning disability. When developing online

courses, teachers must understand how to create an environment with a sense of community

where dialogue can happen and students are comfortable. Given this, students will be able to

interact and engage in content and with each other. (Kop 2011, 24) Relating to the theoretical

framework of this study, Connectivist learners need to be engaged and have the ability to create

and share activities.

Thus, prior research connects to the theoretical framework of the current study as both the Situated Cognitive Learning Theory and Connectivism Learning Theory recommend varying learning environments and student engagement with course material in the presence of an expert. Therefore, the research study of discussion sought to determine, through quantitative results, which instructional method has the most impact on academic success for the gifted population. These results contributed to prior research by providing statistical data as to the most effective means of instruction for gifted students rather than simply investigating this group's perceptions of the learning environment.

LEARNING DISABLED STUDENT POPULATION (IEP: INDIVIDUALIZED EDUCATION PLAN)

The second subpopulation in this study was students identified with learning disabilities who currently possess an Individualized Education Plan (IEP), which identified the type of disability and accommodations for classroom instruction as well as assessment. When considering this subpopulation, it was of utmost importance to consider prior literature regarding the education of students with learning disabilities. Prior research studies have determined that students with disabilities often learn slower, need additional time to fully understand and investigate course material, and require differentiated instruction to grasp complex topics. A qualitative and quantitative study by Almari and Wood (2017) investigated students with various learning disabilities in an online environment. These researchers utilized a survey to identify the student's perceived achievement and satisfaction with the online platform. The survey results indicated that students view the presence of a teacher and support of individual communication as key factors in academic success. The researcher then utilized EFA, a statistical method, to determine that the variance explained by the presence of a teacher was 36.50%, and the variance

explained by support of individual communication was 16.80%. In terms of the online instructional method, this research indicated that students with disabilities were more likely to select online instructional methods when compared to all other student populations (Almari and Wood 2017, 61). The decision to select online instructional methods was due to the ease of communication and interaction with the teacher and other students. As students with disabilities often struggle to communicate in person, many feel that online communication via email or chat rooms provides students with disabilities the opportunity to participate in a more meaningful capacity. According to this research, students with disabilities may perform better in terms of interaction within online environments than in the traditional setting. The online environment can allow these students to control sensory overload and create consistent routines based on course agendas (Almari and Wood 2017, 61). Additionally, this research indicated that "no significant difference was found between students with disabilities and those without disabilities in terms of learning and achieving in online courses, in contrast to the situation found in the traditional classroom" (Almari and Wood 2017, 61). An additional study by Obaid and Sakarneh (2023) supported these claims by analyzing teaching methodologies as it pertained to students identified as having a learning disability. This study examined the effect of two different teaching methodologies on students with learning disabilities. The two methodologies used in the study were Behaviorism and Constructivism. Thus, connecting to Connectivism, a branching idea from Constructivism, allowing students to create a knowledge network using individual learning experiences. Diversity of opinions is where learning and knowledge will take place (Siemens 2005, 1).

Using real-life exposure as a teaching strategy yielded a productive classroom. This strategy supports part of the current study's theoretical framework. It can be inferred that

students with learning disabilities will learn concepts more easily when constructivism-based strategies are employed. Traditional pedagogy techniques are an alternative to this. These techniques are teacher-centered, with the teacher being the only source of information. In the previous study, that approach did not have a significant positive impact on test scores.

Importantly, when using online as an instructional format, educators need to prepare learners for active engagement in a world not defined by structured cause-effect relationships (Siemens 2008, 8). Concluding that removing obstacles for active engagement was critical for students to achieve academic success. Thus, the online method of instruction for students with disabilities has proven to be effective in mediating the students' difficulty in understanding and has shown to aid in the additional time needed to complete work as students can work at one's own pace.

However, a more recent study by Aiello (2023) investigated the achievement difference between remote and face-to-face learners while considering student characteristics. This study utilized independent t-tests and two-way ANOVA techniques to analyze academic achievement and methods of learning among a variety of student characteristics, including students with disabilities. The results indicated a significant impact of course delivery on the achievement of students with disabilities. Additionally, the results of the independent sample t-test by Aiello (2023) indicated that all students, regardless of characteristics, achieved higher scores in the face-to-face setting when compared with results in a remote learning environment. Earlier research also indicated "that social interaction between learners and the instructor contributed to producing an increase in learning achievement" (Almari and Wood 2017, 66). Therefore, as the online method of instruction often limits students' interactions with the instructor, there may be cause for concern regarding students' academic success within the online platform. As there was

a challenge with the online method of instruction for students with disabilities, it was vital to explore the current research regarding students with disabilities in the traditional and hybrid methods of instruction. Many current research studies showed a positive correlation between teacher-student interaction and academic success for students with disabilities. Thus, the traditional and hybrid methods of instruction provide a greater opportunity for the teacher to engage with these students and provide meaningful feedback and assurance of overall understanding of the material. Students with disabilities frequently require intervention with course material to scaffold assignments or differentiate materials to conform to specific modes of learning. The traditional and hybrid methods of instruction allow teachers and classroom assistants to provide such intervention immediately. In contrast, the online platform may require a longer time for intervention to occur, which could discourage these students in terms of understanding or confidence with the course material. According to a recent study, "it was concluded students with disabilities needed intervention when learning online" (Aiello 2023, 25). Thus, prior research supports the theoretical framework of the current study as students with learning disabilities need to engage with course material through various mediums with interactive support and interventions from experts as well as technological tools.

Therefore, past studies have determined that there are benefits to all three forms of instructional methods for students with disabilities, while data analysis to determine the statistical significance of instructional methods confirms that face-to-face generated greater success over remote learning for the general population. However, data analysis for the predictive factors, including instructional methods that led to greater academic success for students with learning disabilities, has not been conclusive. Thus, the current study sought to

determine the instructional method that had the most impact on students with learning disabilities and other classroom factors that may provide additional impact on academic success.

ATTENDANCE RATE

Classroom attendance was a vital part of education, regardless of the instructional method for which course material was presented. Students must be present in the classroom, whether a brick-and-mortar building or the online platform, to receive course material, engage in social interaction and discussions, and develop the critical thinking skills necessary to fully understand content knowledge leading to academic success. It is essential to clarify that attendance rate indicated the student was present during instruction but did not indicate whether the student was fully engaged in classroom activities. Investigating attendance rate is a simple verification of whether a student was present during the school day. A quantitative study by the National Forum on Educational Statistics (ED) (2019) examined the correlation between student attendance, demographic groups, academic performance, grade levels, and graduation. The results of this study indicated that student attendance was a vital part of student academic success in the traditional school setting. According to the National Forum on Educational Statistics (ED), "... chronic student absence reduces even the best teacher's ability to provide learning opportunities. Students who attend school regularly have been shown to achieve at higher levels than students who do not have regular attendance" (2019, 1). Thus, past data analysis has shown that student attendance impacted academic success and indicated the importance of utilizing attendance rate as a predictor variable within the current research study. The prior study was conducted within the Sioux Falls School District in South Dakota during the 2005-2006 and 2006-2007 school years, which determined "... a statistically significant negative correlation between grade point

average (GPA) and number of days absent from school" (2009, 18). These results further confirm the importance of attendance rate as a predictor variable of academic success, as past studies have indicated that academic success was negatively associated with the number of days absent from school. An additional study by Gaftandzhieva et al. (2022) investigated the impact that attendance rate had on student success within the online learning platform. A quantitative analysis was conducted utilizing a Chi-Square test to determine the association between student success and participation in various classroom activities. The results indicated a strong correlation between student attendance/participation in online activities and final grades in the course. Additionally, a logistic regression model was utilized to determine the impact of student attendance during various classroom activities. This study found that "Student's attendance is significantly associated with academic performance. Most students who had more than 60% attendance achieved Good (37.7%), Very Good (32.1%), and Excellent (18.9%) academic grades when compared to the other categories of academic achievement" (Gaftandzhieva et al. 2022, 13). Therefore, past studies indicated that attendance rate and academic success are correlated, but there was not much data regarding the student populations that were examined during these studies. Thus, it was critical to determine if attendance rate impacts academic success when discussing students with a learning disability and students identified as gifted or accelerated. There was a clear correlation between student success and attendance. However, it was essential to consider whether the instructional method or student engagement could have impacted students' success and not simply the fact that the student was present during the instruction.

An additional research study by Kim et al. (2020) conversely found that even though attendance rate was correlated with academic success, other factors may have impacted the success during each full day of school attendance. This quantitative study utilized a mediation

analysis consisting of multiple regression analyses. According to this study, "the direct effect of attendance on academic performance became nonsignificant (B = .03), t(.71), p = .48, when controlling for participation, suggesting a strong mediation effect" (Kim et al. 2020, 272). Thus, the study indicated that participation during a day of school attendance was the impactful factor in student success and not merely the fact that a student was present for instruction. This study utilized a mediation model, where attendance was a predictor, final exam score was the response variable, and participation was the mediator. Therefore, the study indicated that academic success based on student attendance was mediated by active engagement or participation during the lesson. This study brings into view the importance of the instructional methods for which students are learning and which instructional methods can foster the greatest engagement and student involvement while presenting course material. The results of this study provided evidence that student participation during class mediates the positive correlation between attendance and academic success that has been reported in many studies in the past (Kim et al. 2020, 272).

Therefore, the current research study planned to investigate the impact that attendance rate has on academic success for the specific populations of students with disabilities and students identified as gifted within three instructional methods: traditional, hybrid, and online. Additional research supported this plan and specifically identified that student participation in lectures, in-class activities, and various assignment types led to greater academic success for students. According to the additional research study, "students' final grades are significantly correlated with the student's participation in different types of activities and learning resources. We have also established some correlations between different types of lectures, exercises, and source codes and found that the students' academic performance is substantially correlated with

some specific types of lectures, exercises, and assignments" (Gaftandzhieva et al. 2022, 15).

Thus, student attendance was a critical factor in education. However, the act of participating in a variety of instructional methods, as the current research study examined, showed to be vitally impactful on student academic success. Past research has shown that attendance and academic success were correlated, but participation may be the driving force of such correlation. It was important to view the impact of attendance within each type of instructional method. Additionally, the majority of studies have considered the entirety of the school's population and have not indicated the impact that attendance and/or participation may have on students with disabilities and students identified as gifted in terms of academic success.

CLASS SIZE

Class size could potentially impact student academic success, specifically for the two subpopulations of the current research study: students identified with a learning disability and students identified as gifted. Through prior research studies discussed above within the learning disabled and gifted sections of the literature review, it was made abundantly clear that both subpopulations of students valued the interaction and time spent with the instructor. Additionally, it was reported that students with an IEP required intervention to understand course material successfully. With that in mind, considering class size as a potential predictor of academic success was a vital part of the current research study. Students who are identified with a learning disability often need extra help, and with smaller class sizes, the teacher interaction rate and intervention rate increase. Additionally, students identified as gifted value the interaction with the teacher as the teacher is a means for expert information and a source to provide challenge and rigor with course material. According to a prior research study by Kim et al. (2020), participation

within the classroom was a significant component of academic success. However, class size could hinder all groups of students from actively participating in the classroom regardless of the instructional method. Whether in-person, hybrid, or online, "student participation decreases as class size increases" (Kim et al. 2020, 279). Thus, as prior research studies discussed above in the attendance rate section of the literature review have shown that participation may be the driving force behind academic success in any environment, it was vital that the current research study examine the impact of class size. Students with learning disabilities are often discouraged from participating in large classes because of the potential incorrect response, leading to criticism or embarrassment. Gifted students also fear the possibility of answering a question incorrectly in front of peers as this group feels the perception of being the brightest members of the class based on the gifted identification. According to a study discussed above, "students' fear of criticism from instructors and classmates may also increase as class size increases, thereby further reducing the likelihood of participation" (Kim et al. 2020, 279). Additionally, gifted students can sometimes become bored in heterogeneously grouped classes based on a feeling of superiority to the underperforming classmates. Thus, class size can have a major impact on the success of specific students. Considering this as a predictor variable for the two subpopulations of students within the proposed study was important. Following these views, one study found that when controlling for teacher gender, race, and experience, a one-student decrease in class size resulted in a .0037 standard deviation increase in mathematics end-of-grade assessment scores (Bosworth 2014, 152). Additionally, the same study found that when controlling for the same effects as above, a one-student decrease in class size resulted in a .0631 standard deviation increase in mathematics end-of-grade assessment scores for students identified as learning disabled (Bosworth 2014, 152).

However, the study by Bosworth (2014) also indicated that students of different ability levels may be impacted differently by class size changes. This study utilized Chi-Square Tests to investigate the relationship between class size and standard deviations of students' end-of-grade assessment scores. The study found a contradictory result to the results mentioned above, as when controlling for the same effects as above, a one-student decrease in class size resulted in a .2444 standard deviation decrease in mathematics end-of-grade assessment scores for students identified as gifted (Bosworth 2014, 152). Although the magnitude of these statistically significant values was relatively small, the values provided some indication of the impact of class size on specific student populations. The same study also examined the impact of smaller class sizes on specific groups of students based on the classroom composition of the student population and the teacher's gender, race, and experience level. The classroom composition factor focused on heterogeneous groupings, grouping students of all backgrounds together in classrooms, and the composition included student demographic identifiers such as race, SES, school per pupil expenditure, and district free and reduced lunch plans. The study indicated that the learning disabled and students identified as gifted benefit less from a small class size than other subpopulations, such as female students, Hispanic students, and students on a free and reduced lunch plan based on mathematics end-of-grade assessment scores (Bosworth 2014, 156). The study results showed that a one-student decrease in class size when controlling for classroom composition resulted in a .0005 and .0015 decrease in the standard deviation of mathematics end-of-grade assessment scores for learning disabled and gifted students, respectively (Bosworth 2014, 156). Once again, although the magnitude of these statistically significant values was relatively small, the values provided some indication as to the impact of class size on specific student populations. Additionally, when comparing the results of average success on

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end-of-grade assessments and the standard deviation of success on end-of-grade assessments, the study indicated a more significant impact on the standard deviation when reducing class size. The previous results indicated "that class size reductions may be relatively more effective at closing achievement gaps than raising average attainment" (Bosworth 2014, 162). A study by Lin et al. (2019) explored the impact of class size on active engagement and academic success with online self-paced instruction. It was shown that the relationship between class size and student academic success did not correlate as a linear relationship. The results of the study showed that a class size of thirty-eight students was associated with the best student performance for a math course. Anything larger had a negative effect on academic performance. Thus, these results provided some support for online students to have a larger class size. The combination of studies above provided evidence that class size may impact student populations differently and supports the inclusion of this as a predictor variable in the current research study.

The study of discussion sought to find more conclusive results regarding students with learning disabilities and students identified as gifted when examining class sizes. As prior research has produced inconsistent results with small significant levels, small sample sizes, and data retrieved from studies conducted in 2001, the study at hand planned to close gaps in prior research. With education changing yearly, data from over twenty years ago does not produce the best analysis of the impact on student academic success. Additionally, the way in which students are identified with learning disabilities and giftedness has become much more in-depth over the recent years. Therefore, the proposed research planned to provide vitally important data for these two populations regarding the impact of class size on achievement within the current educational standards.

PRIOR ACADEMIC SUCCESS

When considering factors within the classroom that may impact academic success, such as instructional method, class size, and attendance, it was important to examine how prior academic success in similar content areas may impact current success. Therefore, it was vital to examine prior research on how student success in the current learning environment may result from the student's prior success with similar course material. A student's ability level is bound to impact academic success in some manner, as confidence with prior knowledge sets the framework for one's ability to process new information and build connections with prior knowledge. A study by Ismail et al. (2018) examined the impact that various factors, such as technology, instruction, and ability level, could have on student performance. The study examined students in a hybrid and traditional learning environment. According to this study, "the student's ability is directly associated with Student Academic Performance" (Ismail et al. 2018, 178). In accordance with this study, there was a relationship between student ability level and academic success in the current course, but was the relationship always representative of a positive correlation between prior performance and current performance? Based on the results of multiple studies, the relationship has a strong indication that students with low prior academic performance will continue to maintain low academic performance, and students with high academic performance will continue to maintain high academic performance.

However, this connection has some driving forces behind the result, one of which was the instructional method for which course material was presented. A study by Park et al. (2019) investigated the success factors for college students in a hybrid learning environment. The study utilized multiple regression and ANOVA techniques to determine significant predictive factors of academic success. This research study indicated that students with low prior GPA perform

significantly better within subsequent traditional face-to-face courses, with hybrid models indicating a wide range of achievement (Park et al. 2019, 13). This study additionally examined high prior GPAs and determined that this group of students attained the best grades within the hybrid instructional method (Park et al. 2019, 13). This study conducted a multiple regression analysis, which indicated that "the background variables, Weighted High School GPA, and SAT Writing scores had statistically significant ($p < .05$) predictive values toward the standardized final grades. The coefficient of determination ($R2 = .24$) indicated that the variance in the background variables could be accountable for up to 24% of the variance in the final grade" (Park et al. 2019, 18). Thus, prior academic success strongly influenced current and future academic success, with the possibility of explaining up to 24% of the variation within the model.

Conversely, this research also indicated that students with low prior GPA and unsuccessful prior online courses tend to continue with lower academic performance in subsequent online courses (Park et al. 2019, 13). An additional study by Bir (2019), which utilized independent sample t-tests, examined the impacts of online and traditional instructional methods for engineering courses. The results indicated that no matter the prior academic standing of a student, one was more likely to perform at a lower level when presented with material in an online format only. The results of this study indicated that high-performing students enrolled in online pedagogy attained lower scores than other counterparts who were enrolled in a traditional based course (Bir 2019, 8). More specifically, "The mean for the students enrolled in the online pedagogy ($M = 2.00$) is lower than that of the students enrolled in the traditional pedagogy ($M = 2.96$)" (Bir 2019, 9). Additionally, the study presented that "Online high AP (Academic Performing) groups had lower academic standing than their corresponding traditional group. The online pedagogy had a negative impact on medium and low AP (Academic Performing) groups

academic performance" (Bir 2019, 10). Therefore, regardless of prior academic standing, current academic performance showed a strong negative correlation with online instruction when compared solely to the traditional format. It is important to note that this study only examined two Mechanics of Engineering courses, one in the online format and the other in the traditional format. Thus, the sample size for the study was relatively small, and the study was only conducted within one university, so the generalizability of the results may be misleading. However, the results still provided clear evidence that online instruction had a negative impact on all groups of students regardless of prior academic standing.

In terms of the current research study, these results indicated a clear need to examine the impact of prior academic success on current academic performance regardless of the instructional method. Prior research has shown some mixed results regarding the impact that prior academic success has on current performance, and the driving force behind these mixed results seems to be the pedagogical methods used to present course material. Therefore, prior research confirms the need to examine the impact of prior academic success on current academic success within all three instructional methods: traditional, online, and hybrid. This research provided additional support for the Situated Cognitive Learning Theory and Connectivism Learning Theory, which support the use of multiple modes of instruction for greater academic success as the guiding principles behind the proposed research study.

