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Self-Esteem, Attitudes Toward Mathematics, and Mathematics Achievement in a Rural Appalachia High School

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Self-Esteem, Attitudes Toward Mathematics, and Mathematics Achievement in a Rural Appalachia High School

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By

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The thesis entitled '**Self-Esteem, Attitudes Toward Mathematics, and Mathematics Achievement in a Rural Appalachia High School'**

presented by **Jennifer Akers**, a candidate for the degree of **Master of Science in Mathematics,**

has been approved and is worthy of acceptance.

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ABSTRACT

The study was conducted at a rural Appalachia high school that is in the northern part of Appalachia. Research on students from Appalachia is difficult to find. The research wanted to see if any relationships occurred between students' self-esteem, attitudes toward mathematics and mathematics achievement. Social and Emotional Standards are becoming an important part of students' educational experience. Students' poor mathematics achievement at Huntington High School has been topic of interest since 2005 and before. If self-esteem and attitudes towards mathematics have a relationship to math achievement, then Huntington High School could use the way they implement Social and Emotional Standards to also help with math achievement. Students in one high school math teacher's class completed two likert-type questionnaires. One is the Attitudes Towards Mathematics Inventory (ATMI) and the other Rosenberg's Self Esteem Scale (RSE). Students' semester average and MAPs test scores were collected. Logistic Analysis as well as regression techniques were used on the data collected. The research showed that student' Attitudes Toward Mathematics had a relationship to students' semester average. Implying that educators need to consider students' attitudes toward mathematics as a factor in successful completion of a high school math course.

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My graduate career, especially this thesis, could not have been completed without my faith in God as well as the support of my family and friends. Each have been encouraging and supportive as I pursued the goal of completing this degree. Lastly, I would like to thank my graduate department chair and thesis advisor Dr. Doug Darbro. He has been an amazing mentor for several years, first as an undergraduate professor and now as my thesis advisor.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

Chapter 1: Introductory

Mathematics achievement has been a topic of research and discussion for many years. Some students seem to excel in mathematics while many others fall behind. Many people who do not achieve highly in mathematics seem to have the idea that they just cannot do well in mathematics. Stage and Kloosterman (1995) found in their study of remedial college mathematics students the mathematics belief scales measurements were a significant predictor of final course grade.[1] Students that struggle in mathematics tend to believe that math minded individuals are the only people that can be successful in mathematics. Some school districts are labeled as high mathematics achievers while other school districts are known to struggle with mathematics. Aiken (1970) conducted literature review research on attitudes toward mathematics. His research summarized "mathematics attitudes and achievement indicate that individuals with more positive attitudes and higher achievement tend to have better personal and social adjustment."[2] School districts are interested in implementing programs to target mathematical achievement. The central focus of this study is to examine if some students are naturally better in mathematics or if there are factors that might contribute to their success in mathematics other than natural talent.

Social-emotional development of school aged children has become a major focus in public schools. Teachers, principals, councilors, and other school personnel are to implement social-emotional standards into the curriculum for each student. It has become important to ensure students have resources to information to help them have positive self-esteem, self-image,

[1] Stage, Frances K., and Peter Kloosterman. "Gender, Beliefs, and Achievement in Remedial College-Level Mathematics." The Journal of Higher Education 66, no. 3 (1995): 294-311. Accessed February 23, 2021. doi:10.2307/2943893.

[2] Aiken, Lewis R. "Attitudes toward Mathematics." *Review of Educational Research* 40, no. 4 (1970): 551-96. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/1169746.

and attitudes. Could students' self-esteem contribute to their success in mathematics? Does a student's attitude toward mathematics be related to their mathematical success? This study will find if any relationship exists between students' self-esteem, attitudes toward mathematics, and mathematical achievement.

Background of the Problem

Huntington High School is a rural southern Ohio school situated in Appalachia. Huntington has been known to always struggle with mathematics achievement. Students seem to be very apathetic towards mathematics classes. Very few students take upper level secondary mathematics courses. In 2004 the school district decided to hire math teachers that graduated high school from school districts that were considered high achieving in mathematics. Still in 2021 very few students take Precalculus and Calculus. The majority of the students who decided to take AP Calculus do not opt to sit for the AP exam. Of the few students that have decided to sit for the AP Calculus test no one has passed it. Data from Hungington's school report card shows that of the 2018 and 2019 graduates only 12.5% received a remediation free ACT score.[3] Students seem to think this is okay because they are from Huntington and Huntington students are not supposed to be good at mathematics. Mathematical achievement is an issue that the district addresses continually in district leadership meetings and in building leadership team meetings. The focus has always been on teaching strategies to help improve student achievement.

Huntington High School is situated in the northern portion of what is known as Appalachia. Appalachia has been known to some as the invisible minority. According to Scott, Hockenberry, and Miller (2015), "While education provides opportunity, some Appalachian

[3] "Ohio School Report Cards," Ohio Department of Education, accessed November 27, 2020, https://reportcard.education.ohio.gov/school/prepared/017160

students see classrooms and schools as a reminder of what they lack."[4] Global mathematical achievement has been an issue in many third world foreign countries. Similarly, mathematical achievement has been a topic of research for female students. Much research has been completed looking at relationships between mathematical achievement among these minority groups. Race has been studied quite extensively as well to see what relationships exist among mathematical achievement. A researcher can find many studies completed in urban school districts and mathematical achievement. Park and Kanyongo (2012) published a study that examined mathematical achievement in 80 schools in a large northeastern urban school district and found that in grade 11 mathematics achievement "Black students had a significantly lower mathematics score than White students."[5]Another study by Breger (1970) centered in Chicago, Illinois researched the relationship between poverty and achievement. This study focused on 495 public schools in the urban Chicago Public School system.[6]

In June 2019 the Ohio State Board of Education adopted Social-Emotional (2019) standards for school districts, buildings, teachers and classrooms.[7] Self-esteem is believed to be a needed trait to be successful in and out of the classroom. It has long been viewed that individuals must see themselves positively to be able to be successful.[8]Much research has been

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[4] Scott, Marc., Hockenberry, Jacklyn., and Miller, Elizabeth., "Tutoring the 'Invisible Minority': Appalachian Writers in the Writing Center." *Open Words: Access and English Studies* 40, no. 1 (2015): 50-61. Accessed February 20, 2021. https://www.pearsoned.com/wp-content/uploads/Scott-etc-Open_Words-Journal_Spring-2015-Final.pdf

[5] Parke, Carol S., and Gibbs Y. Kanyongo. "Student Attendance, Mobility, and Mathematics Achievement in an Urban School District." The Journal of Educational Research 105, no. 3 (2012): 161-75. Accessed February 22, 2021. doi:10.2307/26586927.

[6] Breger, Lisa. "Poverty and Student Achievement in Chicago Public Schools." The American Economist 62, no. 2 (2017): 206-16. Accessed February 22, 2021. doi:10.2307/26754415.

[7] "Social and Emotional Learning Standards." Ohio Department of Education, accessed February 20, 2021, http://education.ohio.gov/Topics/Learning-in-Ohio/Social-and-Emotional-Learning/Social-and-Emotional-Learning-Standards

[8] Baumeister, Roy F., Jennifer D. Campbell, Joachim I. Krueger, and Kathleen D. Vohs. "Does High Self-Esteem Cause Better Performance, Interpersonal Success, Happiness, or Healthier Lifestyles?"

completed on students' self-esteem in the classroom. Research on minority groups such as third world foreign countries, women, African American students, and English as a second language students in America exist. Research on rural Appalachian American schools, self-esteem and mathematical achievement is lacking.

Researchers suggest that attitudes toward mathematics and mathematical achievement are correlated. There are many studies that have varying degrees of correlation. Aiken (1970) conducted a literature review research on attitudes toward mathematics. He included three dozen journal articles, two dozen doctoral dissertations, and half a dozen reports of studies concerned with attitudes toward mathematics. His research summarized "mathematics attitudes and achievement indicate that individuals with more positive attitudes and higher achievement tend to have better personal and social adjustment." But in his research the correlation was considered low.[9] Not only do researchers disagree on the strength of correlation but some have found that the correlation between academic achievement and attitudes are not related at all. Peixoto and Almedia (2010) ultimately found "negative attitudes towards school seem to be associated more with low self-esteem."[10]

The research community disagrees on self-esteem being a contributing factor to academic success. Literature can be found relating self-esteem to academic performance. In 1965 Rosenberg (1965) showed that self-esteem has positive links with academic success.[11] But since

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Psychological Science in the Public Interest 4, no. 1 (2003): 1-44. Accessed November 26, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/40062291.

[9] Aiken, Lewis R. "Attitudes toward Mathematics." *Review of Educational Research* 40, no. 4 (1970): 551-96. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/1169746.

[10] Peixoto, Francisco, and Leandro S. Almeida. "Self-concept, Self-esteem and Academic Achievement: Strategies for Maintaining Self-esteem in Students Experiencing Academic Failure." European Journal of Psychology of Education 25, no. 2 (2010): 157-75. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/23421533.

[11] Rosenberg, M. 1965. *Society and the Adolescent Self-Image.* Princeton, NJ: Princeton University Press.

then other research has been conducted suggesting that self-esteem and academic achievement may be related to more variables. Aryana (2010) collected data from pre-university students in Qaemshahr and found statistically significant evidence that self-esteem and academic achievement are related.[12] On the contrary, Baumeister, Campbell, Kruger & Vohs (2003) showed self-esteem has little to no positive impact on academic achievement.[13] Their research showed no correlation.

Statement of the Problem

Huntington Local School District is committed to cultivating the brilliance in every child.[14] Previous research is inconclusive on what factors are related when studying self-esteem, attitudes towards mathematics and mathematical achievement. The research will identify any correlations that may exist between these variables for the students of Huntington High School. The results of this study will give Huntington School District valuable data analysis to be used to make informed decisions on how to help support the schools mission for their students. Other school districts will be able to use the study as a model to gather and analyze their student data.

Purpose of the Study

This study includes quantitative and qualitative data. This study examines three measures which are students' attitudes towards mathematics, students' self-esteem and students' mathematical achievement. We may examine factors in different groupings to find if any

[12] Aryana, M. "Relationship Between Self-esteem and Academic Achievement Amongst Pre-University Students." *Journal of Applied Science* 10,no. 20 (2010): 2474-2477. Retrieved November 27, 2020, from http://docsdrive.com/pdfs/ansinet/jas/2010/2474-2477.pdf

[13] Baumeister, Roy F., Jennifer D. Campbell, Joachim I. Krueger, and Kathleen D. Vohs. "Does High Self-Esteem Cause Better Performance, Interpersonal Success, Happiness, or Healthier Lifestyles?" *Psychological Science in the Public Interest* 4, no. 1 (2003): 1-44. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/40062291.

[14] "Dear Huntington Family," Huntington Administrative Team, Accessed November 27, 2020, https://www.huntsmen.org/article/274409?org=hlsd

correlations exist. If there are statistically significant relationships the study hopes to find a formula to help predict the likelihood of mathematical achievement given a students' score on the Rosenberg Self-Esteem Scale (RSE) and the Attitudes Toward Mathematics Inventory (ATMI). The subjects in this study will include students from Mrs. Akers' Algebra 1 and Algebra 2 classes at Huntington High School in Chillicothe, Ohio.

Mathematical achievement is defined as the growth on the MAPs Algebra 1 or 2 test from the beginning of the year to mid-year as well as students' first semester averages from their respective Algebra class. The NWEA (2017) states that the correlation coefficient between MAP tests and Ohio state math tests is .73-.82 indicating a strong correlation.[15] There has been much research on the reliability and validity of teachers' grades and student achievement. Brookhart et al (2016) cites that the correlation between grade point average and the mathematics component of the ACT is between .56 and .58.[16] The use of semester averages will help see each participants' achievement in the classroom as well as on a standardized test. The RSE is a 10 item 4-point Likert type scale. This data tool is easily implemented and has proven to be valid with a Cronbach alpha ranging from .77 to .88.[17] The ATMI is a 40 item 5-point Likert scale with a Cronback alpha of .97.[18] The data tools are available to the public thus allowing the findings from this research to be able to be replicated at other school districts.