SUMMARY

This chapter aimed to identify relevant pieces of literature that connect to the theoretical framework of this study, the two student subpopulations, and the potential predictors of academic success. As mentioned throughout the literature review, the potential predictors of academic

success were instructional methods/formats, attendance rate, class size, and prior academic performance on standardized tests. Various databases were accessed, and specific terms related to the predictors were searched to determine the relevant articles published between 2005 and 2023. Throughout the review process, each article was analyzed in great detail, and vital information that linked to the current study or provided insight regarding possible rebuttals was utilized. A detailed review of all references from each major article was conducted to produce additional articles regarding the two subpopulations, instructional methods/formats, or the potential predictors of academic success. The current research study, guided by the Situated Cognitive Learning Theory and the Connectivism Learning Theory, sought to provide additional results to prior literature by closing gaps through the examination of two specific subpopulations of students. This study connected current research involving the entire student population with two specific groups, students with learning disabilities and students identified as gifted, by examining the academic success on the Ohio State End of Course Assessment in Algebra 1 for these two student populations across different instructional methods while considering attendance rate, class size, and prior academic performance.

CHAPTER III METHODOLOGY

INTRODUCTION

The following chapter provides an extensive overview of the methods implemented in this logistic regression exploratory study. The main goal of this thesis was to determine significant predictors of academic success based on the Ohio State End of Course Assessment in Algebra 1 for two student populations: students with learning disabilities and gifted students. This thesis considered the following potential predictors of academic success: instructional method (Traditional, Hybrid, or Online), class size, attendance rate, and prior academic performance on third-, fifth-, and seventh-grade Ohio State End of Course Assessments. This chapter includes the study's setting, participants selected, instrumentation used for assessment data collection, procedures completed, data processing, statistical analysis techniques, limitations, and ethical considerations. Within the sections of this chapter, relevant prior studies were cited to support statistical techniques, variable selection, and power analysis based on this thesis's sample size. In addition, this chapter built the framework for the study results, which will be discussed in detail in Chapter 4.

REVIEW OF RESEARCH QUESTIONS, VARIABLES, AND ASSUMPTIONS

Primary Research Question

Is instructional method (Traditional, Hybrid, Online) a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 when considering students on Individualized Education Plans (IEPs) and students on Written Education Plans (WEPs)?

Secondary Research Questions

1. Is class size a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 for IEP and/or WEP students?

2. Is attendance rate a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 for IEP and/or WEP students?

3. Is prior performance a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 for IEP and/or WEP students?

Variables

These variables were selected based on prior research, which indicated inconclusive results regarding the impact of instructional methods, class size, attendance rate, and prior academic performance on current academic success. Based on the assumptions for this study and the largest number of subjects, the Hybrid instructional method was set as the reference category for the instructional methods predictor variable. The assumptions also supported below average as the reference category for the class size predictor variable and met the state criteria, indicating higher attendance rates for the attendance rate predictor variable.

Dependent (Response) Variable:

(Y): Algebra 1 Ohio State End of Course Assessment

Independent (Predictor) Variables:

(X1): Instructional Method (Hybrid, Traditional, Online)

(X2): Class Size (Below Average, Above Average)

(X3): Attendance Rate (Met State Criteria, Did Not Meet State Criteria)

Covariate Variables:

(X4): Third Grade Math Ohio State End of Course Assessment

(X5): Fifth Grade Math Ohio State End of Course Assessment

(X6): Seventh Grade Math Ohio State End of Course Assessment

Assumptions

Four assumptions were established based on the review of prior literature, the variables of this study, and the logistic regression statistical technique. The first assumption for this thesis was that the hybrid method of instruction would provide more viable learning conditions for the two subpopulations of students within this study, leading to a greater impact on academic success. The second assumption was developed based on inconclusive evidence in prior literature, but it remained that for the two student populations of this thesis a small class size may provide improved opportunities for an increase in academic success. The third assumption emerged from a wealth of prior research, which indicated that higher attendance rates strengthen conceptual understanding, leading to increased academic success. The last assumption of this study assumed that prior academic success on previous end of course exams could indicate success on the Algebra I Ohio State End of Course Assessment.

SETTING AND PARTICIPANTS

The research for this study was conducted based on data collected from seven school districts in Northeastern Ohio. The districts involved in the study included a mixture of traditional, hybrid, and online platforms. Additionally, the school districts included a wide range of characteristics from rural to suburban and high SES to low-middle SES. Within this study, there was one school district with a traditional format and four school districts with a hybrid format. These schools were Austintown School District, Beaver Local School District, Canfield School District, Columbiana Exempted Village School District, and Southern Local School

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District, all located within Mahoning and Columbiana Counties in Northeast Ohio. There were two online schools located in Northeast Ohio, namely Virtual Learning Academy in Jefferson County and Utica Shale Academy in Columbiana County. The sample population for this research study was students identified with a learning disability who tested under Ohio State Tests standard conditions based on each Individualized Education Plan (IEP) and disability codes. Additionally, the sample population included students identified as gifted who currently possess a Written Education Plan (WEP) indicating the areas of accelerated learning. The students were current eleventh and twelfth-grade students from a school district located in Northeastern Ohio. The sample size was n = 526 students from the seven school districts. The data for this sample population was from the 2022-2023 school year. Using the previous year's data ensured that all students involved had taken all Ohio State End of Course Assessments analyzed in this study. This study examined the Ohio State End of Course Assessments for the following mathematics courses: Algebra 1, Seventh Grade, Fifth Grade, and Third Grade.

Thus, this study sought to generalize to the entire population of high school students identified with a learning disability who currently possess an Individualized Education Plan (IEP) testing under standard conditions for standardized mathematics testing and students identified as gifted who currently possess a Written Education Plan (WEP) for school districts located in Northeastern Ohio. If the results were to be generalized to the larger population of Ohio school districts, this study would need a larger sample from schools across Ohio. Data from multiple states would need to be accessed if the results were to be generalized to schools across the country.

Limitations

      Considering the current study's population, one limitation would be the sample size and the lack of diversity in the school districts' locations. Since the study only examined school districts in Northeast Ohio, the sample size may be small when considering the generalizability for high schools in the state of Ohio and across the United States. Therefore, this limitation prevented the study from generalizing to a larger population and forced the study to provide valid information only for Northeast Ohio high schools.

      Another limitation of this study involved the students with learning disabilities as the study did not consider when and how long each student had been identified. Thus, the study did not consider each student's identification at the time the student tested on prior assessments. Therefore, the study did not consider the student's accommodations during those previous assessments. Thus, the current thesis did not examine the methods of intervention utilized within the differing instructional methods. Additionally, this study limited data to students without Significant Cognitive Disabilities, as this was necessary because of testing standards, which may impact the generalizability of students with learning disabilities.

      A third limitation of this study involved the gifted students, as the study did not consider when and how long each student had been identified. Thus, the study did not consider each student's identification at the time the student tested on prior assessments. Additionally, this study did not consider the areas of identified acceleration for the gifted students, and thus, all students may not have had the mathematics acceleration identifier. Thus, the current thesis did not examine the methods of intervention utilized within the different instructional methods. All of these factors may restrict the generalizability of the gifted student population.

The last limitation involved the method of instruction during the prior academic years, as this study only examined the type of instruction a student received during the high school years. Thus, the student's current instructional method may have been different when each student took the Ohio State End of Course Assessment in third-, fifth-, and seventh-grade mathematics. Students identified in each instructional method for this thesis may have been in a different instructional method for all of the Ohio State End of Course Assessments. Therefore, there was a risk to the generalizability when examining prior academic success as a covariate for current academic success, as the student's instructional method may have changed throughout the years.

Power Analysis and Effect Size

Based on the primary research question and the main hypothesis of this thesis, a power analysis, which utilized G* Power 3.1, was conducted. The power analysis was conducted within the z-test category under the logistic regression statistical technique. The primary research question investigated if instructional method (Traditional, Hybrid, and Online) was a significant predictor of academic success on the Ohio State End of Course Assessment in Algebra 1 for students identified as gifted and/or identified with a learning disability. The main hypothesis of this thesis assumed that the hybrid method of instruction would provide the most beneficial instruction for these subpopulations of students based on prior literature, which touted the ease of access to instructors, intervention, rigor, and course material. With that, the hybrid method was set as the reference category for instructional methods, while traditional and online methods were set as the response categories. Hence, when calculating the Priori Power Analysis, this thesis viewed passing given the hybrid instructional method as the reference proportion and passing given not hybrid, indicating traditional and online methods of instruction as the response proportion. The results of the Priori Power Analysis indicated that a sample size of 1216 students

would be necessary to achieve a power of 80%. However, the sample size for this thesis was only 526 students. Therefore, an observed power analysis was conducted, which utilized G* Power 3.1 to determine the actual power of this thesis. The results of the observed power analysis indicated that a power of only 45.32% would be achieved with the given sample size.

The effect sizes for this study's model were calculated by odds ratios (OR). Odds ratios for each predictor in this study's model were calculated using R. When the dependent variable was binary, as in the current thesis, a linear function could still provide estimates of the effect of each odds ratio through logarithmic transformations. Odds ratio is a kind of effect size used for 2 x 2 contingency tables and non-linear regression (Ialongo 2016, 158). Odds ratio is defined as "the likelihood that an event occurs due to a certain factor against the probability that it arises just by chance (that is, when the factor is absent). If there is an association, then the effect changes the rate of outcomes between groups" (Ialongo 2016, 158). According to the previous study, logistic regression offers the opportunity to examine effect sizes for covariates and variables with more than two levels (Ialongo 2016, 159).

Research Supporting Adequate Sample Size for Logistic Regression

Since the power analysis results raised concerns for this thesis's credibility, an in-depth investigation was conducted into sample size and power analysis for logistic regression techniques. The investigation utilized Google Scholar and the Shawnee State University's library catalog to provide resources to defend this thesis's sample size and research plan. Prior research on logistic regression techniques indicated multiple issues regarding sample size calculations and power analysis outputs. The issues included the requirement of extremely large sample sizes to produce adequate power outputs even when samples indicated adequate power had been achieved following the data analysis. Thus, statistical norms have been developed which utilize

the number of events per variable (EPV) as a means to determine adequate sample sizes for

logistic regression analysis. Based on the results of eleven research studies [17, 21, 31, 44, 50, 51, 65-67, 76, 77],

with over 26,000 citations in other studies, that investigated the sample size and power of logistic

regression models, it was clear that a sample size of 500 or greater with the number of events per

variable (EPV) of 10 or greater would support a valid logistic regression statistical study.

According to studies by Concato et al. (1995), Peduzzi et al. (1995), and Peduzzi et al. (1996),

with over 10,000 citations combined when the number of events per variable (EPV) was 10 or

greater, the validity of logistic regression models was maintained. All of the above-mentioned

research studies utilized multivariable analysis techniques to examine the impact that a reduction

in the number of events per variable would have on Type I, Type II, and Type III errors for the

models. Additionally, the studies investigated the impact of an EPV reduction on the regression

coefficients for each model. According to one study regarding the accuracy of regression

coefficients, "At an EPV of 10 or greater, the average bias was generally within $\pm$ 10% of the

true value" (Peduzzi et al. 1995, 1504). Thus, regression coefficients were relatively unchanged

from the true value when the EPV for the model was 10 or greater. Additionally, according to the

same study, "The rates of full convergence were 100% for EPV $\geq$ 10, 99% for EPV = 5, and

80% for EPV = 2" (Peduzzi et al. 1995, 1504). Therefore, when the EPV was 10 or greater, the

logistic regression model was certain to converge, indicating that the model would fit the given

data well. A book by Long (1997) investigated sample size's impacts on maximum likelihood

(ML) estimations within regression models, including logistic regression. According to the

results within the book, "It is risky to use ML with samples smaller than 100, while samples over

500 seem adequate" (Long 1997, 54). Additionally, Long (1997, 54) indicated that literature

supports at least five observations per parameter, but for the research conducted within the book,

it was suggested that at least ten observations per parameter should be obtained. Furthermore, a study by Peng et al. (2002) offered support for having a sample size of 100. The study stated that "several authors on multivariate statistics have recommended a minimum ratio of 10 to 1, with a minimum sample size of 100 or 50, plus a variable that is a function of the number of predictors" (Peng et al. 2002, 10). Therefore, prior studies have confirmed that a sample size above 500 and an EPV of 10 or greater was adequate for a logistic regression model to maintain validity.

However, as it was vital to support the power analysis for this thesis, it was also crucial to present information regarding studies which indicated that the use of events per variable (EPV) criteria was not adequate to confirm the sample size of a logistic regression model. A recent study by van Smeden et al. (2019) utilized simulation study techniques to determine the predictive performance of logistic regression models based on the EPV criteria. According to this study, "... the EPV fails to have a strong relation with metrics of predictive performance across modelling strategies. Given our findings, it is clear that EPV is not an appropriate sample size criterion for binary prediction model development studies" (van Smeden et al. 2019, 2467). Thus, this study indicated that the EPV of 10 or greater criteria fell short when examining predictive abilities for specific outcomes. However, this study only examined a single case in which the EPV failed to create a convergent model. Additionally, as the thesis of discussion did not predict outcomes but rather investigated the significance of each specific variable in terms of the impact on academic success, the EPV criteria still maintained the model validity.

Therefore, as the bulk of prior research supported the use of sample sizes of 500 or greater with the number of events per variable (EPV) of 10 or greater for logistic regression models, the current research thesis found it reasonable to proceed with the study. As the sample

size for this thesis was 526 students with an events per variable (EPV) = 75 students, both values exceed the criteria thresholds outlined in most prior research studies.

INSTRUMENTATION

Ohio State End of Course Assessments

The Ohio State End of Course Assessments are state achievement tests that indicate how students' knowledge and skills have grown during each tested year based on Ohio's Learning Standards. The tests are used to guide future teaching and to ensure that students are fully prepared for success in school and beyond. The Ohio State End of Course Assessments have been in place as the mode of standardized testing since the 2014-2015 school year. The results of these assessments are part of each school's report card, providing information to the public regarding each school's performance compared to other districts across the state.

A test specifications document (Ohio Department of Education 2020) for the design of these assessments demonstrated the alignment to the learning standards, cognitive complexities, and potential items that may appear on each assessment. Each assessment was broken into reporting categories that separate items into clusters of learning standards. Additionally, questions are separated by Depth of Knowledge (DOK) and cognitive demand. Depth of Knowledge (DOK) was utilized for mathematics testing and specifies the complexity of thinking required for students to complete each task successfully. The categories for Depth of Knowledge (DOK) included level one recall, level two skills/content, and level three strategic thinking. For example, the Algebra 1 assessment covers forty-three standards across four reporting categories within three Depth of Knowledge (DOK) levels. This document also provided the types of items that may appear on each assessment and the content limits based on grade-level expectations. A test blueprint document (Ohio Department of Education 2020) has been created for each

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assessment, indicating the categories of assessment, the Depth of Knowledge (DOK) requirements, and the points associated with each cluster of Ohio's Learning Standards.

Finally, an item development document has been developed by the Ohio Department of Education (2023) to explain the process of assessment preparation. A partnership between the Ohio Department of Education and Workforce (DEW) and Cambium Assessment was established to draft new assessment questions. Then, each question was revised and reviewed by Content Advisory Committees and Fairness Committees, which have been established for each test subject. The new test items are then field-tested and validated based on rubrics and range-finding. Finally, the results from the field-tested items were scored, the data was reviewed, and based on each committee's findings, new items were approved for operational testing.

The Ohio State End of Course Assessments are administered during the normal testing window in the spring of each school year, and retakes are administered during the fall of the following school year. The Ohio State End of Course Assessments in seventh-grade mathematics and Algebra 1 consist of two ninety-minute testing windows, while the Ohio State End of Course Assessments in third- and fifth-grade mathematics consists of two seventy-five-minute testing windows. The number of questions on each part varies yearly, but the content covered remains consistent. The mathematics assessments consist of the following question types: Equation Item (EQ), Gap Match Item (GM), Grid Item (GI), Hot Text Item (HT), Inline Choice Item (IC), Matching Item (MI), Multiple Choice Item (MC), Multi Select Item (MS), Simulation Item (Sim), and Table Item (TI). A score of 684 was classified as proficient, and a score of 725 was classified as accelerated (Han 2022, 5). Based on the two populations of students within this thesis, the above thresholds were utilized as the cutoff values for passage of the assessments.

Reliability and Validity

The reliability of the Ohio State End of Course Assessments goes back to the adoption of Ohio's Learning Standards in English and Mathematics in 2010 as part of a multi-state effort. These tests are designed to measure the progress of student achievement toward the Ohio Learning Standards. These standards are addressed and tested in grades three to eight and high school. Each grade a student was tested in will have a subscore representing each subject's learning standards. For example, Algebra 1 subscores will target Number, Quantities, Equations and Expressions, Functions, Statistics, and Modeling and Reasoning. These assessments are fixed and administered in an online format (Paper format as an accommodation for special circumstances). Each question pertained to the individual subject and was then connected to Ohio Learning Standards.

Regarding the validity of the Ohio State End of Course Assessments, the Ohio Department of Education created Content Advisory and Rubric Validation committees. These committees include educators, content specialists, and other stakeholders in the education of Ohio students to ensure that Ohio State End of Course Assessments are valid forms of assessment for each student. There was a committee responsible for each assessment, and the members of each committee included a majority of classroom teachers from a wide range of school districts across the state of Ohio. These committees meet regularly to examine new test questions for the assessment bank and materials associated with specific test questions or content. The committee members examined these test questions to ensure each accurately assessed Ohio's Learning Standards for each grade level and subject area. Additionally, the committee members report to the Ohio Department of Education to ensure that every assessment question has appropriate Depth of Knowledge (DOK) for the grade level of each assessment and

to ensure that the content that was assessed was accurate for the subject as well as clearly written for ease of understanding based on grade level abilities. For example, the Algebra 1 Depth of Knowledge (DOK) consists of eight to sixteen test points for level one, twenty-five to forty for level two, and eight to sixteen for level three (Vojacek 2022, 2). After state testing, the committee reconvenes to examine the students' responses from the machined scored test items embedded in the online field test for each assessment year. This meeting was designed to ensure that the machine accurately scores test items. If any issues arise, the committee has the right to change the field test scoring rubric to clarify certain test items and ensure the validity and reliability of each field-tested question.

PROCEDURE

Data Collection

The research for this study was conducted based on data collected from the seven school districts in Northeastern Ohio mentioned above. The researchers contacted each district involved in the study to receive approval for the requested data. Each district provided the data based on the information released by the Ohio Department of Education. The data was collected from each school district involved for the 2022-2023 school year's data release provided by the Ohio Department of Education for eleventh and twelfth-grade students during the current 2023-2024 school year. School districts listed in the research design collected data from the Algebra 1, third-, fifth-, and seventh-grade mathematics assessments for the aforementioned student populations. Data was collected from Access, a data acquisition site that collects assessment data and student demographic information. It also lists students who were identified as gifted or having a learning disability. Any student identifiable information was deleted from the data

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before it was collected, and no student educational records were released as part of the study.

In addition to Ohio State End of Course Assessment Scores, each school district's class size and attendance rate were collected from Ohio's School Report Cards. School data from these reports was from the 2022-2023 school year.

Ethical Considerations

An exempt IRB application was completed and approved by Shawnee State University's Institutional Review Board for this study. Both researchers completed PHRP, Protecting Human Research Participants, training as part of the IRB application process, ensuring that the researchers understood the obligations for research involving human subjects.

No student-identifiable information was obtained or released during this study, so there are no ethical issues involving the two subpopulations. Additionally, as no student-identifiable information was obtained or released during this study, there are no ethical issues involving the educational standing of any student. Regarding the school districts involved in the study, the district name was not associated with any student in the release of the data analysis. Thus, the reputation of each school district was not harmed as a result of this analysis. The researchers have identified the district from which each student was from as a means to report the findings of the study to each district, but a district comparison was not conducted to alleviate ethical concerns regarding district reputation.

DATA PROCESSING AND ANALYSIS

Methodology Defense

This thesis utilized logistic regression techniques since the research planned to determine whether students passed the Ohio State End of Course Assessments or not, but did not predict

actual assessment scores, which resulted in all scores being converted to zeros and ones. Another reason for the score conversions stemmed from the COVID-19 pandemic when the Ohio Department of Education reported student scores for the Spring 2020 testing window on a scale from one to five. One represented limited understanding of course material, two represented basic understanding, three represented proficient understanding, four represented accelerated understanding, and five represented advanced understanding. Threshold scores were determined based on the Ohio Department of Education's identifiers for proficiency at 684 and accelerated learning at 725. A value of one was designated to gifted students, who achieved a score of 725, and to students with a learning disability, who achieved a score of 684. Any student who did not achieve one of the two threshold scores was designated a zero value. Converting student scores to zeros and ones eliminated the need to calculate average scores for each student for the Spring 2020 testing session, which would have been difficult as the one to five scale was based on raw score ranges, not a specific formula. Additionally, Hybrid was set as the reference category for the instructional method variable, $X1$. Students identified as having an IEP or WEP were coded as YES. Any student coded as NO indicates that the student did not match this criteria. Class size was categorized into two levels: below average and above average. According to Ohio high school data, the average high school class size in the state was 16.6 (Pallay 2022). Thus, any student who attended a school district with an average class size below 16.6 were categorized as below average, and students in a school district with an average class size above 16.6 were categorized as above average. Based on the assumptions of this thesis and Ohio high school data, below average, indicating a smaller than average class size was set as the reference category for the class size variable, $X2$. Attendance rate was categorized into two levels: met the state criteria and did not meet the state criteria. According to the Ohio Department of Education chronic

absenteeism was categorized as any student who missed more than ten percent of the educational hours for a single school year (Ohio Department of Education 2023). In an effort to curb chronic absenteeism in the state of Ohio, the Department of Education partnered with Stay in the Game, an organization formed in 2019 to increase student attendance. According to this organization, the state goal is for students to attend school more than ninety percent of the time (Stay in the game! attendance network - keep learning, every day 2024). Thus, any student who attended a school district with an attendance rate greater than ninety percent was categorized as met the state criteria, and any student who attended a school district with an attendance rate of ninety percent or below was categorized as did not meet the state criteria. Based on the assumptions of this thesis and Ohio's state goal, met the state criteria, indicating a higher attendance rate, was set as the reference category for the attendance rate variable, X3. The researchers of this thesis have taken into consideration the class size and attendance rate from each school district from the 2022-2023 school year and not from prior years. Both of these variables could have varied prior to the 2022-2023 school year. Furthermore, school districts were lettered A - G. Any student data with two or more missing test scores from third, fifth, and seventh grades were excluded from the data set. For any student with one missing test score, a mean from the other two test scores was used to calculate that missing value. This method was popular for missing data values despite being well-known for producing biased estimates (Allison 2009, 76). The biased estimates were not a concern for this thesis, considering the sample size met the events per variable (EPV) of 10 or greater that was supported for a logistic regression analysis. Additionally, the missing values were observed only in the prior academic success variable. The quantitative variables, which were either dichotomized or categorized, in the model were from third-grade math, fifth-grade math, seventh-grade math, and Algebra 1 test scores on Ohio State

End of Course Assessments, class size, and attendance rate. The categorical variables in the study were instructional methods (traditional, hybrid, online), student population (students with an IEP or WEP), and school districts (lettered A- G).

All statistical calculations performed in this study were computed with the statistical package R, version 4.3.0 (2023-04-21). These calculations included descriptive statistics, logistic regression models, graphs, and tables. A 95% confidence interval was calculated for each student population. An alpha level or p-value of .05 was utilized to determine all statistically significant values.

Logistic regression was a type of linear regression and was used when the dependent variable was dichotomous, unordered/ordered polytomous (three or more categories that are ordered/unordered), or polytomous nominal/ordinal (three or more variables that are naturally ordered or not) (Menard 2002, 91). Three types of logistic regression were considered for this study: Binary, Multinomial, and Ordinal. Binary logistic regression was used when the dependent variable was dichotomous and the independent variables were either continuous or categorical (Midi et al. 2010, 254). The dependent variable for this study was categorical, whether a student achieved academic success or not based on Ohio State End of Course Assessment score thresholds for passing. The independent variables in the study were identified as categorical and continuous. For the purpose of this thesis, binary logistic regression was appropriate. Multinomial logistic regression was used when the dependent variable of the model had two or more categories and followed procedures similar to binary logistic regression (Kwak and Clayton-Matthews 2002, 1). Ordinal logistic regression examined the natural ordering of the response variable (Bender and Grouven 1997, 547). The previous two types of logistic regression

did not align with the variables defined in this study. Therefore, binary logistic regression was adequate for the analysis of this study.

In further research of methodology, logistic regression has some downfalls that were considered in this thesis. A study done by Mood (2010) examined the problems that occur when using logistic regression. The problems outlined in the study focused on unobserved heterogeneity. In any study, there is a chance that some of the variation in the response variable will be caused by variables that are not observed or considered by the researcher. Additionally, other concerns addressed in this study include the issue of interpreting the log-odds ratios (LNOR) or odd ratios (OR), comparing LNOR or OR across various models with different independent variables, and comparing LNOR or OR across samples and groups within those samples over time. These problems are impacted by the unobserved heterogeneity that the researcher does not consider when analyzing data. Concluding that "Because coefficients depend both on effect sizes and the magnitude of unobserved heterogeneity, we cannot straightforwardly interpret and compare coefficients as we do in linear regression" (Mood 2010, 79). The author offered ways to limit the problems that were listed above. First, researchers must be aware of these problems at the start of data collection. Researchers should avoid collecting data as dichotomous and qualitative variables if continuous alternatives are available. Finally, researchers should collect information on variables that could impact the outcome of the study when using logistic regression, regardless of the importance or relation to other variables.

The current study examined the problems that could potentially arise in a logistic regression model. The current study's limitations align with the problems stated in the study by Mood (2010). The dates when students were identified with a learning disability, or gifted could impact an individual student's success. Both student populations have accommodations that

affect the learning process and testing environment for students with a learning disability. Furthermore, online students could have different accommodations for both student populations, which could impact a student's test score. The same can be said for when students are tested for IQ level. Despite these factors, this thesis examined the statistical significance of these unobserved variables. The sample size for this study was adequate and within acceptable values that would limit the problems listed above. All of the dichotomous independent variables in this study have no other alternatives, continuous variables, that could be used, which limits the problems in interpreting LNOR and OR of the logistic regression model. Therefore, all potential problems with using a logistic regression approach have been considered in the data analysis of this thesis's sample.

Logistic Regression Inferences, Assumptions, and Tests

The current study examined the assumptions associated with logistic regression techniques. An article by Stolzfus (2011) that has been cited over 1000 times was used as a guide regarding the assumptions of logistic regression. The first assumption was independence of errors. None of the variables in this study have repeated values or any correlated outcomes. The second assumption was the linearity in the logit for any continuous variables. This assumption was examined using the statistical package R. The interaction of each continuous variable and the natural logarithm was created to help determine any statistical significance. The third major assumption was the absence of multicollinearity. Each variable in the study was unique to the model used to predict academic success; therefore, redundancy was not of concern. DFBetas were observed and carefully considered. This thesis noted that anything associated with a large standard error for the estimated beta coefficients of the variables would violate this assumption. The last assumption for using logistic regression was the lack of strongly influential outliers. R

was used to compare the model fit and beta coefficients when including and excluding the outlier cases to determine the influence these values had on the model.

Similar Studies and Variable Selection

This thesis was guided by many prior research studies based on the methodology, statistical techniques, and variables that such studies utilized. One pivotal study by Alzen et al. (2018) has been downloaded over 27,000 times and cited in 115 other educational studies. This study was important for the current research thesis because it utilized logistic regression techniques to examine failure rates within STEM courses as impacted by the Learning Assistant Model (LA). The study additionally examined dichotomous variables of gender, race, first-generation status, prior performance based on GPA and ACT scores, and prior enrollment in Learning Assistant Model (LA) courses. Thus, this study supported the inclusion of instructional methods and prior academic performance as dichotomized variables within the current thesis. Additionally, as this prior study utilized logistic regression to investigate academic success within STEM courses, this supported the selection of logistic regression techniques for the current thesis.

The Learning Assistant Model (LA) was an instructional method that differed based on each course of discussion. This model could include small group intervention to facilitate a deeper understanding of course material, technological interventions to stimulate cognitive development, or additional instruction outside regular class time (Alzen et al. 2018, 2). All of the above mentioned techniques are implemented to create more active engagement amongst the students and change the setup from teacher-led to student-led classrooms. Thus, this study provided clear connections to the current thesis, as this thesis investigated the impact that instructional methods had on academic success on the Ohio State End of Course Assessment in

Algebra 1. As instructional methods offer different levels of active engagement for students and provide different levels of teacher and student involvement in the learning process, this prior study supported using instructional methods as a potential predictor of academic success. The prior study also supported the theoretical framework of the current thesis, the Situated Cognitive Learning Theory, and the Connectivism Learning Theory. Both educational theories of the thesis's theoretical framework focus on creating student-centered learning environments through various modes of instruction with the integration of technology to both support struggling students and provide rigor for accelerated students. Since the Learning Assistant Model (LA) focused on intervention techniques and enhancement of cognitive understanding, the prior study provided excellent support for this thesis's theoretical framework.

The study by Alzen et al. (2018, 4) was conducted based on data from the University of Colorado Boulder with sixteen cohorts in Physics, Calculus, and Chemistry courses. The study investigated the impact Learning Assistant Models (LA) had on course failure rates, where course failure was defined as receiving a D, F, or withdrawal from the course of study. As the thesis of discussion focused on mathematics assessment scores, the Learning Assistant Model for the Calculus courses of the prior study was investigated. For the Calculus courses, the Learning Assistant Model (LA) utilized small groups, activities constructed to enhance conceptual understanding, and additional instructional time for intervention (Alzen et al. 2018, 4). The prior study investigated the impact of small groups relating to a reduction in class sizes, intervention similar to that utilized by intervention specialists for students with learning disabilities, and activities to stretch understanding, which was similar to concepts employed by general education teachers to support gifted students. Thus, the prior study supported the use of class size and the two subpopulations, students identified with a learning disability and gifted students, within the

current thesis. The prior study selected certain control variables to account for bias derived from the different types of Learning Assistant Models (LA) used within the different courses and from the differences in the prior performance among the students within the sample. This also connected to the current thesis as class size, attendance rate, and prior academic performance were utilized as control variables or covariates. The results of the prior study provided evidence, based on mean comparisons, that a student was more likely to take advantage of the Learning Assistant Model (LA) if the student had a higher high school GPA and admissions test score (Alzen et al. 2018, 8). Thus, the prior study provided more support for the addition of prior academic performance within the current thesis, as specific student characteristics could impact academic success. The prior study indicated that due to a lack of covariates, the model provided only partial associations between course failure and Learning Assistant Models (LA). The study utilized the statistical software R to compute all calculations and explained how logistic regression estimates were presented as logits, which were transformed into odds ratios by exponentiating the logit estimations. The results of the prior study indicated that "...students who were exposed to the LA program in at least one STEM gateway course had 6% lower failure rates in concurrent or subsequent STEM gateway courses" (Alzen et al. 2018, 8). Furthermore, the prior study found that "The odds ratio estimate in Table 5 for model 3 is 0.367 for LA exposure with a confidence interval from (0.337–0.400)" (Alzen et al. 2018, 8). Thus, the results indicated a lower probability of failure existed for students who received the Learning Assistant Model (LA) as the odds ratio was less than one, and the confidence interval did not contain one, indicating statistical significance. However, the study initially calculated an odds ratio of 0.65 before controlling for the additional variables within the logistic regression model (Alzen et al. 2018, 8). Thus providing further support for the logistic regression techniques selected for the

current thesis as covariate adjustments significantly altered the odds ratio. The current thesis planned for these issues by utilizing logistic regression techniques to determine significant predictors of academic success when controlling for the specific variables of class size, attendance rates, and prior academic performance.

Another study that supported the use of logistic regression with similar variables was seen by Pingry et al. (2012). This study determined which student characteristics and disability-related services impacted graduation among college students with disabilities. In parallel, the current thesis was also concerned with students with learning disabilities and the instructional formats that affect academic performance. The prior study specifically focused on the services that these students qualify for and graduation rates. The services that students typically receive involve extended time with assessments, read-aloud instructions, and small group settings. Accommodating services can vary with students enrolled in online schools, leading to a potential limitation that the current thesis considered when analyzing the data. The prior study did go further in documenting disabilities by categorizing each type. In high school classrooms, a commonly seen disability was ADHD. Accommodating students with this specific disability was at the discretion of individual school districts. The previous study used binary logistic regression to help find the variables that predicted graduation. This thesis also used this type of regression due to the categorical nature of the dependent variable, academic success.

Notably, the factors that negatively impacted graduation rates seen in Pingry et al. (2012) study were also of concern in the current thesis. For example, the prior study noted that universities may fail to provide access to technology or train students to use such technology. Additionally, classroom assistants and note-taking services decreased the odds of students graduating. It was noted that this does not imply that these services are harmful to students. The

use of these tools needs to be optimized and coordinated more effectively. This observation was helpful for the current study. Connectivism provides theoretical support to students using technology as a tool for learning. Critically, students need to share knowledge using technology. Given that one of the instructional formats was online, the current aim of the study was to explain any variation with this format. If students, as seen in the previous study, are not knowledgeable with the available technology, it can inhibit student communication with instructors and other students. Thus, lacking knowledge with technology provided one explanation for the non-success of online students.

In comparison, it can be noted that logistic regression was a tool to analyze the outcome of categorical variables. As seen in many research studies, it was common for educational researchers to use logistic regression to indicate student success, whether it was academic or, in the previous study, graduation. Variables like attendance rate, class size, prior academic performance, and students identified as gifted or having a learning disability are common occurrences in research. Therefore, it was appropriate for the current thesis to continue to examine these variables more extensively.

In addition to the studies above, a study by Bosworth (2014), which has been cited over 150 times and downloaded more than 4,000 times, supported the use of class size as a potential predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 for the two subpopulations of the current thesis. The study by Bosworth (2014) utilized Chi-Square Tests to investigate the relationship between class size and standard deviations of students' end-of-grade assessment scores. This study found that when controlling for teacher gender, race, and experience, a one-student decrease in class size resulted in a .0631 standard deviation increase in mathematics end-of-grade assessment scores for students identified with

learning disabilities (Bosworth 2014, 152). However, the study also indicated that students of different ability levels may be impacted differently by class size changes. Contradicting the result mentioned above, the study found that when controlling for the same effects, a one-student decrease in class size resulted in a .2444 standard deviation decrease in mathematics end-of-grade assessment scores for students identified as gifted (Bosworth 2014, 152). Although the magnitude of these statistically significant values was relatively small, the values provided some indication of the impact of class size on specific student populations. Thus, the incorporation of class size as a potential predictor variable for the current thesis was supported by the results of this prior study that found differing conclusions based on student population characteristics.

The same study by Bosworth (2014) also examined the impact of smaller class sizes on specific groups of students based on the classroom composition of the student population and the teacher's gender, race, and experience level. The classroom composition factor focused on heterogeneous groupings, grouping students of all backgrounds together in classrooms, and the composition included student demographic identifiers such as race, SES, school per pupil expenditure, and district-free and reduced lunch plans. The findings concluded that students with learning disabilities and gifted students benefit less from a small class size than other subpopulations, such as female students, Hispanic students, and students on a free and reduced lunch plan based on mathematics end-of-grade assessment scores (Bosworth 2014, 156). The results indicated that a one-student decrease in class size when controlling for classroom composition resulted in a .0005 and .0015 decrease in the standard deviation of mathematics end-of-grade assessment scores for students with learning disabilities and gifted students, respectively (Bosworth 2014, 156). Once again, although the magnitude of these statistically

significant values was relatively small, the values provided support regarding the impact of class size on specific student populations. The current thesis expanded on the prior study by adding instructional method as a classroom composition factor. Therefore, the prior study provided sustenance in adding class size as a potential predictor of academic success when students with learning disabilities and gifted students are immersed in different instructional methods.

Additionally, when comparing the results of average success on end-of-grade assessments and the standard deviation of success on end-of-grade assessments, the study indicated a more significant impact on the standard deviation when reducing class size. The previous results indicated "that class size reductions may be relatively more effective at closing achievement gaps than raising average attainment" (Bosworth 2014, 162). Thus, this provided additional support for the current thesis's inclusion of class size as a predictor variable since gap closing was a major requirement for students identified with learning disabilities. When examining the Ohio State School Report cards, a crucial component of school success was the ability of each school to close achievement gaps, and this was immensely more impactful for the population of students with learning disabilities.

Another variable considered in the current study pertained to the attendance rate of students. A study by Balfanz and Byrnes (2006) discussed attendance rate and other factors that can limit the achievement gap for high-poverty students. In the study, various analyses were used that looked at three schools from fifth to eighth grade that focused on math achievement. From prior research, Balfanz and Byrnes (2006) provided many explanations for the achievement gap in the middle grades. The causes that were stated range from shortages of mathematics teachers who are skilled and knowledgeable to undermotivated students. Additionally, it was explained that possible reasons for these causes stem from inexpensive legislative reforms, high-stakes

testing, and district or statewide standards. Schools not categorized as high poverty tend to have stronger programs and knowledgeable mathematics teachers, which limit the achievement gap. Furthermore, Balfanz and Byrnes (2006) stated that insufficient data exists to explain the gaps seen with minority students.

One of the analyses conducted in the prior study was a logistic regression analysis. This analysis was used to determine which factors, as stated above, impact closing the achievement gap for students during the middle school years. The data was coded using ones and zeros. A one indicated that a student gained more Grade Equivalents (GEs) on a SAT-9 standardized test than time spent in school. The factors that were examined were behavior marks, attendance rates, effort in math class, and percentage of homerooms that were high-gain. The study explained, "Schools need to provide teachers and class- rooms that enable the average student to gain more than a grade equivalent of mathematical skill and knowledge per year for multiple years. At the same time, students need to show up, behave in class, and try hard to learn. When these factors come together, achievement gaps close" (Balfanz and Byrnes 2006, 153). Attendance rate did have a positive effect on closing the achievement gap. However, it was acknowledged in this article that generalizing these results was difficult as the data analysis left more unexplained than explained regarding the factors in the model.