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[15] "Linking the Ohio State Assessments to NWEA MAP Growth Tests," Northwest Evaluation Association, Accessed November 27, 2021 https://www.nwea.org/content/uploads/2017/01/OH-MAP-Growth-Linking-Study-AUG2016.pdf

[16] Brookhart, Susan M., Thomas R. Guskey, Alex J. Bowers, James H. McMillan, Jeffrey K. Smith, Lisa F. Smith, Michael T. Stevens, and Megan E. Welsh. "A Century of Grading Research: Meaning and Value in the Most Common Educational Measure." Review of Educational Research 86, no. 4 (2016): 803-48. Accessed February 6, 2021. http://www.jstor.org.proxy01.shawnee.edu/stable/44668237.

[17] Rosenberg, M. 1965. *Society and the Adolescent Self-Image.* Princeton, NJ: Princeton University Press.

[18] Tapia, Martha. "The Attitudes toward Mathematics Instrument." Paper presented at Annual Meeting of the Mid-South Educational Research Association, Tuscaloosa, AL. Accessed November 27, 2020. https://files.eric.ed.gov/fulltext/ED404165.pdf

Significance of the Study

This study will fill the gap in research that examines the relationship among mathematical achievement, self-esteem, and attitudes towards mathematics that include participants in rural Appalachian. Rural students have long been ignored in prior research pertaining to these variables. The study is aimed to help fill the gap in research that represents this population.

The results of this study will be beneficial to Huntington Local Schools to decide where funding and what kind of interventions may be put in place to help meet the mathematics need in the district. This study will provide school districts with a way to assess the relationship between self-esteem, attitudes toward mathematics and mathematical achievement. If no relationship exists then districts need to look further into what variables are related to mathematical achievement.

Research Questions

The research questions for this project are:

1) Are self-esteem, attitudes toward mathematics, and change in MAP score predictive of success in the secondary mathematics classroom?

Hypothesis 1: The first hypothesis is that there is not a significant relationship between self-esteem, attitudes toward mathematics, change in MAP score and mathematical achievement.

2) Are self-esteem and attitudes toward mathematics predictive of change in MAP score?

Hypothesis 2: The second hypothesis is that there is not a significant relationship between self-esteem, attitudes toward mathematics and change in MAP score.

3) Is the midterm MAP test score predictive of semester average in an Algebra class?

Hypothesis 3: The third hypothesis is that MAP test scores do not predict semester grades in

Algebra 1 or Algebra 2.

Research Design

MAP student scores and first semester grades from Huntington High School will be gathered on high school students in Jennifer Akers' Algebra 1 and Algebra 2 classes. Participants will complete the Rosenberg Self-Esteem Scale (RSE). They will also complete Attitudes Toward Mathematics Inventory (ATMI). Participants will complete the RSE and ATMI during a normal scheduled class period. The research will explain to the students the purpose of the RSE and ATMI. Participants will be allotted approximately forty-five minutes to complete the two inventories. Approximately 75 participants will be in this study.

MAPs scores are available to the researcher through a login to the NWEA website. Huntington High School principal has given the researcher permission to use the website and scores as part of this study. The researcher will code the names to protect the identity of each data point. The students' first semester grades will be collected using ProgressBook. The researcher has gained permission from the principal to collect this data according to the directions of this study. Students MAPs scores, first semester grades (first and second nine weeks), answers to RSE, and ATMI will be entered into a spreadsheet.

Theoretical Framework

Self-esteem is the belief or attitude one possesses of itself. M. Rosenberg, Schooler, Schoenback, & F. Rosenberg (1995) states that global self-esteem is "the individual's positive or negative attitude toward the self as a totality."[19] Global self-esteem examines the complete attitude of a person. Ohio schools have been required by the State Board of Education to aid

[19] Rosenberg, Morris, Carmi Schooler, Carrie Schoenbach, and Florence Rosenberg. "Global Self-Esteem and Specific Self-Esteem: Different Concepts, Different Outcomes." American Sociological Review 60, no. 1 (1995): 141-56. Accessed February 26, 2021. http://www.jstor.org.proxy01.shawnee.edu/stable/2096350.

students to develop positive self-esteem by implementing social-emotional standards into the curriculum. Self-esteem is believed to be a needed trait to be successful in and out of the classroom. It has long been viewed that individuals must see themselves positively to be able to be successful (Baumeister, Campbell, Kruger & Vohs, 2003)[20].

According to the school's website, "Huntington Local School District believes in the importance of education. Our mission is to cultivate the brilliance in every child. We are dedicated to sustaining a learning environment that is nurturing, safe and healthy for our students and staff."[21] Aiken (1970) stated that "the relationship of attitudes, which are integrally related to expectations, to performance appears to be especially important in mathematics learning."[22] The attitudes of the students may interfere with achievement more than the ability level. Sonnert, Barnett & Sadler, P. (2020) found evidence that mathematics attitude had a positive association with calculus achievement in college.[23]

The Foucault Theory of Power will be used as a theoretical framework. Borch (2005) explains that in Foucault's theory, "nobody stands passively outside of power" and that "everyone reproduces power in his/her ways of compliance or resistance."[24] Foucault's discursive formations will be used in this study to find out if students have pre-formed attitudes

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[20] Baumeister, Roy F., Jennifer D. Campbell, Joachim I. Krueger, and Kathleen D. Vohs. "Does High Self-Esteem Cause Better Performance, Interpersonal Success, Happiness, or Healthier Lifestyles?" *Psychological Science in the Public Interest* 4, no. 1 (2003): 1-44. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/40062291.

[21] "Dear Huntington Family," Huntington Administrative Team, Accessed November 27, 2020, https://www.huntsmen.org/article/274409?org=hlsd

[22] Aiken, Lewis R. "Attitudes toward Mathematics." *Review of Educational Research* 40, no. 4 (1970): 551-96. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/1169746.

[23] Sonnert, G., Barnett, M. & Sadler, P. "The Effects of Mathematics Preparation and Mathematics Attitudes on College Calculus Performance." *Journal for Research in Mathematics Education* 51, no. 1(2020):105-125. Accessed November 27, 2020. https://www.jstor.org/stable/10.5951/jresematheduc.2019.0009

[24] Borch, Christian. "Systemic Power: Luhmann, Foucault, and Analytics of Power." Acta Sociologica 48, no. 2 (2005): 155-67. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/20059932.

about their mathematics education or self-esteem issues. The overarching goal of this project is to examine the relationship between attitudes, self-esteem scores, and achievement in mathematics at Huntington High School.

Assumptions, Limitations, and Scope

It is assumed that participants will answer the RSE and ATMI questions truthfully and will try their best. Due to the current global pandemic, face to face instruction has been sporadic and many students have been required to complete remote learning. The classroom has looked very different with the requirement of masks in school. These are factors that the researcher has no control over.

If a relationship or relationships are found to exist this information will be used by the district to help the allocation of funds and resources to help the students become successful. Other school districts will be able to follow the procedures of this study to see if they replicate the same results. Other districts can use this study to help identify relationships that exist in their particular district. Due to this study being conducted at Huntington High School the results may not be able to be generalized to every other school district.

Definitions

-Attitudes Toward Mathematics Inventory is a 40 item Likert-Type Inventory. A=0 Strongly Disagree, B=1 Disagree, C=2 Neutral, D=3 Agree, E=5 Strongly Agree

-First Quarter Success is measured by 50-100 percent

-MAP is Measures of Academic Progress. The Algebra 1 and Algebra 2 MAPs tests are used to compare students nationally. It also sets growth goals for each student.

-MAP Mathematical Success - Coded 0 for not making growth and 1 for making growth.

-Rosenberg Self-Esteem Scale is a 4-point Guttman scale consisting of 10 items. Participants

score each item as a 1 to 4 with 1 strongly agree, 2 agree, 3 disagree, and 4 strongly disagree

-Second Quarter Success is measured by 50-100 percent

-Semester Average is the average of the first and second quarter success and is measured by 50-100 percent.

-Self-Esteem is the belief in oneself

Summary

Chapter 1 is an introduction to the research question, Are self-esteem and attitudes toward mathematics an indicator of success or failure in the secondary mathematics classroom? There has been a gap in prior research identified. Chapter 1 has introduced the lack of research including rural mathematics students. The literature review in Chapter 2 will reveal the conflicting research on self-esteem, attitudes towards mathematics, and success. It will also show the degree of the lack of representation of rural Appalachian students while other minority groups have been the subjects of research. The research design has been introduced in Chapter 1, but further details of the design will be presented in Chapter 3.

Chapter 2: The Literature Review

This chapter will explore the past and current research in self-esteem, attitudes towards mathematics, studies on minority populations, rural American education, and mathematics education. The paper will look at the different studies that related different variables to academic achievement. Studies on mathematical achievement with the independent variables will also be included. The literature review will reveal the need for further investigation of self-esteem, attitudes toward mathematics and mathematical achievement in rural Huntington High School.

Self-esteem and Academic Achievement

According to Hosogi et al (2012) "Self-esteem is the 'feeling of self-appreciation' and is an indispensable emotion for people to adapt to society and live their lives."[25] Researchers have been studying the relationship between self-esteem and academic achievement for many years. This literature review will begin with research from 1992. In 1992 Keltikangas-Järvinen cited several studies that found that self-esteem and academic achievement were not related ((e.g. Abadzi, 1984; Alsaker, 1989; Byrne, 1986; Demo & Parker, 1987)[26] When studying 1253 12 and 15 year old students from Finland, Keltikangas-Järvinen (1992) “results reveal a stronger relationship between self-esteem and school achievement than previous research might give reason to expect; the predictive significance of self-esteem was here as strong or stronger than previously shown concurrent correlation."[27] The results of this research encourages schools to look at improving students’ self-esteem when students are identified as having low self-esteem.

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[25] Hosogi, Mizuho, Ayumi Okada, Chikako Fujii, Keizou Noguchi, and Kumi Watanabe. “Importance and Usefulness of Evaluating Self-Esteem in Children.” *BioPsychoSocial Medicine* 6, no. 1 (March 20, 2012): 9. https://doi.org/10.1186/1751-0759-6-9.

[26] Keltikangas-Järvinen, Liisa. “Self-Esteem as a Predictor of Future School Achievement.” *European Journal of Psychology of Education* 7, no. 2 (1992): 123–30.

[27] Keltikangas-Järvinen, Liisa. “Self-Esteem as a Predictor of Future School Achievement.” *European Journal of Psychology of Education* 7, no. 2 (1992): 123–30.

Keltikangas-Järvinen (1992) results find "the predictive significance of self-esteem is so strong that students with low self-esteem constitute a challenge for schools.[28]

Then the sociology community started looking at global self-esteem and specific types of self-esteem. Rosenberg et al. (1995), found that "although our (Rosenberg et al.) analyses suggest that raising the academic self-esteem or self-estimates of intelligence among students may increase academic performance, nothing in our findings suggests that raising their levels of global self-esteem or general self-confidence, or decreasing their levels of general self-deprecation would have any such effect."[29] The findings suggest that educators should invest time into cultivating students' specific self-esteem of academic self-esteem instead of the students' global self-esteem when the goal is improving student achievement. This theory was found true in a 2008 study of Estomian students, Pullmann and Allik found that "self-reported academic self-esteem is a strong and accurate predictor of school achievement."[30]

Conversely, Peixoto and Almeida (2010) studied 9555 7th, 9th, and 11th grade students in Lisbon with 352 of the 9555 had retaken at least one year of school found " that self-esteem is maintained through positive self-representations in non-academic facets of self-concept and/or by devaluing school-related competences."[31] This study suggests that students use a negative view of school in order to keep a positive self-esteem. Then in 2012 Bong et al. confirmed that

[28] Keltikangas-Järvinen, Liisa. "Self-Esteem as a Predictor of Future School Achievement." *European Journal of Psychology of Education* 7, no. 2 (1992): 123–30.
[29] Rosenberg, Morris, Carmi Schooler, Carrie Schoenbach, and Florence Rosenberg. "Global Self-Esteem and Specific Self-Esteem: Different Concepts, Different Outcomes." *American Sociological Review* 60, no. 1 (1995): 141–56. https://doi.org/10.2307/2096350.
[30] Pullmann, Helle, and Jüri Allik. "Relations of Academic and General Self-Esteem to School Achievement." *Personality and Individual Differences* 45, no. 6 (October 1, 2008): 559–64. https://doi.org/10.1016/j.paid.2008.06.017.
[31] Peixoto, Francisco, and Leandro S. Almeida. "Self-Concept, Self-Esteem and Academic Achievement: Strategies for Maintaining Self-Esteem in Students Experiencing Academic Failure." *European Journal of Psychology of Education* 25, no. 2 (2010): 157–75.