In comparison, the current thesis used attendance rate as a predictor, examined student populations that included a variety of SES, and used binary logistic regression. Attendance rate was a critical variable in supporting an instructional method that impacts student achievement. In the study described above, Balfanz and Byrnes (2006) tried to determine what specifically affects student performance in high-poverty schools. The attendance rate showed a positive correlation to the logistic regression model in the study. Despite the evidence of the study not fully

confirming this result to a more considerable extent, it was noted that more exploration was needed. The previous results supported the current thesis to use attendance rate as a continuation of the former study, adding more information that could be used for future studies.

In conclusion, an in-depth investigation of prior research was conducted to ensure that the findings of significant educational studies supported the statistical techniques and variables utilized within this thesis. Examining prior studies confirmed that logistic regression techniques were appropriate for determining academic success based on the variables and subpopulations of students within this thesis.

SUMMARY

The primary research question for this study was concerned with finding the predictors that statistically impact the academic success of two specific student populations: those identified as gifted or having a learning disability. The researchers aimed to identify these predictors using a logistic regression model supported by prior educational research. In careful consideration, the measure used to indicate success, the dichotomized dependent variable, was based on the test scores from both student populations on the Algebra I Ohio State End of Course Assessment. The threshold for success was based on the characteristics of the student population. A score of 684 or 725 with respect to the student populations in the study was the indicator of success. Further support for using this instrument in measuring success was seen in the reliability and validity of the test instrument. Due to the alignment of the assessment to Ohio's Learning Standards, the reliability of measuring the specific standards to an individual student's test score was acceptable. The Content Advisory and Rubric Validation committees also confirmed the validity of this instrument.

By definition, binary logistic regression was the appropriate type of logistic regression because the dependent variable in the study had a categorical nature of two outcomes. Previous educational studies guided the assumptions that follow this statistical procedure. Despite the smaller sample size for this study, it satisfied the EPV of 10 or greater that most educational research supported. The power of 45.32% for this study was of little concern after examining prior studies, which indicated that the sample size of 526 and the EPV of 75 were both sufficient to maintain the model validity. The effect size for each predictor variable was calculated by using odds ratios. The assumptions for using logistic regression were followed and calculated using the statistical package R. The researchers meticulously followed well-known sources cited for logistic regression procedural methods.

In addition to all the considerations stated previously, the methodology and procedures used in this study were approved by Shawnee State University's Institutional Review Board. Prior research fully supported carefully considering all assumptions of the statistical tests and variables. The researchers want future studies to consider researching these variables further concerning the student populations in this study. Importantly, it has been noted that not enough research had been conducted as it pertained to these student groups. The generalized nature of educational research often overlooked students who were gifted or identified as having a learning disability. The goal was to promote further exploration and develop a means for instructional staff at primary and secondary schools to accommodate and provide pedagogical techniques that improve academic achievement for the two student populations in this thesis. The next chapter will explore the analysis of the data set and thoroughly examine the assumptions of logistic regression and the statistical significance of each predictor that address this thesis's primary and secondary research questions.

CHAPTER IV RESULTS

INTRODUCTION

In this chapter, the results of the study on the impact that instructional method (Hybrid, Online, and Traditional) has on academic success based on the Algebra 1 Ohio State End of Course Assessment while controlling for prior academic performance on the Seventh-Grade Ohio State End of Course Assessment for students with learning disabilities and gifted students are presented. Additionally, the impact of class size and attendance rate on academic success based on the Algebra 1 Ohio State End of Course Assessment while controlling for prior academic performance on the Seventh-Grade Ohio State End of Course Assessment for students with learning disabilities and gifted students are presented. Furthermore, this section starts with a reiteration of the data, participants, procedures, and instruments used to conduct the study. Next, the chapter includes preliminary results, confirming the use of specific statistical techniques, removing two covariates, eliminating an interaction term, handling separation issues, and revising research questions and goals.

SETTING AND PARTICIPANTS

The research for this study is based on data collected from seven school districts in Northeast Ohio. The districts involved in the study include a mixture of traditional, hybrid, and online platforms. Additionally, the school districts include a wide range of characteristics from rural to suburban and high SES to low-middle SES. Within this study, there is one school district with a traditional format, four school districts with a hybrid format, and two school districts with an online format, all located within Northeast Ohio. The sample population for this research study is students identified with a learning disability who test under Ohio State Tests standard

conditions based on each Individualized Education Plan (IEP) and disability codes. Additionally, the sample population includes students identified as gifted who currently possess a Written Education Plan (WEP) indicating the areas of accelerated learning. The sample size is n = 526 current eleventh and twelfth-grade students from one of the seven school districts. The data for this sample population is from the 2022-2023 school year. Using the previous year's data ensures that all students involved have taken all Ohio State End of Course Assessments analyzed in this study. This study examines the Ohio State End of Course Assessments for the following mathematics courses: Algebra 1 and Seventh Grade. Table 1 displays the number of students, class size, attendance rate, and instructional method for the seven school districts within the study. Table 2 shows the frequencies and percentages for the two student populations for each instructional method and the total sample.

Table 1. School District Descriptive Statistics

School District Letter	# of Students	Student:Teacher Ratio (Class Size)	Attendance Rate	Method
School District A	143	15.86:1	0.907	Hybrid
School District B	56	16.93:1	0.900	Hybrid
School District C	204	16.44:1	0.930	Traditional
School District D	34	16.47:1	0.920	Hybrid
School District E	14	18.41:1	0.895	Hybrid
School District F	58	17.27:1	0.905	Online
School District G	17	50.51:1	0.819	Online
Total	526			

Table 2. Instructional Method Student Population Frequencies & Percentages

Method	# of Students		Percent of Sample	
	Gifted	IEP	Gifted	IEP
Hybrid	143	104	0.579	0.421
Total	247		0.470	
Traditional	191	13	0.936	0.064
Total	204		0.388	
Online	19	56	0.253	0.747
Total	75		0.142	
Total Sample	353	173	0.671	0.329
	526			

INSTRUMENTATION AND DATA PROCEDURES

The Ohio State End of Course Assessments are utilized for the academic success component of this study. These assessments are state achievement tests that indicate how students' knowledge and skills have grown during each tested year based on Ohio's Learning Standards. The Ohio State End of Course Assessments have been in place as the mode of standardized testing since the 2014-2015 school year. Each assessment is broken into reporting categories that separate items into clusters of learning standards. Additionally, questions are separated by Depth of Knowledge (DOK), which specifies the complexity of thinking required for students to complete each task successfully. The categories for Depth of Knowledge (DOK) include level one recall, level two skills/content, and level three strategic thinking. For example, the Algebra 1 assessment covers forty-three standards across four reporting categories within three Depth of Knowledge (DOK) levels. The Ohio State End of Course Assessments are administered during the normal testing window in the spring of each school year, and retakes are administered during the fall of the following school year. The Ohio State End of Course

Assessments in Seventh-Grade Mathematics and Algebra 1 consist of two ninety-minute testing windows. The number of questions on each part varies yearly, but the content covered remains consistent. The mathematics assessments consist of the following question types: Equation Item (EQ), Gap Match Item (GM), Grid Item (GI), Hot Text Item (HT), Inline Choice Item (IC), Matching Item (MI), Multiple Choice Item (MC), Multi Select Item (MS), Simulation Item (Sim), and Table Item (TI). A score of 684 is classified as proficient, and a score of 725 is classified as accelerated (Han 2022, 5). Based on the two populations of students within this study, the above thresholds are utilized as the cutoff values for passage of the assessments to create the categories of Pass and Not Pass.

The research for this study is based on data collected from the seven school districts in Northeast Ohio mentioned above. The researchers contacted each district involved in the study to receive approval for the requested data. Each district provided the data based on the information released by the Ohio Department of Education. The data collected from each school district involved the 2022-2023 school year's data release provided by the Ohio Department of Education for eleventh and twelfth-grade students during the current 2023-2024 school year. School districts listed in the research design collected data from the Algebra 1 and Seventh-Grade Mathematics assessments for the aforementioned student populations. The data collected is from Access, a data acquisition site that collects assessment data and student demographic information. It also lists students who are identified as gifted or having a learning disability. Any student identifiable information was deleted from the data before collection, and no student educational records were released as part of the study. In addition to Ohio State End of Course Assessment Scores, each school district's class size and attendance rate were collected from Ohio's School Report Cards. School data from these reports was from the 2022-2023

school year. Table 3 displays the Pass and Not Pass frequencies and percentages for the Algebra 1 Ohio State End of Course Assessment for each student population within the different instructional methods and the total sample. Table 4 shows the Pass and Not Pass frequency and percentage for all students in the study for the Seventh-Grade Mathematics Ohio State End of Course Assessment.

Table 3. Ohio State End of Course Assessment in Algebra 1 Breakdown

INSTRUCTIONAL METHOD BREAKDOWN Ohio State End of Course Assessment in Algebra 1					
	Pass (Percentage)		Not Pass (Percentage)		Total
Hybrid	Gifted	IEP	Gifted	IEP	
	124 (0.502)	44 (0.178)	19 (0.077)	60 (0.243)	
	168 (0.680)		79 (0.320)		247
Traditional	Gifted	IEP	Gifted	IEP	
	158 (0.775)	13 (0.064)	33 (0.162)	0	
	171 (0.838)		33 (0.162)		204
Online	Gifted	IEP	Gifted	IEP	
	16 (0.213)	23 (0.307)	3 (0.040)	33 (0.440)	
	39 (0.520)		36 (0.480)		75
Total	Gifted	IEP	Gifted	IEP	
	298 (0.567)	80 (0.152)	55 (0.105)	93 (0.177)	
	378 (0.719)		148 (0.281)		526

Table 4. Ohio State End of Course Assessment Prior Performance Breakdown
(Instructional Method and Student Population Characteristics were not included based on data timeline limitations of the study)

Ohio State End of Course Assessment Prior Performance Breakdown			
Assessment	Pass (Percentage)	Not Pass (Percentage)	Total
Seventh Grade Mathematics	355 (0.675)	171 (0.325)	526

PRELIMINARY RESULTS

Mixed Effects Logistic Regression

The researchers ran a mixed effect or multilevel logistic regression approach for the study due to the possibility of nested data within the school districts. An ANOVA test of the random intercept model with the random effect District against a constant-only model is statistically significant, $\chi^2(1, N = 526) = 29.654, p < .001$, indicating that mixed effect or multilevel techniques are necessary. However, running models with the random effect, District, and fixed effects of IEP or Gifted, Method (X1), Class Size (X2), and Seventh-Grade score (X6) returns model outputs with singularity warnings. This results from the random effect returning a variance and standard deviation of 0. According to prior research, there are various methods to handle singularity issues with a random effect model. These methods include removing the random effect if the coefficients, standard errors, and significance are not affected (Bolker et al. 2023). According to an additional source, when models were run with the random effect and without the random effect, the changes were negligible, and examining the dependent variable as binomial produced unbiased results (Pasch et al. 2013, 165). Another method starts with the most complex model and removes fixed effect and or random effect variables until the model obtains a variance and standard deviation for the random effect (Singmann and Kellen 2019, 10). However, prior research indicates this method should be used with caution as it may result in all fixed effects being removed, which would indicate a similar result to the first method in that the random effect is not necessary. The researchers conclude that as the dependent variable for this study is binomial (Pass or Not Pass) and the coefficients, standard errors, and significance did not change with the removal of the random effect, District, prior research confirms that removing the random effect and running basic logistic regression techniques is acceptable for this study.

Removal of Covariates

While examining the prior academic performance variables, Third-, Fifth-, and Seventh-Grade Ohio State End of Course Assessment scores, the researchers determined that the Third-Grade (X4) and Fifth-Grade (X5) covariates result in singularity warnings because the correlations with the Method (X1) variable are close to 0. The Third-Grade and traditional method correlation is 0.055, and the Fifth-Grade and online method correlation is -0.063. When running the logistic regression model with all of the covariates included, the model returns singularity warnings due to the Third-Grade (X4) and Fifth-Grade (X5) covariates having correlations with the Method (X1) variable near 0. Singularity warnings correspond to poor power, numerical problems, non-convergence of models, and inappropriate inferential procedures (Bates et al. 2023, 49). Thus, the researchers made the decision to remove the Third-Grade (X4) and Fifth-Grade (X5) assessment scores from the model. Therefore, the Seventh-Grade (X6) assessment score, which is categorized as zero (Not Pass) and one (Pass), is the focal point for the covariate as it is the most recent assessment prior to the Algebra 1 Ohio State End of Course Assessment, which is the dependent variable, Y, for this study categorized as zero (Not Pass) and one (Pass). Additionally, the Seventh-Grade assessment maintains the same format as the Algebra 1 assessment with two ninety-minute testing sessions and question formats, which are listed above. Lastly, the Seventh-Grade assessment maintains a normal correlation with the Method (X1) variable, as the correlation coefficients were not close to 0, 1, or -1.

Elimination of the Interaction Term

While examining the interaction term for students with learning disabilities with instructional method and for gifted students with instructional method, the researchers

determined that the interaction term results in singularity warnings. Considering the population

of students with learning disabilities, the interaction between IEP and instructional methods

returns correlations ranging from -0.001 to 0.000 with the traditional method of instruction. This

results in a singularity warning for the model. Considering the gifted student population, the

interaction between Gifted and instructional methods returns correlations ranging from -0.001 to

0.01   with the traditional method of instruction. This results in a singularity warning for the

model. Singularity warnings correspond to poor power, numerical problems, non-convergence of

models, and inappropriate inferential procedures (Bates et al. 2023, 49). Therefore, as the

interaction term results in singularity warnings for the model, the researchers decided to drop the

interaction term. Thus, the researchers conclude that the model for the study will examine each

student population and instructional method as separate fixed effect variables.

Separation Issues

In the examination of possible singularity issues and large standard errors, the researchers

analyzed the predictor variables for any separation issues. Creating a 3 x 2 contingency table for

class size and instructional method reveals separation for the category class size above with the

traditional instructional method and for the category class size below with the online

instructional method. Both categories had a zero value, resulting in a quasi-complete separation.

Prior research on separation gave guidelines for handling this issue. Based on this research,

recommendations for resolving separation problems include filtering the predictor levels by

removing levels, combining levels of the predictor, and removing the predictor from the model

(Altman et al. 2004). The primary research question relies upon the instructional method for the

student populations in the study; therefore, removing the variable is not feasible. The predictor,

class size, has only two levels above and below average. Due to the two level nature of the

predictor, filtering or combining levels is not practical. However, according to prior research, another option is to leave the problem variable, class size, in the model because the coefficients, standard errors, and test statistics for the remaining variables are still valid maximum likelihood estimates (Allison 2008, 8). The models for IEP and Gifted that include the variable class size do not result in large standard errors or coefficients. Additionally, the 95% confidence intervals are not large enough to cause concern. Thus, as prior research suggests, if unreasonable values for the statistical outputs mentioned above do not occur, then proceed with the models without changing the variable and report the likelihood ratios (Altman et al. 2004). Therefore, the researchers conclude that the models maintain class size as a predictor variable for the analysis.

Revised Research Questions, Variables, and Assumptions

Primary Research Question

Is instructional method (Traditional, Hybrid, Online) a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 when considering students on Individualized Education Plans (IEPs) and students on Written Education Plans (WEPs)?

Secondary Research Questions

1. Is class size a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1?

2. Is attendance rate a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1?

3. Is prior performance a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1?

Variables

Dependent (Response) Variable:

(Y): Algebra 1 Ohio State End of Course Assessment (Pass/Not Pass)

Independent (Predictor) Variables:

(X1): Instructional Method (Hybrid, Traditional, Online)

(X2): Class Size (Below Average, Above Average)

(X3): Attendance Rate (Met State Criteria, Did Not Meet State Criteria)

Covariate Variables:

(X6): Seventh Grade Math Ohio State End of Course Assessment (Pass/Not Pass)

Assumptions

The researchers established four assumptions based on the review of prior literature, the variables of this study, and the logistic regression statistical technique. The first assumption for this thesis is that the hybrid method of instruction will provide more viable learning conditions for the two subpopulations of students within this study, leading to a more significant impact on academic success. The second assumption is based on inconclusive evidence in prior literature. Still, it remains that for the two student populations of this thesis, a small class size may provide improved opportunities for an increase in academic success. The third assumption emerged from a wealth of prior research, which indicates that higher attendance rates strengthen conceptual understanding, leading to increased academic success. The last assumption of this study assumes that prior academic success on previous end of course exams could indicate success on the Algebra I Ohio State End of Course Assessment.

STATISTICAL TECHNIQUE, MODEL RESULTS, AND REPORT

This section will include the following:

- The inferential statistical analysis will be discussed, including the logistic regression modeling and ANOVA results. This will confirm the optimal model for both student populations and present the significant predictors of academic success.

- A discussion of the statistical results and how the results indicate significant predictor variables will be mentioned.

Logistic regression analysis

A binomial logistic regression analysis is performed on academic success (Pass/Not Pass) on the Algebra 1 Ohio State End of Course Assessment as an outcome of five predictors: student population (IEP or Gifted), method (Traditional, Hybrid, Online), class size (Above Average and Below Average), attendance rate (Met State Criteria and Did Not Meet State Criteria), and prior academic performance (Pass/Not Pass). Data from n = 526 students are available for analysis: 378 (71.90%) students are classified with a Pass status, and 148 (28.10%) students are classified with a Not Pass status. The analysis is performed using R (R Core Team, 2023).

The descriptive statistics for each categorical variable are presented in Table 5. Frequencies represent the number of students per level of each categorical variable, and percentages represent the percent of students per level of each categorical variable.

Table 5. Descriptive Statistics for Categorical Variables

Categorical Variable	Frequency			Percentage (%)		
Method	**Hybrid**	**Online**	**Traditional**	**Hybrid**	**Online**	**Traditional**
	247	75	204	46.96	14.26	38.78
Class Size	**Above Average**	**Below Average**		**Above Average**		**Below Average**
	145	381		27.57		72.43
Attendance Rate	**Met State Criteria**	**Did Not Meet State Criteria**		**Met State Criteria**		**Did Not Meet State Criteria**
	439	87		83.46		16.54
Seventh-Grade Prior Performance	**Pass**	**Not Pass**		**Pass**		**Not Pass**
	355	171		67.49		32.51

IEP

A test of the full model with five predictors IEP, method, class size, attendance rate, and prior academic performance (Seventh-Grade) against a constant-only model is statistically reliable, $\chi^2(6, N = 526) = 174.62, p < .001$, indicating that the set of predictors reliably distinguishes between academic success on the Algebra 1 Ohio State End of Course Assessment Pass and Not Pass. A backwards regression model is run to determine the most optimal predictors for this study. Based on the results of the backwards regression model, IEP, method, class size, and prior academic performance (Seventh-Grade) are determined to be the optimal predictors. An ANOVA of the backwards model with the full model is not statistically significant, $\chi^2(1, N = 526) = .461, p = .497$, indicating that the backwards regression model with attendance rate removed is a better fit. The variance in academic success accounted

for is adequate with McFadden's rho = 0.279, df = 5. (see Hensher and Stopher 1979 and

Louviere et al. 2000). The AIC for the full model (464.52) is higher than the AIC for the

backwards model (462.98), indicating that the backwards model is a slightly better fit.

Predictive success using R and a minimum difference threshold (MDT) of 0.757 is

utilized based on prior research confirming the superiority of MDT in minimizing the absolute

difference between sensitivity and specificity over other threshold values (Jiménez-Valverde and

Lobo 2007, 364). The number of accurately classified cases is acceptable, with 398 of 526 cases

(75.67%). Sensitivity and specificity values are 0.735 and 0.811, respectively. Graph 1 shows a

plot of sensitivity and specificity for various cutoff values for the backwards regression model.

Graph 1. Plot of model sensitivity and specificity for various cutoffs, IEP Backwards Model
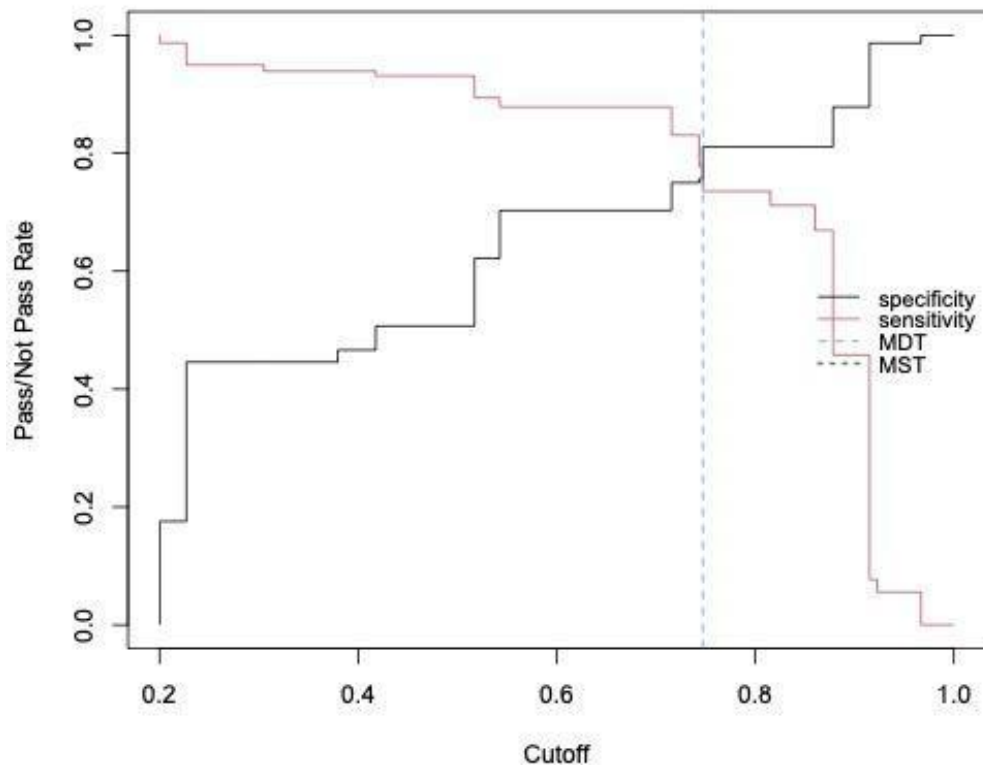
Table 6 displays the regression coefficients, Wald statistics, odds ratios, and 95% confidence intervals for odds ratios for the five predictors. IEPYES compares IEP students to Gifted students, MethodOnline compares Online students to Hybrid students, X2Below compares students in a below average class size to students in an above average class size, and X61 compares students that passed the Seventh-Grade assessment to students that did not pass. According to the Wald criterion, IEPYES (z = -3.100, p < .01), MethodOnline (z = -3.447, p < .001), X2Below (z = -3.569, p < .001), and X61 (z = 8.906, p < . 001) reliably predict academic success on the Algebra 1 Ohio State End of Course Assessment. This confirms that IEP, Method, X2 (class size), and X6 (prior academic success in Seventh-Grade) are significant predictors of academic success (lowest p-value). The odds ratios for IEPYES (0.409), MethodOnline (0.211), and class size X2Below (0.248) show meaningful change in the likelihood of academic success on the Algebra 1 assessment based on a one-unit change from IEPYES to IEPNO (thus, Gifted), MethodOnline to MethodHybrid, and class size X2Below to X2Above. However, Seventh-Grade success X61 (10.058) shows the largest change in likelihood of academic success on the Algebra 1 assessment based on a one-unit change from X61 (Pass) to X60 (Not Pass).

In connection with the primary research question regarding instructional methods' significance as a predictor of academic success on the Algebra 1 Ohio State End of Course Assessment the study examines two comparison levels. The first comparison is between the Online and Hybrid instructional methods. For students with a learning disability, IEP, this comparison is statistically significant, indicating that the comparison between Online and Hybrid impacts the logistic regression model. When examining IEP students, the odds ratio is interpreted as controlling for IEP status, Class Size, and Prior Academic Performance in the backwards

model, the odds of success for a student in the Hybrid instructional method is $\frac{1}{-0.211} = 4.739$ higher than for a student in the Online instructional method.

However, when examining the comparison between the Traditional and Hybrid methods the results of the backwards logistic regression analysis reveal no statistical significance. Thus, this comparison did not provide any additional insight to the meaningfulness of this logistic regression analysis. Even though the Traditional to Hybrid method comparison is not statistically significant for this study's model, the odds ratio for IEP students is interpreted to examine the likelihood of success amongst the students in the differing instructional methods. The odds ratio is interpreted for IEP students as, controlling for IEP status, Class Size, and Prior Academic Performance in the backwards model, the odds of success for a student in the Traditional instructional method is 1.493 higher than for a student in the Hybrid instructional method. This result does not provide any information as to the impact of success on the Algebra 1 Ohio State End of Course assessment, as this comparison is not statistically significant for the model.

In regards to the secondary research question involving the significance of class size as a predictor of academic success, the results of the backwards logistic regression analysis indicate that class size is a statistically significant predictor of academic success for IEP students. The odds ratio for IEP students is interpreted as controlling for IEP status, Method, and Prior Academic Performance in the backwards model, the odds of success for a student in an Above Average Class Size is $\frac{1}{-0.248} = 4.032$ higher than for a student in a Below Average Class Size.

When examining the secondary research question regarding prior academic performance as a significant predictor of academic success, the results of the backwards logistic regression analysis indicate that class size is a statistically significant predictor of academic success for IEP students. The odds ratio for IEP students is interpreted as, controlling for IEP status, Method, and

Class Size in the backwards model, the odds of success for a student with a Pass status on the Seventh-Grade Ohio End of Course Assessment is 10.058 higher than for a student with a Not Pass Status.

An additional result that the researchers examine is that IEP students had a lower likelihood of academic success on the Algebra 1 Ohio State End of Course Assessment than students identified as gifted. The odds ratio for this result is interpreted as, controlling for Method, Class Size, and Prior Academic Performance in the backwards model, the odds of success for a student on an IEP is 0.409 higher than for a student not on an IEP (thus, Gifted).

The assumptions for logistic regression are considered, and statistical tests confirm that none of the assumptions are violated. Independence for both student populations is not violated because none of the measures are repeated, as all students in the sample are different (see Kwak 2002). Variance Inflation Factor (VIF) values range from 1.186 (Seventh-Grade, X6) to 2.863 (Method), indicating that multicollinearity is not a problem. (Mindi et al. 2010, 259). The linearity of the logit assumption is not considered, as all variables are categorical. Casewise diagnostics for running the logistic regression analysis for the current study are considered and verified. Standardized residuals are investigated with a threshold value of |3|. The largest standardized residual is -2.617 and is well within the range of |3| (see Menard 2002). To analyze the DFFITS, which examines the change in predicted probabilities if subjects are removed, the researchers utilize an industry standard cutoff formula of $\left| 2\sqrt{\frac{k+2}{n-k-2}} \right|$, where k = # of predictors, n = total sample (see Belsley et al. 2005 and The Pennsylvania State University Department of Statistics Online Programs 2018). The cutoff for the DFFITS in this study is 0.232. Any values greater than this threshold are investigated, but the largest value is 0.284, and the researchers determine that the influence of this value does not impact the predicted probabilities for each

student in the sample. To investigate DFBetas, which examine the change of coefficients if subjects are removed, the researchers utilize the standardized approach of |1| (see Menard 2002). All of the DFBetas values are reviewed, and none of the values exceeded |1|. Finally, leverage values are examined, which focus on x-outliers, and the acceptable formula of $3\left(\frac{k+1}{n}\right)$ is utilized (see Kutner et al. 2005 and The Pennsylvania State University Department of Statistics Online Programs 2018). The threshold value is calculated as 0.034. Any values greater than this threshold are examined, but the largest value is 0.040, and the researchers determine that these outlying x-values are not influential in the predictive analysis.

Table 6: Logistic regression analysis of academic success status as a function of school and student information.

Variables	β	Wald (z-ratio)	p-value	Odds Ratio (OR)	95% CI Lower, OR	95% CI Upper, OR
(Constant)	1.064	2.973	.003**	2.898	1.469	6.023
IEPYES (Compare IEP to Gifted)	-0.893	-3.100	.002**	0.409	0.233	0.721
MethodOnline (Compare Online to Hybrid Instruction)	-1.556	-3.447	.001***	0.211	0.085	0.503
MethodTraditional (Compare Traditional to Hybrid Instruction)	0.401	1.274	.203	1.493	0.804	2.770
X2Below (Compare Class Size Below Average to Above Average)	-1.396	-3.569	.0004***	0.248	0.112	0.524
X61 (Compare 7th grade Pass to Not Pass)	2.308	8.906	<.001***	10.058	6.103	16.888

Using the backwards model, which is statistically reliable, a receiver operating characteristic curve (ROC) is used to determine the accuracy of the backwards model using the area under the curve (AUC) displayed in Graph 2. The AUC is 0.824, which indicates a good accuracy classification (Tape, 2003).

Graph 2. ROC Curve, Academic Success Status IEP Backwards Model
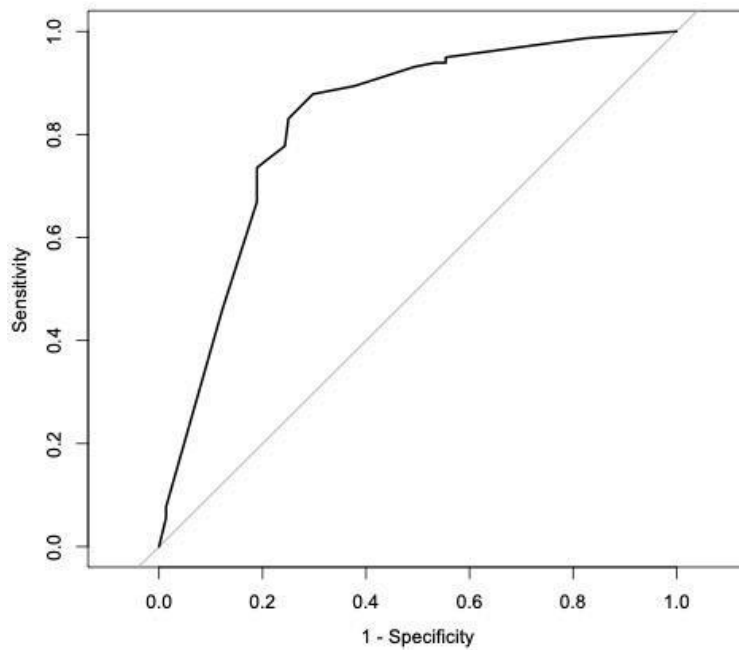
Gifted

A test of the full model with five predictors Gifted, method, class size, attendance rate, and prior academic performance (Seventh-Grade) against a constant-only model is statistically reliable, $\chi^2(6, N = 526) = 174.62, p < .001$, indicating that the set of predictors reliably distinguishes between academic success on the Algebra 1 Ohio State End of Course Assessment Pass and Not Pass. A backwards regression model is run to determine the most optimal predictors for this study. Based on the results of the backwards regression model, Gifted, method, class size, and prior academic performance (Seventh-Grade) are determined to be the optimal predictors. An ANOVA of the backwards model with the full model is not statistically

significant, $\chi^2(1, N = 526) = .461, p = .497$, indicating that the backwards regression

model with attendance rate removed is a better fit. The variance in academic success accounted

for is adequate with McFadden's rho = 0.279, df = 5. (see Hensher and Stopher 1979 and

Louviere et al. 2000). The AIC for the full model (464.52) is higher than the AIC for the

backwards model (462.98), indicating that the backwards model is a slightly better fit.

Predictive success using R and a minimum difference threshold (MDT) of 0.757 is

utilized based on prior research confirming the superiority of MDT in minimizing the absolute

difference between sensitivity and specificity over other threshold values (Jiménez-Valverde and

Lobo 2007, 364). The number of accurately classified cases is acceptable, with 398 of 526 cases

(75.67%). Sensitivity and specificity values are 0.735 and 0.811, respectively. Graph 3 shows a

plot of sensitivity and specificity for various cutoff values for the backwards regression model.

Graph 3. Plot of model sensitivity and specificity for various cutoffs, Gifted Backwards Model
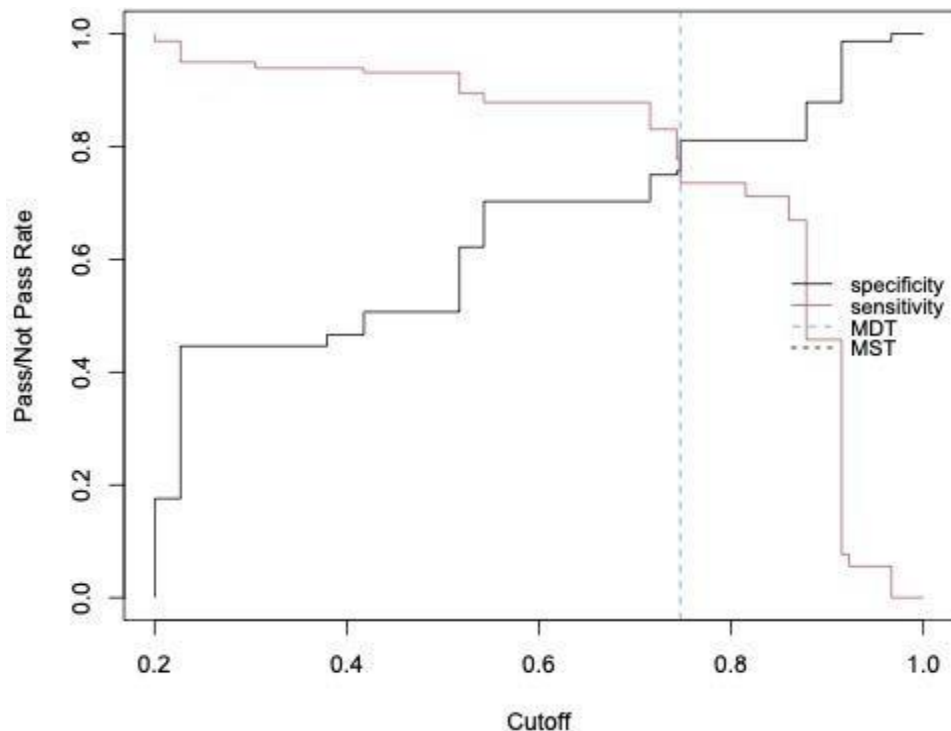
Table 7 displays the regression coefficients, Wald statistics, odds ratios, and 95% confidence intervals for odds ratios for the five predictors. GiftedYES compares Gifted students to IEP students, MethodOnline compares Online students to Hybrid students, X2Below compares students in a below average class size to students in an above average class size, and X61 compares students that passed the Seventh-Grade assessment to students that did not pass. According to the Wald criterion, GiftedYES ($z = 3.100$, $p < .01$), MethodOnline ($z = -3.447$, $p < .001$), X2Below ($z = -3.569$, $p < .001$), and X61 ($z = 8.906$, $p < .001$) reliably predict academic success on the Algebra 1 Ohio State End of Course Assessment. This confirms that Gifted, Method, X2 (class size), and X6 (prior academic success in Seventh-Grade) are significant predictors of academic success (lowest p-value). The odds ratios for MethodOnline (0.211) and class size X2Below (0.248) show meaningful change in the likelihood of academic success on the Algebra 1 assessment based on a one-unit change from MethodOnline to MethodHybrid and class size X2Below to X2Above. However, the odds ratios for GiftedYES (2.442) and Seventh-Grade success X61 (10.058) show the largest change in likelihood of academic success on the Algebra 1 assessment based on a one-unit change from GiftedYES to GiftedNO (thus, IEP) and X61 (Pass) to X60 (Not Pass).

In connection with the primary research question regarding instructional methods' significance as a predictor of academic success on the Algebra 1 Ohio State End of Course Assessment the study examines two comparison levels. The first comparison is between the Online and Hybrid instructional methods. For gifted students, WEP, this comparison is statistically significant, indicating that the comparison between Online and Hybrid impacts the logistic regression model. When examining Gifted students, the odds ratio is interpreted as controlling for Gifted status, Class Size, and Prior Academic Performance in the backwards

model, the odds of success for a student in the Hybrid instructional method is $\frac{1}{-0.211} = 4.739$

higher than for a student in the Online instructional method.

However, when examining the comparison between the Traditional and Hybrid method the results of the backwards logistic regression analysis reveal no statistical significance. Thus, this comparison did not provide any additional insight to the meaningfulness of this logistic regression analysis. Even though the Traditional to Hybrid method comparison is not statistically significant for this study's model, the odds ratio for Gifted students is interpreted to examine the likelihood of success amongst the students in the differing instructional methods. The odds ratio is interpreted for Gifted students as, controlling for Gifted status, Class Size, and Prior Academic Performance in the backwards model, the odds of success for a student in the Traditional instructional method is 1.493 higher than for a student in the Hybrid instructional method. This result does not provide any information as to the impact of success on the Algebra 1 Ohio State End of Course assessment, as this comparison is not statistically significant for the model.

In regards to the secondary research question involving the significance of class size as a predictor of academic success, the results of the backwards logistic regression analysis indicate that class size is a statistically significant predictor of academic success for Gifted students. The odds ratio for Gifted students is interpreted as controlling for Gifted status, Method, and Prior Academic Performance in the backwards model, the odds of success for a student in an Above Average Class Size is $\frac{1}{-0.248} = 4.032$, higher than for a student in a Below Average Class Size.

When examining the secondary research question regarding prior academic performance as a significant predictor of academic success the results of the backwards logistic regression analysis indicate that class size is a statistically significant predictor of academic success for Gifted students. The odds ratio for Gifted students is interpreted as, controlling for Gifted status,

Method, and Class Size in the backwards model, the odds of success for a student with a Pass

status on the Seventh-Grade Ohio End of Course Assessment is 10.058 higher than for a student

with a Not Pass Status.