"domain-specific self-constructs such as self-efficacy and self-concept were better predictors of task value and achievement than was general self-esteem" in elementary and middle school students in Korea.[32] These studies suggest that self-esteem is not related to academic achievement or is negatively related to academic achievement.

So as the research progressed from 1992 it seemed that self-esteem would not be considered as a factor of academic achievement. Then a longitudinal study including 426 students that began in 1987 and was published in 2013 found that self-esteem increased students' academic self-efficacy "which in turn mediated the effect of conscientiousness and self-esteem on senior high school grades." [33] This study calls for teachers to be cognizant of their students' preexisting personality in order to improve their students' beliefs about their abilities. In conclusion, the research did not reveal corroborated results when studying the relationship between self-esteem and academic achievement.

Attitudes Toward Mathematics and Academic Achievement

Students' attitudes toward mathematics gained research popularity beginning in 1974. One of the first studies on attitudes toward mathematics was conducted by Alken. Alken studied 200 college freshmen using attitude scales to measure appreciation and use of mathematics.[34] Zimmerman, Bandura and Martinez-Pons (1992) found "students' beliefs in their efficacy for

[32] Bong, Mimi, Catherine Cho, Hyun Seon Ahn, and Hye Jin Kim. "Comparison of Self-Beliefs for Predicting Student Motivation and Achievement." *The Journal of Educational Research* 105, no. 5 (2012): 336–52.
[33] Di Giunta, Laura, Guido Alessandri, Maria Gerbino, Paula Luengo Kanacri, Antonio Zuffiano, and Gian Vittorio Caprara. "The Determinants of Scholastic Achievement: The Contribution of Personality Traits, Self-Esteem, and Academic Self-Efficacy." *Learning and Individual Differences* 27 (October 1, 2013): 102–8. https://doi.org/10.1016/j.lindif.2013.07.006.
[34] Alken, Lewis R. "Two Scales of Attitude toward Mathematics." *Journal for Research in Mathematics Education* 5, no. 2 (1974): 67–71. https://doi.org/10.2307/748616.

self-regulated learning affected their perceived self-efficacy for academic achievement."[35] Then following the lead of Alkin, Stages and Kloosterman (1995) conducted a study called "Gender, Beliefs, and Achievement in Remedial College-Level Mathematics" and found different results for males and females. They found that beliefs about mathematics were significantly related to final course grade for females but unrelated to final course grade for males.[36] In 1996 Tapia created a 49 Likert-type questionnaire to measure high school students' attitudes toward mathematics. The final Attitudes Toward Mathematics Inventory consists of forty statements with a coefficient alpha of 0.97.[37] The original goal of the inventory was to develop an instrument that could be used for middle and high school students, but Tapia found the instrument works the best with high school mathematics students. In respect to students' attitudes toward mathematics, Hannula (2002) proposed a new framework for analyzing attitudes and changing attitudes. In Hannula's (2002) case study one of the results included the conclusion that "negative attitudes towards mathematics can be a successful defense strategy for a positive self-concept."[38] Hannula (2006) continued to use the framework from 2004 related to the theory of self-regulated learning and found that students need to "feel safe and perceive that they can contribute to the (learning) process."[39] The research seems to agree that attitudes

[35] Zimmerman, Barry J., Albert Bandura, and Manuel Martinez-Pons. "Self-Motivation for Academic Attainment: The Role of Self-Efficacy Beliefs and Personal Goal Setting." *American Educational Research Journal* 29, no. 3 (1992): 663–76. https://doi.org/10.2307/1163261.
[36] Stage, Frances K., and Peter Kloosterman. "Gender, Beliefs, and Achievement in Remedial College-Level Mathematics." *The Journal of Higher Education* 66, no. 3 (1995): 294–311. https://doi.org/10.2307/2943893.
[37] Tapia, Martha. "The Attitudes toward Mathematics Instrument." Paper presented at Annual Meeting of the Mid-South Educational Research Association, Tuscaloosa, AL. Accessed November 27, 2020. https://files.eric.ed.gov/fulltext/ED404165.pdf
[38] Hannula, Markku S. "Attitude towards Mathematics: Emotions, Expectations and Values." *Educational Studies in Mathematics* 49, no. 1 (2002): 25–46.
[39] Hannula, Markku S. "Motivation in Mathematics: Goals Reflected in Emotions." *Educational Studies in Mathematics* 63, no. 2 (2006): 165–78.

toward mathematics are related to mathematical achievement. What is not clear in the research is if a relationship between attitudes and achievement exists among all groups of students or select groups. This study seeks to find the answer to whether attitudes toward mathematics is related to mathematical achievement in high school students at Huntington High School.

Underprivileged Groups and Mathematical Achievement

When conducting a Google search of studies on minority groups, underprivileged groups and mathematical achievement, with African American gaps well documented. Some examples include Ladson-Billings (1997) "It Doesn't Add Up: African-American Students' Mathematics Achievement"[40], Gutierrez (2002) "Advancing African-American, Urban Youth in Mathematics: Unpacking the Success of One Math Department"[41] and Walker (2007) "Why Aren't More Minorities Taking Advanced Math?"[42] The aforementioned researchers call for more research to be conducted on African American students and mathematical achievement to understand and close the achievement gap between African Americans and the white counterpart. But other researchers claim that the call for research for closing the gap between underprivileged groups and middle-class white students is part of the problem. Researcher such as Gutiérrez (2008) calls for research on advancement instead of concentrating on "disparities in middle White students and students who are Black, Latina/Latino, First Nations, English language learners or working class."[43]

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[40] Ladson-Billings, Gloria. "It Doesn't Add up: African American Students' Mathematics Achievement." *Journal for Research in Mathematics Education* 28, no. 6 (1997): 697–708. https://doi.org/10.2307/749638.

[41] Gutiérrez, Rochelle. "Advancing African-American, Urban Youth in Mathematics: Unpacking the Success of One Math Department." *American Journal of Education* 109, no. 1 (2000): 63–111.

[42] Walker, Erica N. "Making Math Count Pages 48-53 Why Aren't More Minorities Taking Advanced Math?" *Educational Leadership* 65, no. 3 (November 2007): 48–53.

[43] Gutiérrez, Rochelle. "A 'Gap-Gazing' Fetish in Mathematics Education? Problematizing Research on the Achievement Gap." *Journal for Research in Mathematics Education* 39, no. 4 (2008): 357–64.

Likewise, women in mathematics have been researched well. When entering the search terms "females" and "mathematical achievement" Google scholar revealed 275,000 results in 0.08 sec.[44] Interestingly many studies have found little to no significant difference in female and male mathematics achievement, yet the topic still receives research attention. In 1977 Fennema and Sherman "results showed important relationships between socio-cultural factors and sex-related cognitive difference."[45] Then in 1998 Muller "found that gender differences on mathematics achievement tests were small but consistent among high school seniors."[46] Then in 2007 Tsui "results show that in neither the US nor China are there gender differences in eighth grade math-achievement test scores."[47] Those results were confirmed again by Lubienski et al. (2013) published a longitudinal study that was conducted in the US consisting of students who were in the kindergarten class of 1998-1999 "shed little light on gender gaps in mathematics performance."[48] Also, Sarouphim and Chartouny (2017) found "no significant gender differences in either achievement or attitudes toward mathematics, thus dispelling the common belief that female students in traditional cultures do not perform well in mathematics and dislike the field."[49]

Rural Students and Academic Achievement

[44] Google Scholar search, (March 2021) females AND mathematical achievement - Google Scholar
[45] Fennema, Elizabeth, and Julia Sherman. "Sex-Related Differences in Mathematics Achievement, Spatial Visualization and Affective Factors." *American Educational Research Journal* 14, no. 1 (January 1, 1977): 51–71. https://doi.org/10.3102/00028312014001051.
[46] Muller, Chandra. "Gender Differences in Parental Involvement and Adolescents' Mathematics Achievement." *Sociology of Education* 71, no. 4 (1998): 336–56. https://doi.org/10.2307/2673174.
[47] Tsui, Ming. "Gender and Mathematics Achievement in China and the United States." *Gender Issues* 24, no. 3 (September 1, 2007): 1–11. https://doi.org/10.1007/s12147-007-9044-2.
[48] Lubienski, Sarah T., Joseph P. Robinson, Corinna C. Crane, and Colleen M. Ganley. "Girls' and Boys' Mathematics Achievement, Affect, and Experiences: Findings from ECLS-K." *Journal for Research in Mathematics Education* 44, no. 4 (2013): 634–45. https://doi.org/10.5951/jresematheduc.44.4.0634.
[49] Sarouphim, Ketty M., and Madona Chartouny. "Mathematics Education in Lebanon: Gender Differences in Attitudes and Achievement." *Educational Studies in Mathematics* 94, no. 1 (2017): 55–68.

A national call to research of students from rural areas such as Appalachia came from Anne Lewis in 1992. Lewis (1992) recalled that the federal government did not pay attention to rural schools until 1979 and by the 1980's their focus had already shifted directions.[50] Unfortunately not many studies can be found after 1992 until 2002. Waters et al.(2008) documented the lack of research on rural education: "To date, mathematics education research has rarely engaged issues that could be considered relevant to rural policy and practice."[51] The Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM) published a theoretical framework in 2002.[52] ACCLAIM was a partnership of the University of Tennessee (Knoxville), University of Kentucky (Lexington), Kentucky Science and Technology Corporation (Lexington), Marshall University (Huntington, WV), University of Louisville, West Virginia University (Morgantown), and Ohio University (Athens, OH).[53] When searching the works that came from the ACCLAIM initiative the researcher found a dialog from two mathematicians from different rural universities discussing misconceptions that their respective universities have encountered.[54] Beach (2004) offers her reflections about a pre-session event that asked mathematics educators to consider rural issues at the 2003 National Council of Teachers of Mathematics , "Ponderings of a Rural Mathematics Educator On Others'

[50] Lewis, Anne C. "An Invisible Minority." *The Phi Delta Kappan* 73, no. 9 (1992): 660–61.
[51] Waters, Michael, Craig Howley, and James Schultz. "An Initial Research Agenda for Rural Mathematics Education." *Journal of Appalachian Studies* 14, no. 1/2 (2008): 125–44.
[52] Howley, Craig. "Theoretical Framework for the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM)." Accessed March 15, 2021. https://files.eric.ed.gov/fulltext/ED473209.pdf.
[53] "The Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM) - ProQuest." Accessed March 24, 2021. https://search.proquest.com/openview/7b924230e93bda5dbf5ef11dd0461514/1?pq-origsite=gscholar&cbl=41299.
[54] Davis, Reid, and Jeff Connor. "Mathematics, Mathematics Education, and Views of Reform: Perspectives from Two Mathematicians Involved with Mathematics Education for the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics." *Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics*, n.d., 25.