An additional result that the researchers examine is that Gifted students had a higher

likelihood of academic success on the Algebra 1 Ohio State End of Course Assessment than

students with learning disabilities, IEP. The odds ratio for this result is interpreted as, controlling

for Method, Class Size, and Prior Academic Performance in the backwards model, the odds of

success for a student identified as Gifted is 2.442 higher than for a student not identified as

Gifted (thus, on an IEP).

The assumptions for logistic regression are considered, and statistical tests confirm that

none of the assumptions are violated. Independence for both student populations is not violated

because none of the measures are repeated, as all students in the sample are different (see Kwak

2002). Variance Inflation Factor (VIF) values range from 1.186 (Seventh-Grade, X6) to 2.863

(Method), indicating that multicollinearity is not a problem. (Mindi et al. 2010, 259). The

linearity of the logit assumption is not considered, as all variables are categorical. Casewise

diagnostics for running the logistic regression analysis for the current study are considered and

verified. Standardized residuals are investigated with a threshold value of |3|. The largest

standardized residual is -2.617 and is well within the range of |3| (see Menard 2002). To analyze

the DFFITS, which examines the change in predicted probabilities if subjects are removed, the

researchers utilize an industry standard cutoff formula of $\left| 2\sqrt{\frac{k+2}{n-k-2}} \right|$, where k = # of predictors,

n = total sample (see Belsley et al. 2005 and The Pennsylvania State University Department of

Statistics Online Programs 2018). The cutoff for the DFFITS in this study is 0.232. Any values

greater than this threshold are investigated, but the largest value is 0.284, and the researchers

determine that the influence of this value does not impact the predicted probabilities for each student in the sample. To investigate DFBetas, which examine the change of coefficients if subjects are removed, the researchers utilize the standardized approach of |1| (see Menard 2002). All of the DFBetas values are reviewed, and none of the values exceeded |1|. Finally, leverage values are examined, which focus on x-outliers, and the acceptable formula of $3\left(\frac{k+1}{n}\right)$ is utilized (see Kutner et al. 2005 and The Pennsylvania State University Department of Statistics Online Programs 2018). The threshold value is calculated as 0.034. Any values greater than this threshold are examined, but the largest value is 0.040, and the researchers determine that these outlying x-values are not influential in the predictive analysis.

Table 7: Logistic regression analysis of academic success status as a function of school and Gifted student information.

Variables	β	Wald (z-ratio)	p-value	Odds Ratio (OR)	95% CI Lower, OR	95% CI Upper, OR
(Constant)	0.171	0.493	.622	1.187	0.608	2.392
GiftedYES (Compare Gifted to IEP)	0.893	3.100	.002**	2.442	1.387	4.301
MethodOnline (Compare Online to Hybrid Instruction)	-1.556	-3.447	.001***	0.211	0.085	0.503
MethodTraditional (Compare Traditional to Hybrid Instruction)	0.401	1.274	.203	1.493	0.804	2.770
X2Below (Compare Class Size Below Average to Above Average)	-1.396	-3.569	.0004***	0.248	0.112	0.524
X61 (Compare 7th grade Pass to Not Pass)	2.308	8.906	<.001***	10.058	6.103	16.888

Using the backwards model, which is statistically reliable, a receiver operating characteristic curve (ROC) is used to determine the accuracy of the backwards model using the area under the curve (AUC) displayed in Graph 4. The AUC is 0.824, which indicates a good accuracy classification (Tape, 2003).

Graph 4. ROC Curve, Academic Success Status Gifted Backwards Model
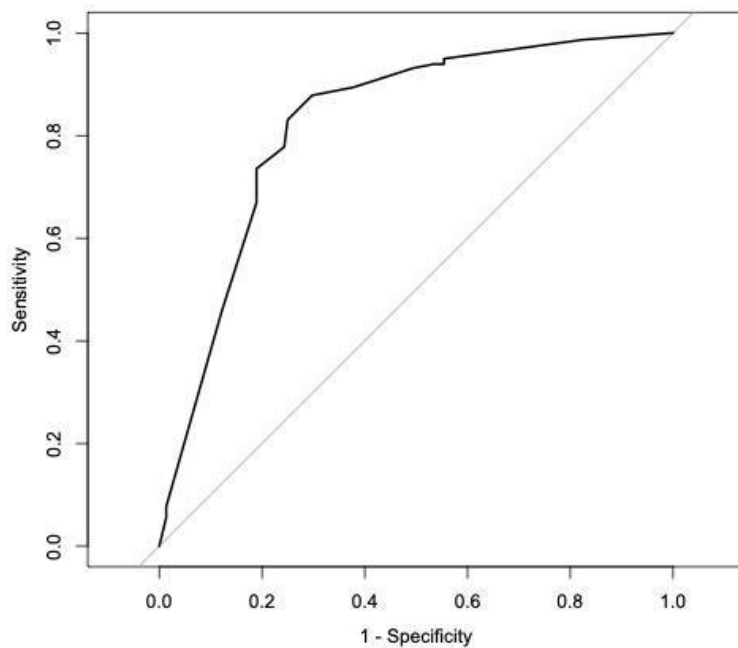
SUMMARY

At the beginning of this chapter, the researchers describe the student populations, the implementation and data procedures, and the study's preliminary results. Furthermore, the researchers discuss the precautions that are used to approach the analysis of the data set. The possibility of nested data within the districts is considered and tested by the use of mixed models. The standard errors and variance of the mixed model are zero, indicating that District as a random effect is unnecessary; therefore, normal logistic regression techniques are used. Removing covariates (Third and Seventh-Grade Assessment scores) is necessary since the

correlation between each and the Method variable is near zero and does not contribute to the prediction of academic success. Finally, the researchers address the separation issues for specific variables in the study, such as Method and Class Size. The standard errors and coefficients of each model had no large values. Therefore, the researchers did not need to consider the separation of variables as problematic in analyzing the results.

Following the preliminary results, descriptive statistics are presented for each student population. This includes the number of students in each instructional method, class size, attendance rate, and prior academic performance.

The purpose of this study is to determine academic success within the instructional methods (Hybrid, Online, and Traditional) based on the Algebra 1 Ohio State End of Course Assessment when considering students with learning disabilities and gifted students while controlling for prior academic performance on a Seventh-Grade Assessment. Additionally, the researchers examine the impact of class size on academic success based on the Algebra 1 Ohio State End of Course Assessment while controlling for prior academic performance on a Seventh-Grade Assessment for students with learning disabilities and gifted students. This study aims to determine the ideal classroom setting for students with learning disabilities and gifted students.

Based on the results of two logistic regression analyses, one for each student population, multiple predictor variables are statistically significant. ANOVAs for each student population for the backwards model, which determined the optimal predictors, over the full model indicate no statistical significance with $p = .497$. Thus, the backwards model is a better model fit for both student populations and confirms that attendance rate is not a statistically significant predictor. Therefore, removing this predictor is a better fit for the model, indicating that Method, Class

Size, and Prior Academic Performance are statistically significant and impact the probability of academic success for each student population on the Algebra I Ohio State End of Course Assessment. The researchers present tables for each student population displaying statistical significance, odds ratios, and 95% confidence intervals for each predictor variable. The researchers also include an ROC curve for each student population, presenting a visual for the Area Under the Curve (AUC), demonstrating model accuracy.

In the next chapter, the researchers will discuss the findings for each of the models in detail and relate the findings to the study's assumptions and prior literature. Additionally, the next chapter will discuss limitations and considerations for future research.

CHAPTER V SUMMARY

INTRODUCTION

This chapter will provide a discussion of this study's major findings and results related to the research questions of this thesis, prior literature with respect to the variables and student populations, and the theoretical framework that guided this study. Moreover, the implications of these results in terms of the educational environment for the two student populations will be discussed. Furthermore, this chapter will discuss the limitations of this study and considerations for future research based on issues that arose within this study. Lastly, this chapter will present recommendations for secondary schools in Northeast Ohio regarding the most beneficial classroom environment for students with learning disabilities and gifted students.

The primary goal of this study was to determine academic success within different instructional methods (Hybrid, Online, and Traditional) based on the Algebra 1 Ohio State End of Course Assessment when considering students with learning disabilities and gifted students while controlling for prior academic performance on a Seventh-Grade Assessment. The secondary objective was to examine the impact of class size on academic success based on the Algebra 1 Ohio State End of Course Assessment while controlling for prior academic performance on a Seventh-Grade Assessment for students with learning disabilities and gifted students. This study aimed to determine the ideal classroom setting for students with learning disabilities and gifted students and how prior performance may be linked to current academic success for the two student populations.

INTERPRETATION OF THE FINDINGS

Primary Research Question

Is instructional method (Traditional, Hybrid, Online) a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1 when considering students on Individualized Education Plans (IEPs) and students on Written Education Plans (WEPs)?

When examining this question, IEP students represent students with learning disabilities, and WEP students represent students identified as gifted. The results of a backwards logistic regression analysis indicated that instructional method was a significant predictor of academic success for both student populations. The Hybrid method of instruction was set as the reference category based on the researchers' assumptions; thus, two comparisons were investigated. The first comparison was between the Online and Hybrid instructional methods. This comparison was statistically significant for both student populations, indicating that the comparison between Online and Hybrid impacted the logistic regression model. Thus, the model was a better fit for the study's data with the variable included. When examining both student populations, the odds ratio was interpreted as controlling for IEP status or Gifted Status, Class Size, and Prior Academic Performance in the backwards model; the odds of success for a student in the Hybrid instructional method was higher than for a student in the Online instructional method. Thus, this result indicated that for both student populations, the Hybrid method of instruction was more significant towards the achievement of academic success on the Algebra 1 Ohio State End of Course Assessment than the Online instructional method.

However, when examining the comparison between the Traditional and Hybrid method, the results of the backwards logistic regression analysis revealed no statistical significance. Thus,

this comparison did not provide any additional insight to the meaningfulness of this logistic regression analysis. Even though the comparison between the Traditional and Hybrid methods was not statistically significant for this study's model, the odds ratio for both student populations was interpreted to examine the likelihood of success amongst the students in the differing instructional methods. The odds ratio was interpreted for both student populations as, controlling for IEP status or Gifted status, Class Size, and Prior Academic Performance in the backwards model, the odds of success for a student in the Traditional instructional method was higher than for a student in the Hybrid instructional method. This result does not provide any information as to the impact of success on the Algebra 1 Ohio State End of Course assessment, as this comparison was not statistically significant for the model.

Therefore, instructional method was a significant predictor of academic success on the Algebra 1 Ohio State End of Course Assessment for the level comparison between the Online and Hybrid method of instruction. However, as the level comparison between the Traditional and Hybrid methods of instruction was not statistically significant, the meaningfulness of the Online to Hybrid comparison may be minute in terms of significance toward academic success.

Secondary Research Questions

1. *Is class size a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1?*

When examining class size, the researchers categorized this variable with two levels: below average, indicating a class size average of less than 16.6 students, and above average, indicating a class size average greater than 16.6 students. The results of a backwards logistic regression analysis revealed that class size was a statistically significant predictor of academic success for both student populations. Thus, the model was a better fit for the study's data with

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the variable included. For both student populations, the odds ratio was interpreted as controlling for IEP status or Gifted status, Method, and Prior Academic Performance in the backwards model; the odds of success for a student in an Above Average Class Size was higher than for a student in a Below Average Class Size. This result indicated that students in a class size above the 16.6 average for any instructional method had a higher likelihood of academic success on the Algebra 1 Ohio State End of Course Assessment than students who were in a below average class size.

2. *Is attendance rate a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1?*

As discussed in Chapter 4, the backwards logistic regression analysis determined that the optimal predictors for this study were IEP or Gifted, Method, Class Size, and Prior Academic Performance. Thus, attendance rate was not impactful to the model, and the model was a better fit for the study's data without this variable included. Therefore, the attendance rate for both student populations was not examined as a significant predictor of academic success.

3. *Is prior performance a significant predictor of academic success based on the Ohio State End of Course Assessment in Algebra 1?*

When examining prior academic performance, the researchers investigated the Seventh-Grade Ohio State End of Course Assessment as the predictor variable. As discussed in Chapter 4, the Third- and Fifth-Grade assessment scores were removed from the study due to separation and singularity issues with the model. The results of the backwards logistic regression analysis indicated that prior academic performance on the Seventh-Grade Assessment was a statistically significant predictor of academic success for both student populations. Thus, the model was a better fit for the study's data with this variable included. For both student

populations, the odds ratio was interpreted as controlling for IEP status or Gifted status, Method, and Class Size in the backwards model; the odds of success for a student with a Pass status on the Seventh-Grade Ohio End of Course Assessment was higher than for a student with a Not Pass Status. This result indicated that students who passed the Seventh-Grade Ohio State End of Course Assessment had a higher likelihood of academic success on the Algebra 1 Ohio State End of Course Assessment than students who did not pass the Seventh-Grade Assessment.

CONNECTIONS TO PRIOR LITERATURE

Based on prior literature, gifted students stressed the importance of instructor interaction within any classroom setup. According to one study on online instructional methods, gifted students "indicated that it was often inadequate, difficult, and not their preferred learning style" Alshehri (2022, 863). In connection to the current study, this gifted student perception was reinforced as the results indicated that the Hybrid method of instruction led to a greater likelihood of academic success. Since the Hybrid method of instruction creates opportunities for direct interaction amongst students and teachers as well as technological advancements, the results of this study support the prior literature regarding gifted students preferred learning methods.

Additionally, prior research confirmed that students with learning disabilities often require a greater rate of intervention to achieve academic success. According to one such study, "social interaction between learners and the instructor contributed to producing an increase in learning achievement" (Almari and Wood 2017, 66). Therefore, as the online method of instruction often limits students' interactions with the instructor, there may be cause for concern regarding students' academic success within the online platform. In relation to the current study's

results, the previous findings were corroborated as the Hybrid method of instruction led to a

greater likelihood of academic success than the Online method for students with learning

disabilities. The Hybrid method of instruction provides scenarios for teacher-student interaction

while supporting students with learning disabilities' preference to communicate virtually with

technological aspects.

In terms of the class size variable for the two student populations, prior literature

indicated mixed results. Even though results varied, there was support from multiple studies

confirming that an above average class size could be more beneficial for students with learning

disabilities and gifted students. The results of one study showed that a one-student decrease in

class size when controlling for classroom composition resulted in a .0005 and .0015 decrease in

the standard deviation of mathematics end-of-grade assessment scores for learning disabled and

gifted students, respectively (Bosworth 2014, 156). The results of the current logistic regression

analysis support this claim as an above average class size, indicating above 16.6 students, led to

a greater likelihood of academic success for both student populations. However, additional

research indicated that the relationship between class size and academic success was not linear.

Thus, success could vary depending on other classroom factors, and one study found that a

one-student decrease in class size resulted in a .0631 standard deviation increase in mathematics

end-of-grade assessment scores for students identified as learning disabled when controlling for

specific classroom factors (Bosworth 2014, 152). Therefore, the current study's analysis

provided a conflicting viewpoint as the results indicated a larger class size increased the

likelihood of academic success for students with learning disabilities. Thus, these results have

contributed new information and support to an otherwise mixed history of prior literature.

When discussing the prior academic performance variable, the results of the current logistic regression analysis support the bulk of previous research. The majority of prior research has found that students' prior performance was a significant predictor of current academic success when viewing prior performance through GPA, state assessment results, or ACT scores. Thus, as the results of the current study indicated, students who passed the Seventh-Grade Ohio State End of Course Assessment had a greater likelihood of academic success (passing) the Algebra 1 Assessment; the current study provided additional support for prior claims.

IMPLICATIONS FOR THEORY AND RESEARCH

Situated Cognitive Learning Theory and Apprenticeship Model

The Situated Cognitive Learning Theory, developed by Brown, Collins, and Duguid, states that students must be presented with problems from an expert and work through the problems together as if the students were experts. The teacher is still responsible for scaffolding the materials to meet all students' needs, and the classroom environment must provide reflection, discussion, and critical thinking opportunities to enable active student engagement. The theory focuses on student interaction with the cognitive knowledge and with other students to become experts in understanding the content, leading to academic success with increasingly more complex problems involving the application of such knowledge. The Cognitive Apprenticeship Model, developed by Collins and Brown, is an application of the Situated Cognitive Learning Theory. This model indicates the importance of both parts of learning: practical instruction and active engagement with presented material through meaningful activities wherein students apply the content. According to Collins, Brown, and Holum, "Teaching methods should be designed to give students the opportunity to observe, engage in, and invent or discover expert strategies in context. Such an approach will enable students to see how these strategies combine with their

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factual and conceptual knowledge and how they use a variety of resources in the social and physical environment" (Collins et al. 1991, 13).

The results of this logistic regression analysis validated the strategies and framework of the Situated Cognitive Learning Theory and the Apprenticeship Model because the results indicated that the Hybrid method of instruction was statistically significant in predicting academic success. A Hybrid method of instruction, by definition, provides students with opportunities to engage not only with course material but also with technology to develop a deeper understanding. The Hybrid instructional method allows students to discover new information, practice with the material in real-life situations, present new knowledge to other students through various modes of communication, and reflect on individual discoveries in a multitude of formats. Thus, as this analysis discovered, the greatest impact to success was the Hybrid method, the results support the strategies and framework of the Situated Cognitive Learning Theory and Apprenticeship Model.

Connectivism Learning Theory

The Connectivism Learning Theory, introduced by two theorists, Siemens and Downes, suggests that students should combine thoughts, theories, and general information in a useful manner. Part of the process will incorporate the use of technology. It acknowledges that technology allows students to connect with others and provides opportunities to make learning choices. Both theorists take different standpoints on this theory. The basic framework of this theory is broken down into principles. Some principles are: Learning and knowledge rest in a diversity of opinions, learning is a process of connecting, learning is more critical than knowing, and decision-making is a learning process. Connecting involves students acting as "nodes" in a network. The nodes (students) will connect through different experiences that help maintain

connections to form knowledge. The benefits of Connectivism seen in the classroom are support for collaboration, diversity, and empowerment of students and teachers. The benefits are, essentially, creating a learning community. The technology aspect of the theory can be seen through social media, gamification, and simulations.

The current study revealed that the Hybrid instructional method was best for both student populations. Hybrid instruction includes the interaction of students while using technology as an additional instructional support for student learning. Students in the Hybrid instructional setting are creating a classroom environment that assimilates information and builds a structure that all students can use to help achieve academic success. This method of instruction also provides the instructor the means to differentiate instruction by use of technology and other resources. The combination of instructional resources can match the needs of each individual student, as in the current study, IEP or Gifted, which supports the claims of the Connectivism Theory.

LIMITATIONS OF THE STUDY

Considering the current study's population, one limitation would be the sample size and the lack of diversity in the school districts' locations. Since the study only examined school districts in Northeast Ohio, the sample size may be small when considering the generalizability for high schools in the state of Ohio and across the United States. Additionally, the study only had one traditional school, which led to separation issues and the inability to examine the interaction term. Therefore, the sample prevented the study from generalizing to a larger population and forced the study to provide valid information only for Northeast Ohio high schools.