Perceptions of the Teaching and Learning of Mathematics in Rural Areas."[55] Then a qualitative study conducted by David Lucas of Ohio University Southern in a town in Illinois called "Perception of Math and Math Education in the Rural Midwest" was published in 2007.[56] ACCLAIM's website http://www.acclaim-math.org/ is no longer used for research of rural Appalachia mathematics.[57] More research is needed for students, educators, parents, and other stakeholders to understand rural Appalachian mathematics students' need to be successful.

[55] Beach, Bonnie Wilcoxen. "Ponderings of a Rural Mathematics Educator On Others' Perceptions of the Teaching and Learning of Mathematics in Rural Areas." *Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics*, n.d., 20.
[56] Lucas, David M. "Perceptions of Math." *Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics*, n.d., 46.
[57] Acclaim Math. "Acclaim Math | Kids Education." Accessed March 15, 2021. http://www.acclaim-math.org/.

Chapter 3: Methodology

Introduction

This study provides a guide researchers can use to determine if a relationship among mathematical achievement, self-esteem, and attitudes towards mathematics of secondary mathematics students exist. Rural students have long been ignored in prior research pertaining to these variables. This study aims to help fill the gap in research that represents this population and give rural mathematics educators tools to use in their classroom to help predict the success of secondary mathematics students.

Setting and Participants

Huntington Local School district is a rural school located a few miles from the city of Chillicothe, Ohio. Huntington Local School District is the center of Huntington Township in Ross County. Participants in this study are Algebra 1 and Algebra 2 from Huntington High School. There were 78 possible participants in this study. The participants range in age from 14 years old to 17 years old. Students were enrolled in either Algebra 1 or Algebra 2 with Mrs. Jennifer Akers as the instructor. None of the classes are accelerated or advanced Algebra 1 or 2. The student population consists of all white/Caucasian students. All students have English as their first language. According to the Ohio Department of Education[58] 96.4% of students attending Huntington High School were classified as economically disadvantaged during the 2019-2020 school year.

Instrumentation

[58] "Ohio School Report Cards." Accessed April 27, 2021. https://reportcard.education.ohio.gov/school/detail/017160.

The Attitude Towards Mathematics Inventory (ATMI) developed by Tapia (1996) is a "revised instrument (that) consists of forty statements and the responses are on a Likert-type scale of five responses from strongly disagree to strongly agree.[59] The instrument has a coefficient alpha of 0.97 with standard error of measurement of 5.67." ATMI was developed for use in secondary mathematics classrooms. Responses to items 1-8, 16-19, 22-24, 26, 27, and 29-40 are assigned the following points A=1, B=2, C=3, D=4, and E=5. Responses to items 9-15, 20, 21, 25, and 28 are assigned the following points A=5, B=4, C=3, D=2, and E=1. A score of 5 represents high positive attitude, 4 represents high-neutral positive attitude, 3 represents neutral attitude, 2 represents high-neutral negative attitude, and 1 represents high negative attitude toward mathematics. To get an overall attitude towards mathematics score the researcher adds up all 40 item point values then divides by 40 to get an overall score of 1-5. A copy of the ATMI can be found in the appendix. The Rosenberg Self Esteem Scale (RSE) was developed in 1965 by Morris Rosenberg to measure self-esteem in high school students.[60] The RSE consists of 10 statements and the responses are on a Likert-type scale of four responses from strongly agree to strongly disagree. "The RSE demonstrates a Guttman scale coefficient of reproducibility of .92, indicating excellent internal consistency."[61] For items 1, 3, 4, 7 and 10 of RSE strongly agree = 3, agree = 2, disagree = 1, and strongly disagree = 0. For items 2, 5, 6, 8, and 9 the scoring is reversed so strongly agree = 0, agree = 1, disagree = 2, and strongly disagree = 4. The score range is from 0-30 with a score less than 15 considered low self-esteem, 15-25 is normal self-esteem and a score greater than 25 is high self-esteem. According to the

[59] Tapia, Martha. "The Attitudes toward Mathematics Instrument." Paper presented at Annual Meeting of the Mid-South Educational Research Association, Tuscaloosa, AL. Accessed November 27, 2020. https://files.eric.ed.gov/fulltext/ED404165.pdf
[60] Rosenberg, M. 1965. *Society and the Adolescent Self-Image.* Princeton, NJ: Princeton University Press.
[61] Rosenberg, Morris. "Rosenberg Self-Esteem Scale (RSE)," 2006, 2. Accessed November 27, 2020 https://www.apa.org/obesity-guideline/rosenberg-self-esteem.pdf

Encyclopedia of Human Behavior (2012) the RSE is the most commonly used scale.[62] In 2015 Boyle et al references RSE in their book about best scales/measures for a variety of constructs.[63] A copy of the RSE is included in the appendix.

Huntington High School gives the NWEA Measure of Academic Progress (MAP) test in the fall, winter, and spring to all students in Algebra 1 and Algebra 2 classes. MAP tests are aligned to Ohio mathematics standards.[64] MAP growth tracks students' individual growth over time. MAP test is a computerized adaptive test. The researcher had access to all MAP tests given to each participant of the study. For this study each participant's growth (positive, zero, or negative) from Fall MAP test to Winter MAP test was recorded. Students quarter 1 and quarter scores from Algebra class were part of the data collection.

Procedures

The researcher received permission from Shawnee State University's Internal Review Board. The IRB approval form can be found in the appendix. Students and parents/guardians received a letter of assent and consent to participate in the study. The names of the participants were kept confidential. The ATMI, RSE, MAP score, and quarter grades are kept in a locked desk in the researcher's classroom. No names or other identifiers were entered into an electronic database. The data was entered into an excel worksheet with only the researcher privy to the identity of the participants. Confidentiality of data was maintained at all times and identification of participants are not available. The assent and consent letters can be found in the appendix. Students completed the ATMI and RSE during Algebra class with the researcher present.

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[62] "Encyclopedia of Human Behavior | ScienceDirect." Accessed April 27, 2021. https://www.sciencedirect.com/referencework/9780080961804/encyclopedia-of-human-behavior.
[63] Boyle, Gregory, Donald Saklofske, and Gerald Mathews. *Measures of Personality and Social Psychological Constructs*. Elsevier, 2015. https://doi.org/10.1016/C2010-0-68427-6.
[64] NWEA. 2016. *Linking the Ohio State Assessments to NWEA MAP Growth Test.* Accessed November 27, 2020 Microsoft Word - OH MAP Growth Linking Study AUG2016.docx (nwea.org)

Students were expected to answer each item honestly. The only negative discomfort for the participants was that they might find filling out the ATMI and RSE boring.

Data Processing and Analysis

For the first research question; Are self-esteem, attitudes toward mathematics, and change in MAP score predictive of success in the secondary mathematics classroom?, logistic regression techniques were used. The maximum priori power possible if all 78 students participated is .63, because of the small sample size, with alpha level 0.05. The required sample size to achieve .80 power is 113 with alpha level 0.05. For the second research question; Are self-esteem and attitudes toward mathematics predictive of change in MAP score?, linear regression techniques were used. Priori power required a sample size of 29 to obtain .80 statistical power at alpha level 0.05 with 8 predictors and moderate, 0.30, effect size. The predictors are low self-esteem, normal self-esteem, high self-esteem, high positive mathematics attitude, high-neural positive mathematics attitude, neutral mathematics attitude, high-neutral negative mathematics attitude, and high negative mathematics attitude. For the third research question; Is the midterm MAP test score predictive of semester average in an Algebra class?, linear regression techniques were used. Priori power required a sample size of 78 to obtain Field's (1996) suggested .80 statistical power at alpha level 0.05 with 1 predictor and moderate, 0.30, effect size.[65] The statistical program G*Power 3.1 was used to calculate priori power for each research question.

When preparing the data for logistic regression techniques for research question 1 the researcher will code the dependent variable (success in the mathematics classroom) dichotomously: coded 0 for a grade below a 77 in the course and 1 for a grade above 77 and

[65] Field, Hartry. "The a Prioricity of Logic." *Proceedings of the Aristotelian Society* 96 (1996): 359–79.

above in the course. Success on MAP test growth is coded as 0 for not making growth from the fall test to the winter test and 1 for making growth. Attitudes toward mathematics is a continuous variable with scores ranging from 1-5. Self-Esteem is a continuous variable with scores ranging from 0-30. To satisfy the linearity assumption the researcher will use the log of the dependent variable to transform the variable into a continuous variable. To ensure independence the researcher did not perform multiple measures on the same participants. The researcher examined the multicollinearity assumption to ensure that none of the predictors were highly correlated. Scatter plots were used to identify any separation threats. In 1996 Signer's model showed that socioeconomic status and ethnicity failed to reach statistical significance but job utility, gender and math achievement were statistically significant in predicting the likelihood to believe achievement and effort cause math grades.[66] The logistic regression model in this study uses attitudes toward mathematics similar to Signer's job utility predictor, self-esteem as a predictor, and MAP test growth as a predictor of math course success in the form of math grades.

Linear regression techniques are used for research questions 2 and 3. The dependent variable in research question 2 is the change in MAP score. This change is a positive or negative number and is continuous. The predictive variables are self-esteem and attitudes toward mathematics. These variables are also continuous. Self-esteem is a scale from 0-30 and attitudes toward mathematics is a scale from 1-5. For research question 3 the dependent variable is the semester average of the students' first and second quarter grade with the winter MAP test score being the predictor variable. The semester average is a continuous variable from 50-100 and MAP test score is a continuous variable from 180-278. The assumptions tested are that a linear

[66] Signer, Barbara, and And Others. *A Study of the Interaction of Ethnicity, Math Achievement, Socioeconomic Status, and Gender on Math Attitudes of High School Students*, 1996. https://eric.ed.gov/?id=ED400302.

relationship exists between the dependent variable and the predictor variables. Scatter plots will be used to check this assumption. Independence is ensured by not taking repeated measures on the same individuals. Residuals will be examined to ensure homoscedasticity and normality. Keltikangas-Järvinen (1992) found that self-esteem could be used to predict grade point average.[67] In 2010 Peixoto and Almeida "results show that self-esteem is maintained through positive self-representations in non-academic facets of self-concept and/or by devaluing school-related competences."[68] Also, Huntington Local School district has been investing in MAP testing. NWEA promotes the MAP test as being aligned with Ohio state standards.[69] To date the district has not completed any research to see if MAP test score can be used to predict course success.

Summary

Logistic regression is used to create a model for the variables in research question 1 that are statistically significant. Linear regression is used to create a predictive model for research questions 2 and 3 with statistically significant predictors. In Chapter 4 the researcher will present the statistical findings.

[67] Keltikangas-Järvinen, Liisa. "Self-Esteem as a Predictor of Future School Achievement." *European Journal of Psychology of Education* 7, no. 2 (1992): 123–30.
[68] Peixoto, Francisco, and Leandro S. Almeida. "Self-Concept, Self-Esteem and Academic Achievement: Strategies for Maintaining Self-Esteem in Students Experiencing Academic Failure." *European Journal of Psychology of Education* 25, no. 2 (2010): 157–75.

[69] NWEA. 2016. *Linking the Ohio State Assessments to NWEA MAP Growth Test.* Accessed November 27, 2020 Microsoft Word - OH MAP Growth Linking Study AUG2016.docx (nwea.org)

Chapter 4: Results

Huntington Local School District adopted the use of the NWEA MAP test to determine if students are making growth in mathematics classes while the state of Ohio has adopted Social Emotional Standards that schools must implement. This study focuses on any correlation between students' self-esteem, attitudes towards mathematics, and mathematics achievement. Achievement is defined in the results as growth in the mathematics classroom as well as grades in the classroom.

The central focus of this study is threefold:

1) Are self-esteem, attitudes toward mathematics, and change in MAP score predictive of success in the secondary mathematics classroom?

2) Are self-esteem and attitudes toward mathematics predictive of change in MAP score?

3) Is the midterm MAP test score predictive of semester average in an Algebra class?

Materials and methods

Sixty-five students were included in this study. In the beginning, there were a total of seventy-eight students introduced to the study. Ten students and their parents opted out of participating in the study. Three students had missing data because of absenteeism or changing school districts. The descriptive information about the students that participated is included in Table 1.

Table 1. Descriptive information of Students

(Mean ± standard deviation)

MAP fall score	**Mean: 215.75 ± 13.24**
	Range: 185-247

MAP winter score	**Mean: 222.37±13.74** **Range: 180-252**	
Diagnosis, MAP	Frequency	Percentage
Positive Growth	54	83.1%
Negative Growth	8	12.3%
No Growth	3	4.6%
Met Growth(Did not meet Growth)	35(30)	53.8%(46.2%)
Total	65	100%
Semester Average		
77% or above	27	41.5%
below 77%	38	58.5%
Quarter 1 Scores	Mean: 76.8±11.99 Range: 60-100	
Quarter 2 Scores	Mean: 73.59±14.73 Range: 50-100	
Semester Average	Mean: 75.05±12.04 Range: 55-100	

A summary of the responses from the ATMI is presented in Appendix A. A summary of the responses from the RSE is presented in Appendix B.

Data analysis

Logistic regression analysis I

Direct logistic regression techniques were performed on dichotomously formed mathematic achievement (77 and above versus 77 and below) as the outcome for the three predictors: MAP Growth (0-no, 1-yes), ATMI score of 1 to 5, and Self-Esteem Score 0-30. There were 3 cases with missing data that were deleted. Analysis was performed using R (R Core Team, 2015).

A test of the full model with all predictors against a constant-only model was statistically reliable, $\chi^2(3, N = 65) = 8.10, p < .05$, indicating that the set of predictors reliably distinguished between those who scored above 77 with those who did not. The variance accounted for was small with McFadden's rho = 0.09, df=3. Prediction success (using 0.415 as the threshold) was 43 of 65 cases (66.2%) accurately predicted correctly with sensitivity and specificity values of 0.667 and 0.658 respectively.

Beginning with the full set of predictor variables, after 4 Fisher Scoring iterations Table 2 shows the regression coefficients, Wald statistics, odds ratios, and 95% confidence intervals for odds ratios for each of the predictors. According to the Wald criterion, only ATMI is statistically significant in predicting mathematic achievement (z=2.071, p<.05). The odds ratio of 2.883 indicates that students with a higher attitude towards mathematics are more than two times likely to receive a math achievement score of 77 or higher. The full model sample size assumption was violated. For three predictors the model required 72 students in the sample size. The study consisted of 65 students in the sample. Variance Inflation Factors (VIF) values ranged from 1.0105 to 1.2431, which indicates that multicollinearity is not a problem with the model. Examination of the significance levels of the additional predictors created by examining the

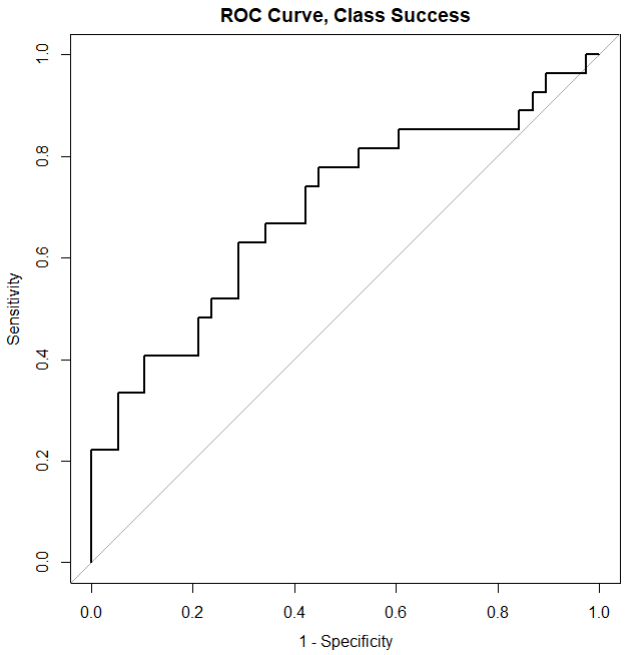
interaction between each predictor and the log of itself (Hosmer & Lemeshow, 1989) indicates that a linear relationship between the predictor variables and the logit of math achievement score may be assumed.

Table 2. Logistic regression for mathematics achievement

Variables	***B***	**Wald (z-ratio)**	**Odds Ratio**	**p-value**	**95% CI Lower**	**95% CI Upper**
RSE	-0.026	-0.457	0.974	0.648	-0.138	0.086
ATMI	1.059	2.071	2.883	0.0383	0.057	2.060
GROWTH	0.882	1.616	2.416	0.106	-0.188	1.953
(Constant)	-3.527	-2.402	0.029	0.016	-6.405	-0.649

A receiver operating characteristics graph (ROC), which has been shown to be a reliable technique for visualizing, organizing, and selecting classifications based on performance, is presented in Graph 1. Swets (1988) found that ROC analysis could be extended for use in visualizing and analyzing behavior of diagnostic systems and for determining accuracy of a test using the area under the curve. For the set of predictors, the area under the curve was found to be 0.6949.

Graph 1. ROC Curve, Model I



The standard logistic regression analysis was followed up with a backward elimination logistic regression analysis. The reduced model retained the predictors ATMI and GROWTH. A test of the reduced model with two predictors against a constant-only model was statistically reliable, $\chi^2(2, N = 65) = 7.886, p < .05$, indicating that the set of predictors reliably distinguished between those who scored above 77 with those who did not. The variance accounted for was small with McFadden's rho = 0.09, df=3. Prediction success (using 0.415 as the threshold) was 42 of 65 cases (64.6%) accurately predicted correctly with sensitivity and specificity values of 0.667 and 0.632 respectively.

After 4 Fisher Scoring iterations, Table 3 shows the regression coefficients, Wald statistics, odds ratios, and 95% confidence intervals for odds ratios for each of the predictors. According to the Wald criterion, only ATMI is statistically significant in predicting mathematic achievement (z=2.091, p<.05). The odds ratio of 2.615 indicates that students with a higher attitudes towards mathematics are over two times more likely to receive a math achievement

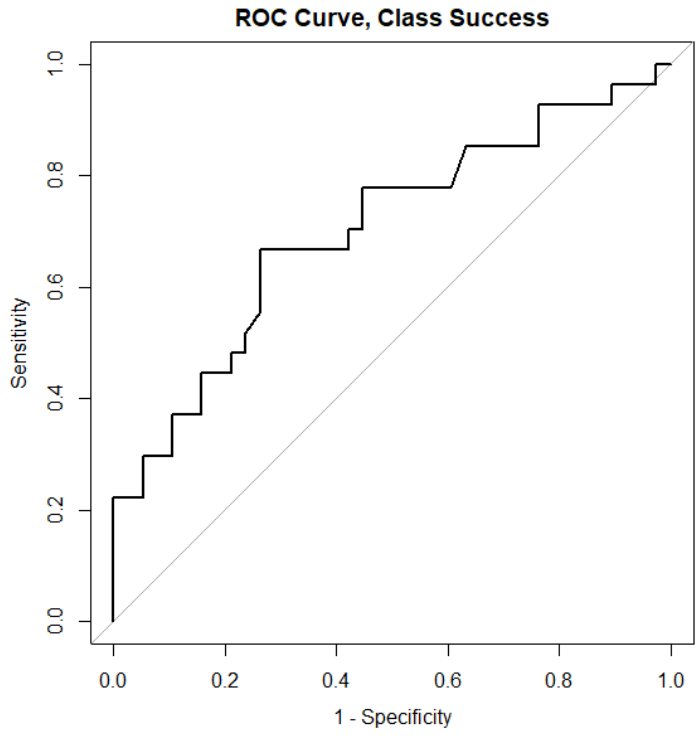
score of 77 or higher. Unlike the full model, the step model with two predictors did not violate the sample size assumption. Variance Inflation Factors (VIF) values were both 1.0024 which indicates that multicollinearity is not a problem with the model. Examination of the significance levels of the additional predictors created by examining the interaction between each predictor and the log of itself (Hosmer & Lemeshow, 1989) indicates that a linear relationship between the predictor variables and the logit of math achievement score may be assumed.

Table 3. Logistic regression for mathematics achievement

Variables	***B***	**Wald (z-ratio)**	**Odds Ratio**	**p-value**	**95% CI Lower**	**95% CI Upper**
ATMI	0.9611	2.091	2.615	0.037	0.060	1.862
GROWTH	0.9071	1.670	2.477	0.095	-0.157	1.972
(Constant)	-3.671	-2.557	0.025	0.011	-6.483	-0.857

A receiver operating characteristics graph (ROC), which has been shown to be a reliable technique for visualizing, organizing, and selecting classifications based on performance, is presented in Graph 2. Swets (1988) found that ROC analysis could be extended for use in visualizing and analyzing behavior of diagnostic systems and for determining accuracy of a test using the area under the curve. For the set of predictors, the area under the curve was found to be 0.7013.

Graph 2. ROC Curve, Step Model



Linear Regression

Question 2: Are self-esteem and attitudes toward mathematics predictive of change in MAP score?

A linear regression technique was performed on the continuous variable difference in MAP1 and MAP2 score. The independent variables were continuous variables RSE and ATMI. Since the VIF values were 1.19 the assumption of no multicollinearity has been met. Durbin-Watson statistics fell within an expected range, thus indicating that the assumption of no autocorrelation of residuals has been met. Finally, the scatterplot of standardized residual on predicted value did not funnel out or curve, and thus the assumption of linearity and homoscedasticity have been met as well.

The model did not reach statistical significance (F(2,62)=0.7452, p=0.479), meaning that there is no statistical evidence that supports predicting change in MAP score by the predictors RSE and ATMI. Table 4 shows the regression coefficients, standard error, t-value, p-vale and 95% confidence intervals for the predictor and the constant.

Table 4: Multiple Regression of RSE, ATMI and MAPs Test

Variables	**B**	**Std.Error**	**t-value**	**p-value**	**95% CI**
RSE	0.0275	0.2450	0.112	0.911	(-.45,.51)
ATMI	2.2222	2.0795	1.069	0.289	(-1.85,6.30)
Constant	0.2825	5.8453	-0.048	0.962	(-11.74,11.17)
F(2,62) = 0.7452				0.479	
Multiple R^2 = 0.0235	Adjusted R^2 = -0.008				

Linear Regression Model

Question 3: Is the midterm MAP test score predictive of semester average in an Algebra class?

Table 5 is a summary of the mean and standard deviation of the MAP scores and semester averages.

Table 5: Summary of mean and standard deviation of MAP and Semester Average

	Mean	**Standard Deviation**
Midterm Map	222.37	13.74
Semester Average	75.05	12.04

A linear regression technique was performed on the continuous variable semester average. The independent variable was the continuous variable winter MAP score. Durbin-Watson statistics fell within an expected range, thus indicating that the assumption of no autocorrelation of residuals has been met as well. Finally, the scatterplot of standardized residual on predicted value did not funnel out or curve, and thus the assumption of linearity and homoscedasticity have been met as well.

The model reached statistical significance, meaning that it successfully predicted semester averages. ($F(1,63)=25.55$, $p<.001$). The model explained 28.9% of variance in semester averages. Students' semester averages were predicted by their winter MAP score ($B=0.47$, $t=5.06$, $p < .001$, 95% CI (0.288,0.653). For every 1 unit increase in winter MAP score, semester average increased by .47. Table 6 shows the regression coefficients, t- statistics, p-value, and 95% confidence intervals for each of the predictors

Table 6: Linear Regression MAP2 and Semester Average

Variables	**B**	**Std.Error**	**t-value**	**p-value**	**95% CI**
MAP2	0.471	0.093	5.055	< .001	(.288, .653)
Constant	-29.637	20.750	-1.428	0.158	(-70.3, 11.03)
F(1,63) = 25.55				< .001	
Multiple R^2 = .2885	Adjusted R^2 = .2772				

Summary of Chapter 4

In summary, the results have showed a statistically significant correlation between students' attitudes toward mathematics and success in the classroom when success is defined at semester average. When predicting semester average the logistic regression model retained ATMI and MAP Growth using backward elimination. Note that the p-value of MAP Growth is $p = 0.095$ in the retained model with the 95% CI of the Growth predictor to include 0. No statistically significant evidence was shown that self-esteem and attitudes toward mathematics are predictors of MAP difference of score. MAP2 scores were a statistically significant predictor of semester average.