Another limitation of this study involved the students with learning disabilities as the study did not consider when and how long each student had been identified. Thus, the study did not consider each student's identification at the time the student tested on prior assessments. Therefore, the study did not consider the student's accommodations during those previous assessments. Thus, this thesis did not examine the methods of intervention utilized within the differing instructional methods. Additionally, this study limited data to students without Significant Cognitive Disabilities, as this was necessary because of testing standards. Lastly, for this subpopulation of students, the study analyzed all students even when an IQ was lower than average. If the study had identified IQ before data collection, only students with an IEP identified with an IQ of at least average could have been selected. Considering all students, regardless of IQ level may have skewed the data analysis due to students with lower than average IQ scores. All of the above concerns impacted the generalizability of this study for students with learning disabilities.

A third limitation of this study involved the gifted students, as the study did not consider when and how long each student had been identified. Thus, the study did not consider each student's identification at the time the student tested on prior assessments. Additionally, this study did not consider the areas of identified acceleration for the gifted students, and thus, all students may not have had the mathematics acceleration identifier. Thus, this study did not examine the methods of intervention utilized within the different instructional methods or for the different gifted identifications. The accommodations, which are utilized to stretch and grow students' conceptual knowledge and critical thinking skills, could impact academic success on Ohio State End of Course Assessments. All of these factors restricted this study's generalizability for the gifted student population.

The last limitation involved the method of instruction during the prior academic years, as this study only examined the type of instruction a student received during the high school years. Thus, the student's current instructional method may have been different when each student took the Ohio State End of Course Assessment in Seventh-Grade mathematics versus the Algebra 1 assessment. Students identified in each instructional method for this thesis may have been in a different instructional method for all of the Ohio State End of Course Assessments. Therefore, as the student's instructional method may have changed throughout the years, this hindered the generalizability when examining prior academic success as a covariate for current academic success.

In summary, the researchers acknowledged multiple limitations to this study, which led to recommendations for future research to improve the design and enhance the validity of potential results.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future research may consider how students are identified with a learning disability, IQ levels at the time of the assessment, and when the student was provided with an IEP. These identifications will ensure that all findings are driven toward mathematical results and guarantee that students with learning disabilities have been accurately defined to make conclusions about academic success.

Additionally, future research may consider how students are identified as gifted, when the student was provided with a WEP and what tests were used to evaluate giftedness. The above will ensure that all results are driven towards mathematical findings and guarantee that students identified as gifted have been accurately defined to make conclusions about academic success.

Future research may also examine the accommodations that students with learning disabilities and students identified as gifted received during instructional time to ensure that the accommodations were not the influential factor in terms of academic success but rather the type of instruction each student received within the general education classroom.

Moreover, future research may consider the instructional methods for each student in the study during all years of testing to ensure that the instructional method remains consistent throughout the testing period. Identifying the instructional methods will provide more firm results on whether the method was associated with the student's academic success, specifically when examining prior academic success based on standardized test results in previous grades.

Furthermore, future research may expand the number of hybrid, traditional, and online schools to ensure that no singularity issues occur when examining the interaction term between instructional method and student population. The interaction term could provide more detailed information regarding each student population in terms of academic success.

Finally, future research may consider the raw scores of Ohio State End of Course Assessments or another standardized test format to predict current academic success from prior performance. As mentioned earlier in this thesis, due to the COVID-19 pandemic, categorizing Ohio State End of Course Assessments was required because the 2020 released scores were converted to a one to five scale in correlation with raw score results. Thus, as one of the prior year's results were not raw scores, it was of necessity for this study to convert all released scores to the one to five scale from the 2020 year's results to identify a Pass cutoff score and a Not Pass cutoff score. Future research could utilize similar data and study design to predict future scores based on prior achievement exam scores.

CONCLUSION AND IMPLICATIONS FOR PRACTICE

The primary objective for this research study was to determine the instructional method that led to the greatest likelihood of academic success for students with learning disabilities and gifted students based on the Algebra 1 Ohio State End of Courses Assessment results. Moreover, this study sought to examine the impact of class size and prior academic performance in terms of academic success on state assessment results.

The first result the researchers examined was that the Hybrid instructional method led to the greatest likelihood of academic success for both student populations. This result provided evidence that the Hybrid method of instruction, which incorporates both in-person and virtual interactions, is more beneficial for these student populations than the Traditional and Online methods of instruction. Thus indicating that the Traditional and Online methods only offer one format of interaction, whether all in-person or all virtually, which limits students' ability to engage with material in context with an expert and through individual exploration. Therefore, Traditional and Online schools may consider the counterpart to each's normal form of instruction as a pathway to educate students with learning disabilities and gifted students.

Secondly, the results of this study indicated that an above average class size supports the greatest likelihood of academic success. In combination with the first result, as the Hybrid method of instruction allows for greater differentiation of materials with less stress, school districts would have less concern for teacher overload if the class size average were larger than the state average. Thus, the results of this study provided implications for school districts in Northeast Ohio to utilize Hybrid instruction more frequently to alleviate teacher workload and ensure that students with learning disabilities and gifted students are educated in the most beneficial classroom setting.

The third result the researchers examined was that success on the Seventh-Grade Ohio End of Course Assessment led to a greater likelihood of success on the Algebra 1 assessment. Thus, this result provided implications for school administrators to develop more opportunities for teachers to examine prior assessment results to determine areas of weakness and strength. Additionally, this result validated the need to increase support in the younger grades to ensure academic success earlier in a student's educational career to provide the best opportunity for academic success in later grades.

An additional result that the researchers examined was that Gifted students had a higher likelihood of academic success on the Algebra 1 Ohio State End of Course Assessment than students identified with learning disabilities. The odds ratio for this result was interpreted as, controlling for Method, Class Size, and Prior Academic Performance in the backwards model, the odds of success for a student identified as Gifted was higher than for a student not identified as Gifted (thus, on an IEP). This result provided implications for school districts, specifically general education teachers and intervention specialists because it indicated that different strategies are necessary to create the best learning environment for these student populations. In terms of gifted students, this result indicated that general education teachers need to create material that stretches students' knowledge of a topic. For students with learning disabilities, this result indicated that the intervention specialists need to create material that bridges the gap for these students to reach academic success.

In conclusion, the researchers acknowledge the limitations of this study, including a small sample size regarding the location of districts and instructional method (Traditional), IEP and gifted identification, accommodations for each student population, and instructional method for previous assessment results. Based on these limitations, the researchers indicated further research

that could be conducted to potentially resolve these issues while discovering new information that could benefit school districts concerning these two student populations. Examining these limitations in more detail could make groundbreaking changes to the world of education for two student populations that have been overlooked in the past.

REFERENCES

1. Aiello, Anthony. "Is There a Difference in Academic Achievement Between Remote Learners and Face-To-Face Learners Between the School Years of 2020-21 and 2021-22?" PhD diss., St. John's University (New York), 2023.

2. Alamri, Abdulrahman, and Tandra Tyler-Wood. "Factors affecting learners with disabilities–instructor interaction in online learning." *Journal of Special Education Technology* 32, no. 2 (2017): 59-69.

3. Allison, Paul D. "Convergence failures in logistic regression." In SAS Global Forum, vol. 360, no. 1, p. 11. 2008.

4. Allison, Paul D. "Missing data." *The SAGE handbook of quantitative methods in psychology* (2009): 72-89.

5. Alshehri, Abdullah Hamoud Abdullah. "Impact of Online Learning on Gifted Students." *International Journal of Education in Mathematics, Science and Technology* 10, no. 4 (2022): 849-867.

6. Altman, Micah, Jeff Gill, and Michael P. McDonald. *Numerical issues in statistical computing for the social scientist*. John Wiley & Sons, 2004.

7. Alzen, Jessica L., Laurie S. Langdon, and Valerie K. Otero. "A logistic regression investigation of the relationship between the Learning Assistant model and failure rates in introductory STEM courses." International journal of STEM education 5, no. 1 (2018): 1-12.

8. Anderson, Terry, ed. *The theory and practice of online learning*. Athabasca University Press, 2008.

9. Balfanz, Robert, and Vaughan Byrnes. "Closing the mathematics achievement gap in high-poverty middle schools: Enablers and constraints." *Journal of Education for Students Placed at risk* 11, no. 2 (2006): 143-159.

10. Bates, Douglas, Martin Maechler, Ben Bolker, Steven Walker, Rune Haubo Bojesen Christensen, Henrik Singmann , Bin Dai, et al. "Linear Mixed-Effects Models Using 'Eigen' and S4." CRAN, November 5, 2023.

11. Belsley, David A., Edwin Kuh, and Roy E. Welsch. Regression diagnostics: Identifying influential data and sources of collinearity. John Wiley & Sons, 2005.

12. Bender, Ralf, and Ulrich Grouven. "Ordinal logistic regression in medical research." *Journal of the Royal College of physicians of London* 31, no. 5 (1997): 546.

13. Bir, Devayan Debashis. "Comparison of academic performance of students in online vs traditional engineering course." *European Journal of Open, Distance and E-Learning (EURODL)* 22, no. 1 (2019): 1-13.

14. Bolker, Ben, and Others. "Singular Fits." GLMM FAQ, October 8, 2023. https://bbolker.github.io/mixedmodels-misc/glmmFAQ.html#singular-fits.

15. Bosworth, Ryan. "Class size, class composition, and the distribution of student achievement." *Education Economics* 22, no. 2 (2014): 141-165.

16. Brown, John Seely, Allan Collins, and Paul Duguid. "Situated cognition and the culture of learning." *1989* 18, no. 1 (1989): 301-319.

17. Bujang, Mohamad Adam, Nadiah Sa'at, Tg Mohd Ikhwan Tg Abu Bakar, and Lim Chien Joo. "Sample size guidelines for logistic regression from observational studies with large population: emphasis on the accuracy between statistics and parameters based on real life clinical data." The Malaysian journal of medical sciences: MJMS 25, no. 4 (2018): 122.

18. Chen, Chen-Su. "Common Core of Data (CCD)." Institute of Education Sciences: National Center for Education Statistics (NCES), 2023. https://nces.ed.gov/ccd/.

19. Collins, Allan, John Seely Brown, and Ann Holum. "Cognitive apprenticeship: Making thinking visible." *American educator* 15, no. 3 (1991): 1-18.

20. Collins, Allan, John Seely Brown, and Susan E. Newman. "Cognitive apprenticeship: Teaching the craft of reading, writing, and mathematics." *Thinking: The Journal of Philosophy for Children* 8, no. 1 (1988): 1-27.

21. Concato, J, P Peduzzi, T R Holford, and A R Feinstein. 1995. "Importance of Events per Independent Variable in Proportional Hazards Analysis. I. Background, Goals, and General Strategy." Journal of Clinical Epidemiology 48 (12): 1495–1501. doi:10.1016/0895-4356(95)00510-2.

22. Dennen, Vanessa P., and Kerry J. Burner. "The cognitive apprenticeship model in educational practice." In *Handbook of Research on Educational Communications and Technology*, pp. 425-439. Routledge, 2008.

23. Downes, Stephen. "New technology supporting informal learning." *Journal of Emerging Technologies in Web Intelligence* 2, no. 1 (2010): 27-33.

24. Eaton, Gina. "An Examination of High School Student Success in Online Learning." Doctoral dissertation, Cleveland State University, 2020. http://rave.ohiolink.edu/etdc/view?acc_num=csu1593795460701708

25. EMIS Services / Home. Accessed December 12, 2023. https://www.access-k12.org/domain/17.

26. Faul, Franz, Edgar Erdfelder, Axel Buchner, and Albert-Georg Lang. "Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses." Behavior research methods 41, no. 4 (2009): 1149-1160.

27. Gaftandzhieva, Silvia, Ashis Talukder, Nisha Gohain, Sadiq Hussain, Paraskevi Theodorou, Yass Khudheir Salal, and Rositsa Doneva. "Exploring online activities to predict the final grade of student." *Mathematics* 10, no. 20 (2022): 3758.

28. Garcia, Elaine, Mel Brown, and Ibrahim Elbeltagi. "Learning within a Connectivist Educational Collective Blog Model: A Case Study of UK Higher Education." *Electronic Journal of E-learning* 11, no. 3 (2013): 253-262.

29. Han, Jimmy. "Understanding Ohio's State Tests Score Reports." Ohio Department of Education, December 7, 2022.

30. Harmony. Accessed December 12, 2023. https://harmony.access-k12.org/Login?ReturnUrl=%2F.

31. Harrell, Frank E., Kerry L. Lee, and Daniel B. Mark. 1996. "Multivariable Prognostic Models: Issues in Developing Models, Evaluating Assumptions and Adequacy, and Measuring and Reducing Errors." Statistics in Medicine 15 (4): 361–87. doi:10.1002/(SICI)1097-0258(19960229)15:4<361::AID-SIM168>3.0.CO;2-4.

32. Hensher, David A., and Peter R. Stopher. Behavioural Travel Modelling. Croom Helm, 1979. https://search-ebscohost-com.proxy01.shawnee.edu/login.aspx?direct=true&db=cat02507a&AN=ohiolink.b10664754&site=eds-live&scope=site.

33. Ialongo, Cristiano. "Understanding the effect size and its measures." *Biochemia medica* 26, no. 2 (2016): 150-163.

34. Ismail, Ahmed Omer, Ahmad K. Mahmood, and Abdelzahir Abdelmaboud. "Factors influencing academic performance of students in blended and traditional domains." *International Journal of Emerging Technologies in Learning (Online)* 13, no. 2 (2018): 170-187.

35. Jiménez-Valverde, Alberto, and Jorge M. Lobo. 2007. "Threshold Criteria for Conversion of Probability of Species Presence to Either–or Presence–absence." Acta Oecologica 31 (3): 361–69. doi:10.1016/j.actao.2007.02.001.

36. Kathleen Dunaway, Michelle. "Connectivism: Learning theory and pedagogical practice for networked information landscapes." *Reference services review* 39, no. 4 (2011): 675-685.

37. Kelley, Todd R., and J. Geoff Knowles. "A conceptual framework for integrated STEM education." *International Journal of STEM Education* 3 (2016): 1-11.

38. Kim, Alice SN, Sharry Shakory, Arman Azad, Celia Popovic, and Lillian Park. "Understanding the impact of attendance and participation on academic achievement." *Scholarship of Teaching and Learning in Psychology* 6, no. 4 (2020): 272-284.

39. Kop, Rita. "The challenges to connectivist learning on open online networks: Learning experiences during a massive open online course." *International Review of Research in Open and Distributed Learning* 12, no. 3 (2011): 19-38.

40. Kurt, Dr. Serhat. "Situated Learning Theory." Educational Technology, February 17, 2021. https://educationaltechnology.net/situated-learning-theory/.

41. Kutner, Michael H., Christopher J. Nachtsheim, John Neter, and William Li. Applied linear statistical models. McGraw-hill, 2005.

42. Kwak, Chanyeong, and Alan Clayton-Matthews. "Multinomial logistic regression." *Nursing research* 51, no. 6 (2002): 404-410.

43. Lin, Chin-Hsi, Jemma Bae Kwon, and Yining Zhang. "Online self-paced high-school class size and student achievement." *Educational Technology Research and Development* 67 (2019): 317-336.

44. Long, J. Scott. 1997. Regression Models for Categorical and Limited Dependent Variables. Advanced Quantitative Techniques in the Social Sciences: 7. Sage Publications. https://search-ebscohost-com.proxy01.shawnee.edu/login.aspx?direct=true&db=cat02507a&AN=ohiolink.b17653691&site=eds-live&scope=site.

45. Louviere, Jordan J., David A. Hensher, and Joffre Dan Swait. Stated Choice Methods : Analysis and Applications. Cambridge University Press, 2000. https://search-ebscohost-com.proxy01.shawnee.edu/login.aspx?direct=true&db=cat02507a&AN=ohiolink.b20419210&site=eds-live&scope=site.

46. Menard, Scott. *Applied logistic regression analysis*. No. 106. Sage, 2002.

47. Midi, Habshah, Saroje Kumar Sarkar, and Sohel Rana. "Collinearity diagnostics of binary logistic regression model." *Journal of interdisciplinary mathematics* 13, no. 3 (2010): 253-267.

48. Mood, Carina. "Logistic regression: Why we cannot do what we think we can do, and what we can do about it." *European sociological review* 26, no. 1 (2010): 67-82.

49. National Forum on Education Statistics (ED). *Every School Day Counts: The Forum Guide to Collecting and Using Attendance Data. NFES 2009-804*. ERIC Clearinghouse, 2009.

50. Nemes, Szilard, Junmei Miao Jonasson, Anna Genell, and Gunnar Steineck. "Bias in odds ratios by logistic regression modelling and sample size." *BMC medical research methodology* 9 (2009): 1-5.

51. Newsom, Jason. "Sample Size Issues for Categorical Analyses and Logistic Regression." Portland State University, June 1, 2021.

52. Ohio Department of Education. "2022-2023 State Report Card | School and District Results." Ohio Department of Education, September 14, 2023.

53. Ohio Department of Education. "Ohio Algebra I Blueprint." Ohio Department of Education, June 11, 2018.

54. Ohio Department of Education. "Ohio's State Tests Item Development Sequence." Ohio Department of Education and Workforce , November 21, 2023.

55. Ohio Department of Education. "Test Blueprints." Ohio Department of Education, May 18, 2020.

56. Ohio Department of Education. "Test Specifications." Ohio Department of Education, May 19, 2020.

57. Ohio Department of Education. 2023. "Ohio's State Tests in English Language Arts, Mathematics, Science and Social Studies." Accessed January 24, 2024. https://education.ohio.gov/Topics/Testing/Ohios-State-Test-in-ELA-Math-Science-Social Studies.

58. Ohio School Report Cards. Accessed December 12, 2023. https://reportcard.education.ohio.gov/home.

59. Ozcan, Bahadir, Hakki Kontas, and Ali Unisen. "Sources of mathematics self-efficacy of gifted and non-gifted students in high school." Research in Pedagogy 11, no. 1 (2021): 85-97.

60. Pallay , Geoff. "Education Statistics in the United States." Ballotpedia, October 10, 2022. https://ballotpedia.org/Education_statistics_in_the_United_States.

61. Pappas, Christopher. "Instructional Design Models and Theories: The Situated Cognition Theory and the Cognitive Apprenticeship Model." eLearning Industry, May 12, 2021. https://elearningindustry.com/situated-cognition-theory-and-cognitive-apprenticeship-mo del.

62. Park, Enoch, Florence Martin, and Richard Lambert. "Examining predictive factors for student success in a hybrid learning course." *Quarterly Review of Distance Education* 2 (2019): 11-74.

63. Pasch, Bret, Benjamin M. Bolker, and Steven M. Phelps. "Interspecific dominance via vocal interactions mediates altitudinal zonation in neotropical singing mice." The American Naturalist 182, no. 5 (2013): E161-E173.

64. Paul, Jasmine, and Felicia Jefferson. "A comparative analysis of student performance in an online vs. face-to-face environmental science course from 2009 to 2016." *Frontiers in Computer Science* 1 (2019): 7.