Chapter 5: Discussion

Introduction

Chapter 5 begins with a brief overview of the literature which justifies the research presented and conducted in this study. The researcher then summarizes the purpose of this study, the procedures, and the findings, which are then integrated into the current literature. Finally, the implications will be stated for the intended audiences; researchers and higher education administrators. The researcher then identifies and explains the limitations of this study. The chapter concludes with suggestions for future research resulting from this research study and a general summary of the study conducted.

Background and Study Findings

Huntington Local School District is committed to cultivating the brilliance in every child.[70] Even though Huntington has implemented a hiring strategy to ensure high quality math teachers, students still seem to test poorly in math. Data from Huntington's school report card shows that of the 2018 and 2019 graduates only 12.5% received a remediation free ACT score. [71] The district places emphasis on improving math achievement by implementing teaching strategies. Strategies that focus on improving students' self-esteem and attitudes towards mathematics has not been used in the district since the researcher has been employed. Despite implementation of researched teaching strategies and change in hiring practices, there is still a lack of understanding why Huntington students struggle with math achievement. Some in the district have suggested that the struggle is because our students are different and possibly the difference could be students are from rural Appalachia. Although studies on minority groups

[70] "Dear Huntington Family," Huntington Administrative Team, Accessed November 27, 2020, https://www.huntsmen.org/article/274409?org=hlsd
[71] "Ohio School Report Cards," Ohio Department of Education, accessed November 27, 2020, https://reportcard.education.ohio.gov/school/prepared/017160

and academic achievement are bountiful, research on rural Appalachia students is very difficult to find.

One factor to consider in terms of math achievement is the effect of students' social and emotional health. In 2019 the Ohio State Board of Education adopted Social and Emotional (2019) standards for school districts, buildings, teachers and classrooms including the standard that students should "Explore and approach new situations with an open mind and curiosity while recognizing that some outcomes are not certain or comfortable."[72] This standard leads to a substandard for high school students that states that students should "Embrace productive struggle as an opportunity for personal growth."[73] Foucault Theory of Power was used as a theoretical framework. Foucault's discursive formations was used to see if students' pre-formed attitudes or self-esteem were related to achievement in the math classroom. This study includes students' self-esteem and attitudes towards mathematics.

Self-esteem is the belief or attitude one possesses of itself. M. Rosenberg, Schooler, Schoenback, & F. Rosenberg (1995) states that global self-esteem is "the individual's positive or negative attitude toward the self as totality."[74] Self-esteem may help to explain why some high school students do better in math than other students even though the students have similar backgrounds. Many people in the education community have the belief that students must see

[72] "Social and Emotional Learning Standards." Ohio Department of Education, accessed February 20, 2021, Ohio's Social Emotional Learning Standards Introduction and Glossary, https://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Social-and-Emotional-Learning/SEL-Standards-K-12.pdf.aspx?lang=en-US

[73] "Social and Emotional Learning Standards." Ohio Department of Education, accessed February 20, 2021, Ohio's Social Emotional Learning Standards Introduction and Glossary, https://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Social-and-Emotional-Learning/SEL-Standards-K-12.pdf.aspx?lang=en-US

[74] Rosenberg, Morris, Carmi Schooler, Carrie Schoenbach, and Florence Rosenberg. "Global Self-Esteem and Specific Self-Esteem: Different Concepts, Different Outcomes." American Sociological Review 60, no. 1 (1995): 141-56. Accessed February 26, 2021. http://www.jstor.org.proxy01.shawnee.edu/stable/2096350.

themselves positively to be able to be successful.[75] Much research exists on self-esteem and academic achievement. The research of Keltikangas-Jävinen (1992) found "predictive significance of self-esteem on academic achievement" even though their research prior to the study concluded the opposite.[76] In 1995, Rosenberg et al concluded that nothing in their study suggested to raising global self-esteem would have any effect on academic achievement. So, with contradictory research no conclusion was made before the study about self-esteem and math achievement.

Research has suggested that attitudes toward mathematics and math achievement are correlated. Aiken (1970) conducted literature review research on the subject and summarized "mathematics attitudes and achievement indicate that individuals with more positive attitudes and higher achievement tend to have better personal and social adjustment" but his correlation was low.[77] Hannula (2002) created a new framework for analyzing and changing attitudes.[78] The framework was expanded in 2006. Hannula's (2006) research was not clear if the relationship between attitudes towards mathematics and achievement exists among all groups of students or just with select groups of students.[79] The researcher wanted to find out if a relationship did exist between attitudes toward mathematics and math achievement at Huntington High School.

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[75] Baumeister, Roy F., Jennifer D. Campbell, Joachim I. Krueger, and Kathleen D. Vohs. "Does High Self-Esteem Cause Better Performance, Interpersonal Success, Happiness, or Healthier Lifestyles?" Psychological Science in the Public Interest 4, no. 1 (2003): 1-44. Accessed November 26, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/40062291.

[76] Keltikangas-Järvinen, Liisa. "Self-Esteem as a Predictor of Future School Achievement." *European Journal of Psychology of Education* 7, no. 2 (1992): 123–30.

[77] Aiken, Lewis R. "Attitudes toward Mathematics." *Review of Educational Research* 40, no. 4 (1970): 551-96. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/1169746.

[78] Hannula, Markku S. "Attitude towards Mathematics: Emotions, Expectations and Values." *Educational Studies in Mathematics* 49, no. 1 (2002): 25–46.

[79] Hannula, Markku S. "Motivation in Mathematics: Goals Reflected in Emotions." *Educational Studies in Mathematics* 63, no. 2 (2006): 165–78.

The purpose of this study was to find if a relationship exists between students' self-esteem, attitudes toward mathematics, and math achievement. By conducting this research, the author intended to identify which predictors were related to student math achievement. To accomplish this task, the author used data collected from the author's Algebra 1 and Algebra 2 classes in the 2020-2021 school year. During the study, permission was received from sixty-five students and parents from the Algebra 1 and Algebra 2 classes. Voluntary participation and a statement about confidentiality was reviewed and informed consent signatures were obtained. Students who participated completed the Rosenberg Self-Esteem Scale (RSE) and Attitudes Towards Mathematics Inventory (ATMI). Students' semester average in the class was collected as well as fall MAPs and winter MAPs test scores. The data was kept on a password-protected computer in a locked office. This study used both descriptive and inferential statistical analyses. The descriptive statistics included were frequencies, means and standard deviations.

For the first research question, the author sought to identify statistically significant predictors of math achievement. The predictors tested were self-esteem measured by RSE scale, attitudes toward mathematics measured by ATMI, and MAPs growth. The research chose to use logistic regression for this question. The answer to research question 1 was ATMI was the only statistically significant predictor with a p-value $< .05$ and a 95% CI for beta (0.057, 2.060) with the full model containing all three predictors. The AUC of the ROC curve of the full model was .6949. The researcher considers the full model a poor model. The author also notes that the sample size assumption was violated in the full model. For three predictors a sample size of 72 was needed to fulfill the sample size assumption and the researcher did not have 72 participants in the study. The researcher conducted a backward logistic regression using the statistical software package R. The reduced model retained two predictors, ATMI and MAPs growth.

Curiously, ATMI was the only statically significant predictor with a p-value < .05 and 95% CI for beta (0.060, 1.862). The predictor MAPs growth had a p-value = 0.095 and a 95% CI for beta (-0.157, 1.972). The AUC for the ROC curve for the reduced model was .7013. The researcher considers the reduced model a fair to average model. The sample size assumption was met for two predictors. The odds ratio for ATMI was 2.615 which means that for each 1 unit increase in ATMI student's semester average success will increase by 2.615. The logistic regression model does a better job predicting semester average success when the predictors ATMI and MAPs growth are included even though MAPs growth is not a statistically significant predictor at the .05 level. The researcher conducted a logistic regression model with just ATMI as a predictor and the AUC of the ROC curve was .65. So, the researcher concludes that the model is best when using ATMI and MAPs growth as predictors of semester average success.

The second research question sought to establish a relationship between self-esteem, attitudes towards mathematics and difference in fall MAPs test and winter MAPs test. For this question, the researcher used the RSE scale, ATMI, and the difference between students' winter and fall MAPs test score. A multiple linear regression was conducted on the variables. Neither variable was found to be statistically significant. The F-statistic was low at $F(2,63) = 0.7452$. The variance of difference in MAPs growth explained by the variables RSE and ATMI was nearly 0. The author concludes that self-esteem and attitudes towards mathematics are not statistically significant predictors of difference in MAPs growth. The author believes this could be due to the nature of the MAPs test. Students may be intrinsically motivated to test better the second time than the first time on MAPs tests. Thus, students test scores naturally increase regardless of students' predisposition to mathematics.

The third research question sought to establish a relationship between winter MAPs test scores and semester average. A simple linear regression was conducted with winter MAPs test being the independent variable and semester average the dependent variable. Winter MAPs test had a p-value statistically significant at the .001 level. The 95% CI on beta was (.288,.653). The F statistic was relatively large with $F(1, 63) = 25.55$ with the model having a p-value $< .001$. Nearly 28% of the variation on semester average can be explained by the change in winter MAPs score. The researcher concludes that with increases in winter MAPs test score students' semester average will increase by small amounts.

In addition to the stated research questions, several other observations should be noted, with the first being that a large number of participants made positive growth on the winter MAPs test but a little over half made adequate growth set by NWEA. Also, less than half were successful at obtaining a 77% or higher semester average. Almost thirty percent of the researcher's participants answered strongly disagree to the inventory statement "I learn mathematics easily" on the ATMI. More than one third of the participants answered strongly disagree to the inventory statement "I have a lot of self-confidence when it comes to mathematics." The author feels there is a need to help the students of Huntington High School develop higher attitudes towards mathematics.

The author also wants to draw attention to evidence of self-esteem not being a predictor in model 1 or model 2 of the research study. The lack of relationship between self-esteem and math achievement can be viewed positively. With 36.9% of participants reported having low self-esteem, students have been able to find a way to be success in the math classroom. Many might expect that students with low self-esteem will not be successful in the math classroom, yet the data revealed that self-esteem did not predict success. Therefore, participants with low self-

esteem but who were successful in the math classroom were able to find strategies to overcome their negative belief in self. Of the students who had low self-esteem scores, nearly forty two percent were successful in the class when success was measure by a semester average of 77% or higher.

Integration of Findings into the Literature

The purpose of this study was to find if a relationship exists between students' self-esteem, attitudes toward mathematics, and math achievement. To do this, the author sought to include theory by reviewing Foucault Theory of Power. According to Foucault's Theory, the power-knowledge discourse is not "knowledge is power" but is the relationship that shows how certain knowledge is suppressed or produced by power and results from the choice or decision of the individual.[80] Within Foucault Theory of Power, attitudes toward mathematics was added as a predictor of success in the mathematics classroom. The predictor influences the student's overall experience in the classroom based on their compliance or resistance to mathematics.

Within the integration of Foucault's Theory of Power, the author sought to understand what psychological factors specifically affect students' achievement in mathematics. For several decades, researchers have examined students' self-esteem and academic achievement. Keltikangas-Jävinen (1992)[81], Peixoto and Almeida (2010)[82] and Bong et al (2012)[83] reported that self-esteem predicts students' academic achievement. Students' attitudes toward

[80] Borch, Christian. "Systemic Power: Luhmann, Foucault, and Analytics of Power." Acta Sociologica 48, no. 2 (2005): 155-67. Accessed November 27, 2020. http://www.jstor.org.proxy01.shawnee.edu/stable/20059932.
[81] Keltikangas-Järvinen, Liisa. "Self-Esteem as a Predictor of Future School Achievement." *European Journal of Psychology of Education* 7, no. 2 (1992): 123–30.
[82] Peixoto, Francisco, and Leandro S. Almeida. "Self-Concept, Self-Esteem and Academic Achievement: Strategies for Maintaining Self-Esteem in Students Experiencing Academic Failure." *European Journal of Psychology of Education* 25, no. 2 (2010): 157–75.
[83] Bong, Mimi, Catherine Cho, Hyun Seon Ahn, and Hye Jin Kim. "Comparison of Self-Beliefs for Predicting Student Motivation and Achievement." *The Journal of Educational Research* 105, no. 5 (2012): 336–52.

mathematics have been studied as a factor in academic achievement. Alkin (1970)[84], Zimmerman, Bandura and Martinez-Pons (1992)[85], Stage, and Kloosterman (1995)[86], Tapia (1996)[87], Hannula (2002 & 2006)[8889], concluded that attitudes toward mathematics relate to math achievement.

The researcher sought to test statistically the relationship between self-esteem, attitudes toward mathematics and math achievement at Huntington High School. The present study did not find evidence of self-esteem predicting math achievement. The lack of evidence to support self-esteem being a predictor of math achievement may be related to the sample. The students in this study are from northern rural Appalachia. Previous researchers have called rural Appalachians an "invisible minority."[90] While other researchers have found a relationship between self-esteem and academic achievement this relationship did not exists with the author's participants from rural Appalachia. Research of students from rural Appalachia is difficult to find. The researcher sought to conduct a study to represent this minority group.

The present study did find evidence that attitudes towards mathematics does have a positive relationship to student achievement when achievement was defined as semester average

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[84] Alken, Lewis R. "Two Scales of Attitude toward Mathematics." *Journal for Research in Mathematics Education* 5, no. 2 (1974): 67–71. https://doi.org/10.2307/748616.

[85] Zimmerman, Barry J., Albert Bandura, and Manuel Martinez-Pons. "Self-Motivation for Academic Attainment: The Role of Self-Efficacy Beliefs and Personal Goal Setting." *American Educational Research Journal* 29, no. 3 (1992): 663–76. https://doi.org/10.2307/1163261.

[86] Stage, Frances K., and Peter Kloosterman. "Gender, Beliefs, and Achievement in Remedial College-Level Mathematics." *The Journal of Higher Education* 66, no. 3 (1995): 294–311. https://doi.org/10.2307/2943893.

[87] Tapia, Martha. "The Attitudes toward Mathematics Instrument." Paper presented at Annual Meeting of the Mid-South Educational Research Association, Tuscaloosa, AL. Accessed November 27, 2020. https://files.eric.ed.gov/fulltext/ED404165.pdf

[88] Hannula, Markku S. "Attitude towards Mathematics: Emotions, Expectations and Values." *Educational Studies in Mathematics* 49, no. 1 (2002): 25–46.

[89] Hannula, Markku S. "Motivation in Mathematics: Goals Reflected in Emotions." *Educational Studies in Mathematics* 63, no. 2 (2006): 165–78.

[90] Scott, Marc., Hockenberry, Jacklyn., and Miller, Elizabeth., "Tutoring the 'Invisible Minority': Appalachian Writers in the Writing Center." *Open Words: Access and English Studies* 40, no. 1 (2015): 50-61. Accessed February 20, 2021. https://www.pearsoned.com/wp-content/uploads/Scott-etc-Open_Words-Journal_Spring-2015-Final.pdf

success. Attitudes toward mathematics did not have a statistically significant relationship with the difference in MAPs test scores.

The researcher originally asserted that those students who have higher self-esteem would have higher mathematics achievement. While there is a vast amount of research that supports the assertion there is a vast amount of research the does not support this assertion. In the findings at Huntington High School there was no relationship between students' self-esteem and mathematics achievement. Based on this finding, when implementing Social and Emotional Standards and the goal is to help achievement, Huntington High School does not need to spend ample amounts of time helping students with self-esteem only.

Implications

There are implications based on the results of this study, primarily for secondary mathematics teachers, public school administrators and school counselors. The findings supported by the overall purpose of the study which was to see if self-esteem and attitudes towards mathematics are associated with achievement in the secondary mathematics classroom in rural northern Appalachia. It is necessary to clarify that the current study was assessed self-esteem, attitudes toward mathematics, and achievement in one semester, therefore, it cannot be generalized from year to year.

Secondary Mathematics Teachers. A significant finding demonstrated in this study was that students' attitudes toward mathematics was related to their mathematics achievement. This finding supports that students' feelings toward mathematics affects their achievement in the classroom. Secondary mathematics teachers need to help students form and cultivate the desire to learn mathematics. Strategies should be implemented in the classroom to help students feel they can achieve in mathematics.

Secondary teachers should consider having students complete the ATMI either before or toward the beginning of the school year to see their students' attitudes toward mathematics. Instruction can be planned accordingly to help students who feel mathematics achievement is out of their reach is obtainable.

Public School Administrators. There are also implications for public school administrators including elementary, middle, and high school principals as well as district superintendents and assistant superintendents. The students in this study were high school students. The elementary and middle school principals should be interested to see if attitudes toward mathematics affects their students' mathematics achievement. Superintendents and assistant superintendents should be concerned about all students' K-12 attitudes toward mathematics and if it affects mathematics achievement. Administrators need to ensure that all teachers are comfortable with teaching mathematics at all grade levels. They should want to make sure teachers are presenting mathematics in a positive light. Administrators should look at professional development opportunities for teachers that give teachers strategies for developing positive attitudes towards mathematics.

School Counselor. With school counselors being involved in implementing Social and Emotional Standards, school counselors need to be aware that students' attitudes toward mathematics affect mathematic achievement. School Councilors can, therefore, help students succeed in mathematics when creating and implementing programs aimed at fulfilling Social and Emotional Standards. Furthermore, it is important for all school employees to train students to make decisions about their education that will positively influence educational outcomes. Focusing on just self-esteem is not what students need to be academically successful.

Limitations

This study has limitations that should be addressed. First, because of the population involved in this study, only students in one teacher's classroom at Huntington High School, this study cannot be generalized to all high school students. It cannot be generalized for all high school students from all demographic regions. Similarly, this study cannot be generalized to all Appalachian high school students.

Suggestions for Future Research

Upon completion of the study, the researcher has identified suggestions for future research that might fill gaps of the current study. First, future researchers may find it more beneficial to include a larger samples size. To increase more generalizability to the Appalachian population, researchers should include data from multiple high schools in Appalachia. Comparing data from several schools from Appalachia would help fill the literature research gap involving students from Appalachia. To generalize to the entire high school population, the researcher should include data from multiple high schools from all demographic areas.

Future researchers from Ohio may find identifying Algebra 1 achievement as receiving a remediation free score on the Ohio End of Course Algebra 1 test a better dependent variable. Researchers from other states may find it beneficial to use their state end of course assessment.

Future researchers looking for a way to measure attitudes toward mathematics at the elementary and middle school level may find a different measurement tool than the ATMI used in this study. Also, future researchers may consider a longitudinal study to see when most students have a change or changes in attitudes toward mathematics.

In terms of replication, this study could be completed with high school students. Secondary mathematics teachers would benefit from knowing their students' attitudes toward mathematics. School administrators and counselors would benefit from knowing how attitudes

toward mathematics affect mathematics achievement so they can use resources to help students become more successful in the mathematics classroom.

Summary

Much research has been conducted on students' self-esteem and academic achievement. Self-esteem is the way an individual views him/herself. Some research has been conducted on attitudes towards mathematics and students' achievement. Students who view mathematics as meaningful and attainable tend to achieve higher in the secondary mathematics classroom. This study attempted to identify any relationships between self-esteem, attitudes toward mathematics, and mathematics achievement. The research did identify attitudes toward mathematics as a predictor on semester success in the math classroom. There were limitations to this study in reference to population, specific sample, and generalization ability. However, this is still an area, particularly in Appalachia, that needs further research. Being able to predict the likelihood of students' success in secondary mathematics could lead to changes in the way teachers and administrators implement Social and Emotional Standards that could lead to more student success in math.

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Appendix A

Below are the results of the ATMI broken down by each item in the questionnaire.

Question	A- Strongly Disagree Total	B- Disagree Total	C- Neutral Total	D- Agree Total	E- Strongly Agree Total	Mean (SD)
Mathematics is a very worthwhile and necessary subject.	4	7	24	21	9	3.37 (1.05)
I want to develop my mathematical skills.	0	4	21	29	11	3.72 (0.82)
I get a great deal of satisfaction out of solving a mathematics problem.	9	14	23	14	5	2.88 (1.14)
Mathematics helps develop the mind and teaches a person to think.	3	6	18	24	14	3.62 (1.07)
Mathematics is important in everyday life.	1	11	23	18	12	3.45 (1.03)
Mathematics is one of the most important subjects for people to study.	1	10	24	18	12	3.46 (1.02)
High school math courses would be very helpful no matter what I decide to study.	5	8	23	22	7	3.28 (1.07)
I can think of many ways that I use math outside of school.	6	13	20	19	7	3.12 (1.14)
Mathematics is one of my most dreaded subjects.	5	9	21	12	18	2.55 (1.25)
My mind goes blank and I am unable to think clearly when	6	14	18	8	19	2.69 (1.35)

working with mathematics.						
Studying mathematics makes me feel nervous.	8	17	15	13	12	2.94 (1.31)
Mathematics makes me feel uncomfortable.	12	19	15	8	11	3.2 (1.35)
I am always under a terrible strain in a math class.	11	15	23	9	7	3.22 (1.21)
When I hear the word mathematics, I have a feeling of dislike.	9	13	19	10	14	2.89 (1.34)
It makes me nervous to even think about having to do a mathematics problem.	12	20	17	9	7	3.32 (1.24)
Mathematics does not scare me at all.	14	14	14	17	6	2.8 (1.30)
I have a lot of self-confidence when it comes to mathematics.	22	14	15	8	6	2.41 (1.32)
I am able to solve mathematics problems without too much difficulty.	16	13	21	12	3	2.58 (1.18)
I expect to do fairly well in any math class I take.	7	6	27	19	6	3.17 (1.08)
I am always confused in my mathematics class.	8	13	22	11	11	2.94 (1.25)
I feel a sense of insecurity when attempting mathematics.	11	21	16	13	4	3.34 (1.16)
I learn mathematics easily.	19	17	17	8	4	2.4 (1.21)
I am confident that I could learn advanced mathematics.	20	18	12	8	7	2.45 (1.33)

I have usually enjoyed studying mathematics in school.	17	8	29	8	3	2.57 (1.15)
Mathematics is dull and boring.	6	15	20	13	11	2.88 (1.22)
I like to solve new problems in mathematics.	20	12	23	8	2	2.38 (1.14)
I would prefer to do an assignment in math than to write an essay.	11	9	11	8	26	3.45 (1.54)
I would like to avoid using mathematics in college	9	11	24	6	15	2.89 (1.32)
I really like mathematics.	17	17	23	2	6	2.43 (1.19)
I am happier in a math class than in any other class.	12	18	20	11	4	2.65 (1.15)
Mathematics is a very interesting subject.	8	12	24	11	9	3.02 (1.19)
I am willing to take more than the required amount of mathematics.	23	15	15	8	4	2.31 (1.25)
I plan to take as much mathematics as I can during my education.	16	15	23	8	3	2.49 (1.33)
The challenge of math appeals to me.	16	11	29	5	4	2.54 (1.13)
I think studying advanced mathematics is useful.	12	10	25	13	5	2.83 (1.18)
I believe studying math helps me with problem solving in other areas.	8	12	27	14	4	2.91 (1.07)
I am comfortable expressing my own ideas on how to look for solutions to a	13	17	24	10	1	2.52 (1.03)

difficult problem in math.						
I am comfortable answering questions in math class.	13	12	21	12	7	2.82 (1.26)
A strong math background could help me in my professional life.	8	8	19	16	14	3.31 (1.29)
I believe I am good at solving math problems.	16	14	23	8	4	2.54 (1.17)
Attitudes	Mean: 3.31	SD: 0.60				
High Positive Attitude	1 out of 65					
High-Neutral Positive Attitude	24 out of 65					
Neutral Attitude	34 out of 65					
High-Neutral Negative Attitude	6 out of 65					
High Negative Attitude	0 out of 65					

Appendix B

Below are the results of the RSE broken down by each item in the questionnaire.