65. Peduzzi, Peter, John Concato, Alvan R. Feinstein, and Theodore R. Holford. "Importance of events per independent variable in proportional hazards regression analysis II. Accuracy and precision of regression estimates." Journal of clinical epidemiology 48, no. 12 (1995): 1503-1510.

66. Peduzzi, Peter, John Concato, Elizabeth Kemper, Theodore R. Holford, and Alvan R. Feinstein. "A simulation study of the number of events per variable in logistic regression analysis." Journal of clinical epidemiology 49, no. 12 (1996): 1373-1379.

67. Peng, Chao-Ying Joanne, Kuk Lida Lee, and Gary M. Ingersoll. "An introduction to logistic regression analysis and reporting." *The journal of educational research* 96, no. 1 (2002): 3-14.

68. Pingry O'Neill, Laura N., Martha J. Markward, and Joshua P. French. "Predictors of graduation among college students with disabilities." *Journal of Postsecondary Education and Disability* 25, no. 1 (2012): 21-36.

69. Potts, Jessica Alison. "Profoundly gifted students' perceptions of virtual classrooms." *Gifted Child Quarterly* 63, no. 1 (2019): 58-80.

70. R Core Team. 2023. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

71. Sabayleh, Obaid A., and Mohammad A. Sakarneh. "Effective Teaching Strategies for Students with Learning Disabilities in Inclusive Classroom: A Comparative Study: Teaching strategies." *Educational Administration: Theory and Practice* 29, no. 1 (2023): 209-220.

72. Siemens. George. "Connectivism: A learning theory for the digital age." *International Journal of Instructional Technology and Distance Learning*: (2005) 2.

73. Siemens, George. "Learning and knowing in networks: Changing roles for educators and designers." *ITFORUM for Discussion* 27, no. 1 (2008): 1-26.

74. Singmann, Henrik, and David Kellen. "An introduction to mixed models for experimental psychology." In New methods in cognitive psychology, pp. 4-31. Routledge, 2019.

75. Stay in the game! attendance network - keep learning, every day. 2024. "Dynamic Statewide Movement and Learning Network Designed to Dramatically Improve Student Attendance." Accessed February 23, 2024. https://stayinthegame.org/.

76. Steyerberg, Ewout W., Marinus JC Eijkemans, Frank E. Harrell Jr, and J. Dik F. Habbema. "Prognostic modelling with logistic regression analysis: a comparison of selection and estimation methods in small data sets." *Statistics in medicine* 19, no. 8 (2000): 1059-1079.

77. Stoltzfus, Jill C. "Logistic regression: a brief primer." *Academic emergency medicine* 18, no. 10 (2011): 1099-1104.

78. Tape, Thomas G. "Interpreting diagnostic tests: The area under an ROC curve." *Unpublished report, University of Nebraska Medical Center, Omaha* (2003).

79. The Pennsylvania State University Department of Statistics Online Programs. "Lesson 9: Influential Points." Lesson 9: Influential Points | STAT 462 Applied Regression Analysis, 2018. https://online.stat.psu.edu/stat462/node/87/.

80. van Smeden, Maarten, Karel GM Moons, Joris AH de Groot, Gary S. Collins, Douglas G. Altman, Marinus JC Eijkemans, and Johannes B. Reitsma. "Sample size for binary logistic prediction models: beyond events per variable criteria." Statistical methods in medical research 28, no. 8 (2019): 2455-2474.

81. Vojacek, Cheryl. "Algebra Test Specifications." Ohio Department of Education, August 26, 2022.

SSU IRB Approved [BR] 10/27/2023 | 6:43 P

Shawnee State University

Study # 2023-39

Exempt Review Application

Title of Research Project:
Impacts Instructional Methods have on Students with Disabilities and Students Identified
as Gifted Based on State Assessment Scores in High School Mathematics Courses

Name of Principal Investigator	Email Address	Phone Number
Douglas Darbro	ddarbro@shawnee.edu	7403513441

Department(s)/Division/Agency Mathematics

Name(s) of Co-Investigators:	Email address:	Faculty	Student	Other
Nicholas Sesonsky	sesonskyn@mymail.shawnee.edu	☐	☒	☐
Jonathan McCullough	mcculloughj@mymail.shawnee.edu	☐	☒	☐
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐

*Please place an asterisk by the investigator name(s) whose NIH certificate(s) is/are already on file with the IRB, if the certificate is less than 3 years old.

Please place a check mark next to the category that best describes your research. You may check more than one category.

☒ Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (a) research on regular and special education instructional strategies, or (b) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

☐ Research involving the use of educational tests (e.g., cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (a) data obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (b) any disclosure of the human subjects' responses outside the research could reasonably place the participants at risk of criminal or civil liability or be damaging to the participants' financial standing, employability, or reputation. No videotaping or photography is allowed for data collection. You may not collect data from appointed public officials or candidate for public office.

Shawnee State University

Study # 2023-39

□ Research involving the collection or study of existing information, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

□ Research and demonstration projects that are conducted by or subject to the approval of supporting agencies, and which are designed to study, evaluate, or otherwise examine: (a) public benefit or service programs; (b) procedures for obtaining benefits or services under those programs; (c) possible changes in or alternatives to those programs or procedures; or (d) possible changes in methods or levels of payment for benefits or services under those programs.

□ Taste and food quality evaluation and consumer acceptance studies, (a) if wholesome foods without additives are consumed or (b) if a food is consumed that contains a food ingredient at or below the level, and for a use, found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration and approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

Does your research include at least one of the above criteria?   Yes × ** No**

1. Describe the key demographics (age, SES, ethnicity, geographic locations, gender, etc) of the sample that you wish to obtain.
Students in grades 11 and 12 that are identified as Gifted or as having a learning disability from a variety of school districts with varying SES.

1a. What is the greatest number of participants that will be recruited? 1000

1b. How will participants be recruited
Participants will be selected by each school district based on one of our identifiers of Gifted or students with a learning disability.

2. Will participants be remunerated for their participation?   Yes   No ×

2a. If so, how will participants be remunerated? Please indicate the type of remuneration and the amount. For instance, the participants will be given a $10 Amazon Gift Card for participation or the participants will receive 3% of their final grade in extra credit in their Introduction course.

Shawnee State University_____   Study # 2023-39

2b. If participants do not complete the study, will partial or full remuneration be given? Please describe how that will be determined.

3. What direct benefits (other than remuneration) exist for the participants who participate?
Not applicable

4. What direct risks could the participants potentially face? Check all that apply.

_____ Risk of breach of confidentiality or privacy

_____ Risk of coercion by researcher(s)

_____ Risk of psychological harm

_____ Risk of physical harm

_____ Other potential risk: _____

If you checked any direct risks in Item 4, then you should complete the "Expedited and Full Review Application."

5. Will the participants be informed of the risks and benefits of the study?   Yes   No

    5a. If so, how will the participants be informed?

    5b. Please check each box if the following criteria match your research.

    ☐ The research involves no greater than minimal risk.
    ☐ It is not practicable to conduct the research without a waiver of informed consent or alteration to informed consent.
    ☐ Waiving or altering the informed consent will not adversely affect the subjects' rights and welfare.
    ☐ The consent document would be the only record linking the subject and the research, and the principal risk would come from a breach of confidentiality.

    5c. Do you wish to waive the signed informed consent?   Yes   No

Shawnee State University

Study # 2023-39

In submitting this form and the corresponding documents, I acknowledge that I have completed Human Research Participants training and that I understand and will uphold the rights of human participants. I also verify that all information contained in this form and any other corresponding documentation is correct based on my knowledge. I understand that I may not have contact with any research participants until the Shawnee State University IRB has given me their approval. I also understand that I must file an *Amendment/Modification Form* if my project extends beyond a year from my approval date and I must file a *Final Study Form* with all consent forms once the study is complete.

Douglas Davboro
Signature of Principal Investigator 1

Nicholas Sesovsky
Signature of Co-Investigator 2

Jonathan McCullough
Signature of Co-Investigator 3

_____
Signature of Co-Investigator 4

_____
Signature of Co-Investigator 5

_____
Signature of Co-Investigator 6

Date of Submission: 10/20/2023 | 7:55 AM EDT

Please compile attachments into one document for each category. If any forms below are not applicable, please attach reasons why.

Human Research Training Certificates: Data Collection Questions and Forms:

Research Summary: Consent Forms:

Assent Forms: Advertisements:

Revisions Requested   Yes   No X   IRB Chair Signature
Date sent for revision (if applicable): _____

Please attach revisions requested with changes clearly marked   Changes marked

Final copy

Rev. 9/3/2013;1/24/22

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DDD

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CERTIFICATE
OF COMPLETION

PHRP Online Training, Inc. certifies that

Nicholas Sesonsky

has successfully completed the web-based course "Protecting Human Research Participants Online Training."

Date Completed: **2023-08-16**   Certification Number: **2991222**

PHRP
Protecting Human
Research Participants
Online Training

CERTIFICATE

OF COMPLETION

PHRP Online Training, Inc. certifies that

Jonathan McCullough

has successfully completed the web-based course "Protecting Human Research Participants Online Training."

Date Completed: **2023-08-20**   Certification Number: **2991224**

PHRP
Protecting Human
Research Participants
Online Training

Table 8. Instructional Method Pass & Not Pass Frequencies
(Not Hybrid: Traditional and Online Instructional Methods, Hybrid was the Reference Category based on the study's assumptions)

HYBRID AS REFERENCE CATEGORY			
	Pass (Percentage)	**Not Pass (Percentage)**	**Total (Percentage)**
Hybrid	168 (0.319)	79 (0.150)	247 (.470)
Not Hybrid	210 (0.399)	69 (0.131)	279 (.530)
Total	378 (.719)	148 (.281)	526

G* Power Calculations

$$Pr(\,y = 1\,(PASS)\mid x = 1\,(Hybrid)) = \frac{168}{247} = .6801619433$$

$$Pr(\,y = 1\,(PASS)\mid x = 0\,(Not\ Hybrid)) = \frac{210}{279} = .752688172$$

$$X\ parm\ \pi = proportion\ of\ hybrid = .469581749$$

$$Z - score\ = \ -1.9599640$$

$$Sample = 1216$$

$$Priori\ Power = 0.8001675$$

$$Actual\ Sample\ Size = 526$$

$$Observed\ Power\ with\ Actual\ Sample\ Size = 0.4531592$$
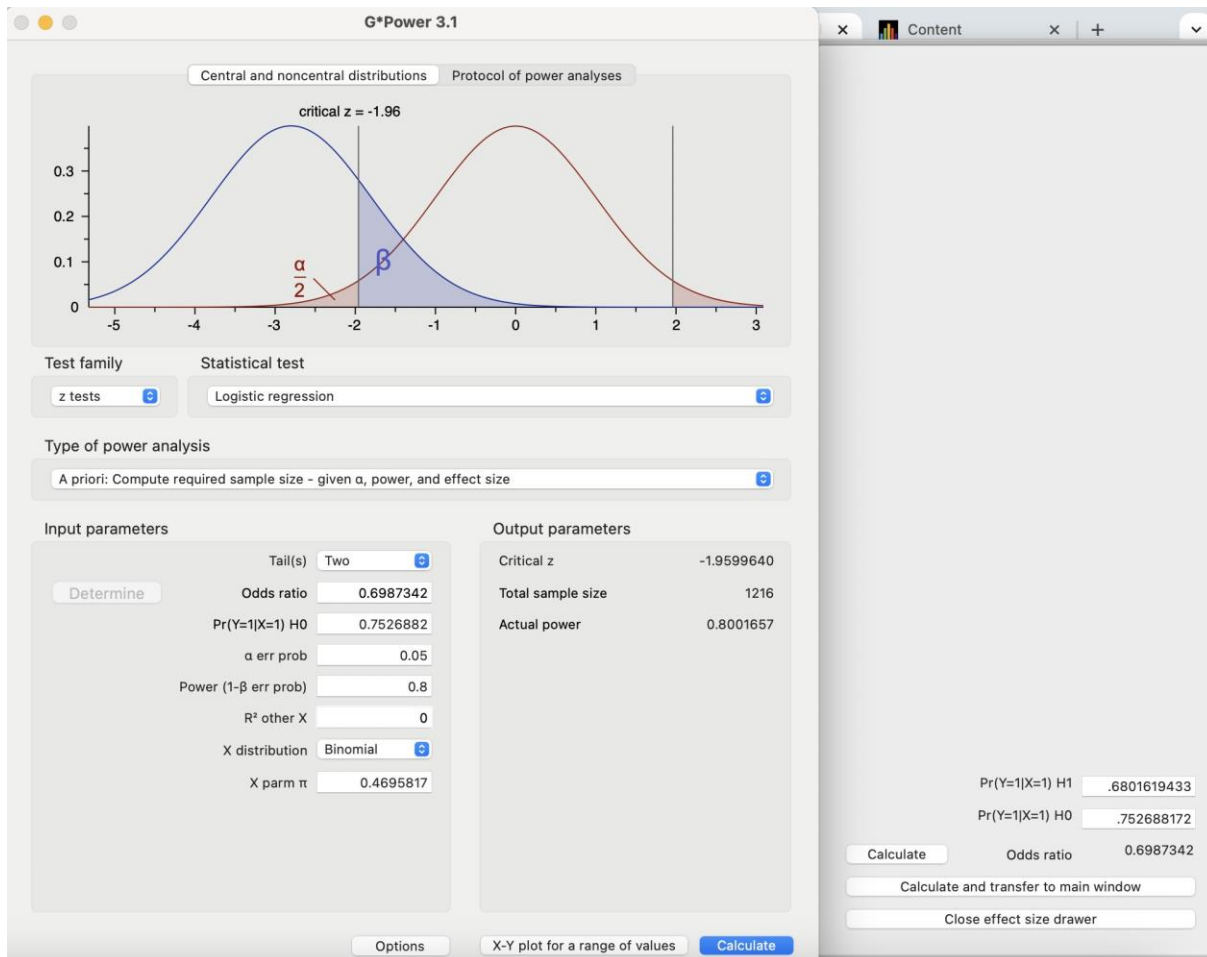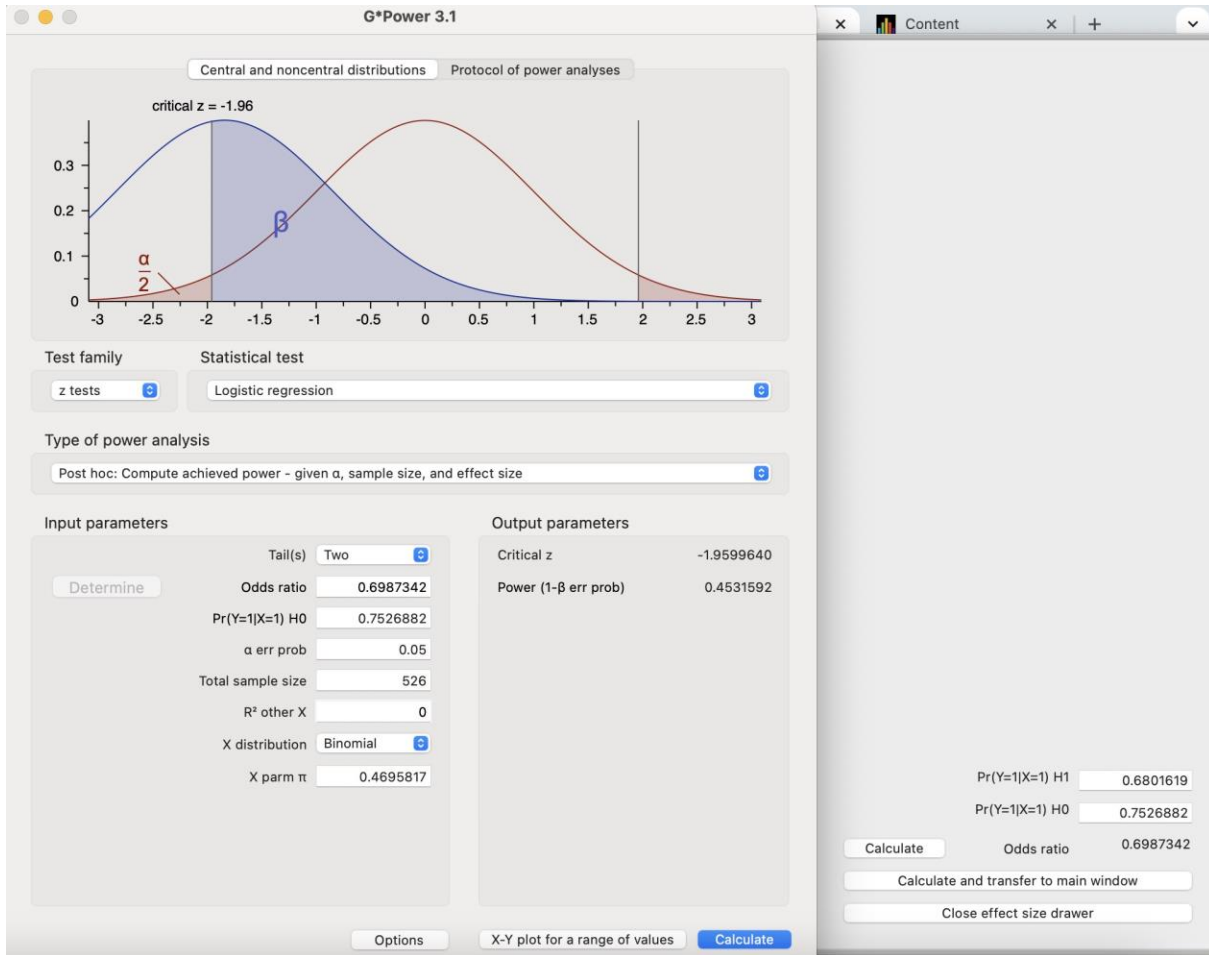
Figure 1. Priori Power Analysis

Figure 2. Observed Power Analysis

BIBLIOGRAPHY

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Candidate for the Degree of

Master of Science Mathematics

Thesis: AN EXPLORATORY STUDY: DETERMINING SIGNIFICANT PREDICTORS OF ACADEMIC SUCCESS ON THE OHIO STATE END OF COURSE ASSESSMENT IN ALGEBRA 1 FOR STUDENTS WITH LEARNING DISABILITIES AND STUDENTS IDENTIFIED AS GIFTED

Major Field: Mathematics

Biographical: High school mathematics teacher since 2017 at Beaver Local School District located in Columbiana County, Ohio teaching Geometry, Algebra 2, and AP Calculus AB. Additionally, an assistant varsity football coach as well as the strength and conditioning coach.

Personal Data: Graduate of Poland Seminary High School in Poland, Ohio in 2013 and currently resides in Youngstown, Ohio.

Education: 2017 Bachelor of Science in Education from Youngstown State University Completed the requirements for the Master of Science in Mathematics, Portsmouth, Ohio in 2024.

ADV ISER'S APPROVAL: Dr. Douglas Darbro

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Education: 2013 Bachelor of Science in Mathematics from Geneva University.

Completed the requirements for the Master of Science in Mathematics, Portsmouth, Ohio in 2024.

ADVISER'S ,3PROVAL: Dr. Douglas Darbro

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