Question	A- Strongly agree Total	B- Agree Total	C- Disagree Total	D- Stronly Disagree Total	Mean (SD)
1	5	35	23	0	1.66 (0.67)
2	14	32	16	3	1.12 (0.80)
3	9	39	13	4	1.82 (0.75)
4	15	29	16	5	1.83 (0.88)
5	6	22	25	12	1.66 (0.89)
6	11	30	16	8	1.32 (0.90)
7	10	16	37	10	1.85 (0.71)
8	22	20	16	7	1.12 (1.01)
9	5	11	35	14	1.89 (0.83)
10	10	24	23	8	1.55 (0.90)
Self-Esteem	Mean: 15.83		SD: 5.24		
Low Self-Esteem	24 out of 65		36.9%		
Normal Self-Esteem	38 out of 65		58.5%		
High Self-Esteem	3 out of 65		4.6%		

Appendix C

For Office Use Only

Protocol #

Shawnee State University

Expedited and Full Review Application

Title of Research Project: "How Does Self-Esteem and Attitude Towards Mathematics Affect Mathematics Achievement at the Secondary Level in a Rural School in Southern Ohio?"

Name(s) of Principal Investigators:	Email address:	Faculty	Student	Other
Jennifer Akers	jennifer.akers@huntsmen.org	☐	X	☐
*Dr. Douglas Darbro	ddarbro@shawnee.edu	X	☐	☐
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐

*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.

Contact Name: Jennifer Akers Contact Phone Number: 740-222-0615

Department(s)/Division/Agency: Shawnee State University Graduate Level Mathematics Department

1. Describe the key demographics (age, SES, ethnicity, geographic locations, gender, etc.) of the sample that you wish to obtain.

14-17 year old Algebra 1 and/or Algebra 2 students from Huntington High School Chillicothe, Ohio. This school is made up of 96.4% SES students and 95.9% white/non-hispanic students.

1a. What is the greatest number of participants that will be recruited? 75 students

1b. How will participants be recruited? All students in Mrs. Jennifer Akers' classes will be asked by Mrs. Akers' to participate in the study. Letters will be mailed home to parents explaining the study with a consent form.

1c. Check the type of populations listed below that will be included in the study.

__X__ Children (under the age of 18)
_____ Prisoners
_____ Participants with diminished cognitive ability
_____ Pregnant women and/or fetuses
_____ No vulnerable populations will be included

2. Will participants be remunerated for their participation? X 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. Students who complete the study will receive a 2% of their mid-term grade in extra credit.

2b. If participants do not complete the study, will partial or full remuneration be given? Please describe how that will be determined. Students who complete only 1 of the 2 MAPS tests but complete all the inventories will receive the same extra credit. Any less will receive no extra credit.

3. What direct benefits (other than remuneration) exist for the participants who participate? Students may learn more about themselves and how attitudes and self-esteem have the potential to determine success in the secondary mathematics classroom.

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

_X__ Risk of breach of confidentiality or privacy

_____ Risk of coercion by researcher(s) loading...

_____ Risk of psychological harm

_____ Risk of physical harm

_____ Other potential risk: _____

4a. Please describe the specific risk(s). The confidentiality could be compromised if the desk or computer is broken into by someone else.

4b. What measures will be taken to limit or minimize the risks? Every precaution will be taken so that only Jennifer Akers' knows the identity of each participant with hard copies being locked in a desk and electronic data will be stored in a password protected computer.

5. What are the expected benefits of the research to the scientific community or the common good?

This study will identify factors that affect the achievement in mathematics. The study may eliminate factors that do not affect achievement in mathematics. This study can be used by our district, who has a history of struggling with mathematics, to help decide where to use more resources to help students be successful in the secondary mathematics classroom.

6. Does the methodology require that participants be deceived about any aspect of the study?

Yes x No

6a. If so, please justify the use of deception and describe the debriefing procedures that will be used (Please attach the debriefing form and/or a script of the debriefing information).

_____

_____

_____

7. How will the participants be informed of the risks and benefits of the study? Participants will receive an assent form that explains the risks and benefits of the study at a level they can understand. The risks and benefits will also be communicated verbally during class.

7a. How will consent be obtained from participants (or their legal guardian? Parents will receive a consent form in the mail from Mrs. Jennifer Akers' explaining the study as well as the risks and benefits to their child. Parents may send the consent form to school with their child.

7b. Will participants be involved who cannot give legal consent? x Yes No

7c. If so, how will assent be obtained from the participants? There will be designated class time for the students in class to decided if they want to be participants of the study. They have an assent form written at a level all students that are allowed to participate can understand.

8. Based on the "What type of review" form, I believe that my research project only requires an expedited review.

Yes (No)

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 a ***Continuing Review Form*** if my project extends beyond a year from my approval date and I must file a ***Study Completion Report*** with all consent forms once the study is complete.

Jennifer Akers
Signature of Principal Investigator 1

Signature of Principal Investigator 2

Signature of Principal Investigator 3

Signature of Principal Investigator 4

Signature of Principal Investigator 5

Signature of Principal Investigator 6

Date of Submission: _____

Akers, Jennifer <jennifer.akers@huntsmen.org> Mon, Feb 22, 2021, 7:56 AM

to Douglas, IRB, thamilton

I am checking on the status of my IRB approval. Last time we corresponded the assent and consent forms were the only items being questioned.

--
Thank You,
Jennifer Akers
Huntington High School
Mathematics Department

IRB <irb@shawnee.edu> Mon, Feb 22, 2021, 12:15 PM

to me, Douglas, Tim

Hi, Jennifer,

I'm sorry—I thought I had already replied to you nearly a month ago, but I must not have. You are, indeed, approved. Good luck with the work.

—Dr. Hamilton

Appendix D

Consent Form for Your Child's Participation in a Research Study
Shawnee State University

1. Study Title: "Are Self-Esteem and Attitude Towards Mathematics Related to Mathematics Achievement at the Secondary Level in a Rural School in Southern Ohio?"

2. Performance Site: Huntington High School in Chillicothe, Ohio

3. Investigators: Primary Investigator: Mrs. Jennifer Akers
Phone: 740-663-2230
Email: jennifer.akers@huntsmen.org
You may contact Mrs. Jennifer Akers anytime Monday through Friday from 7:35am to 2:35pm or leave a message/send an email to schedule another time.

4. Purpose of the Study: I would like to examine if a relationship exists between self-esteem factors, students attitudes towards mathematics and mathematics achievement.

5. Subject Inclusion: Students enrolled in Mrs. Jennifer Akers' Algebra 1 and Algebra 2 courses for the 2020-2021 school year.

6. Number of subjects: Your child will be 1 of 75 subjects

7. Study Procedures: Your child will complete "Attitudes Toward Mathematics Inventory" and the "Rosenberg Self-Esteem Scale." Your child's first and second quarter grades in their secondary mathematics course will be collected as well as their beginning year and middle year MAPS mathematics test scores.

8. Benefits: If your child completes the study, they will receive a 2% of their mid-term grade in extra credit. Your child will learn about their attitudes toward mathematics and their self-esteem. They will receive information at the end of the study if there are any relationships that exist among their attitudes inventory and/or self-esteem inventory and their achievement scores in Algebra 1 and/or Algebra 2. Students who chose not to participate in the study may also receive a 2% of mid-term grade as extra credit points for completing a worksheet on linear and quadratic equations that will take as long to complete as the two inventory questionnaires.

9. Risks: The only risk is the inadvertent release of sensitive information collected during the study. However, this study is confidential. Your child's information is only available to Mrs. Jennifer Akers. Your child's information will be coded in a way that no one will be able to connect your child to their identifying information in any documentation. Your child will have a pseudonym in the research paper.

10. Right to Refuse: Your child may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.

11. Privacy: Results of the study may be published, but no names or identifying information will be included in the publication. Participant identity will remain confidential unless disclosure is required by law. All documents will be stored in a locked desk drawer in Huntington High School and on a password protected computer for a period of 3 years, at which point the documents and files will be destroyed.

12. Signatures: I verify that I am the parent or legal guardian of the child that is younger than 18 years of age. The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators listed above. If I have questions about

subjects' rights or other concerns, I can contact Sunil Ahuja, Provost, Institutional Review Board, Shawnee State University (740) 351-3017. I agree to allow my child to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

☐ I give permission for my child to participate in the research study.

☐ I do not give permission for my child to participate in the research study.

Your child's name: _____

Parent/Legal Guardian's name:_____

Parent/Legal Guardian's Signature:_____

Date_____

Appendix E

"Are Self-Esteem and Attitude Towards Mathematics Related to Mathematics Achievement at the Secondary Level in a Rural School in Southern Ohio?"

Assent Form

My name is Mrs. Akers. I am either your Algebra 1 or Algebra 2 teacher at Huntington High School. I am currently a graduate student at Shawnee State University. I am inviting you to participate in a research study examining if your attitude and self-esteem in math is related to how well you do in math class. Your parent(s) know I am talking with you about the study. This form will tell you about the study to help you decide whether or not you want to take part in it.

What am I being asked to do?
If you decide to be in the study, I will ask you to complete two inventory questionnaires. One inventory questionnaire is about your attitude towards math. The other inventory is questions about your self-esteem, how you feel about yourself. Your beginning of year MAPS test score, middle of year MAPS test score, first nine weeks grade, and second nine weeks grade will also be collected as part of the data.

What are the benefits to me for taking part in the study?
If you take part in this study, you might find out if your attitude and feelings toward math are related to your grades in math class. You will also receive a 2% of your mid-term grade as extra credit points for completing the study. Taking part in this study may not have direct benefits to you, but it will help me learn how our school can use resources to help our students do well in high school math courses. Students who chose not to participate in the study may also receive a 2% of mid-term grade as extra credit points for completing a worksheet on linear and quadratic equations that will take as long to complete as the two inventory questionnaires.

Can anything bad happen if I am in this study?
I do not expect anything bad happening to you, but some kids may find filling out the two questionnaires boring. I assure you we will spend the least amount of time as possible completing the questionnaires.

Who will know that I am in the study?
If you decide to be in the study, I will not tell anyone else how you respond or act as part of the study. Even if your parents or teachers ask, I will not tell them about what you say or do in the study.

Do I have to be in the study?
No, you don't. The choice is yours. No one will get angry or upset if you don't want to do this. And you can change your mind anytime if you decide you don't want to be in the study anymore.

What if I have questions?
If you have questions about the study, you can ask me now or anytime during the study. You can also call me at 740-663-2230 or e-mail me at Jennifer.akers@huntsmen.org. If you have any questions about your rights as a participant in this research or if you feel you have been placed at risk, you can contact Sunil Ahuja, Provost, Institutional Review Board, Shawnee State University (740) 351-3017. You will receive a copy of this form for your records.

Signing below means that you have read this form and that you are willing to be in this study:

Name of the Participant (Write your name on the line): _____

Signature of the Participant (Put your signature on the line): _____

Date:_____

Appendix F

ATTITUDES TOWARD MATHEMATICS INVENTORY

Name _____ *School* _____

Teacher _____

Directions: This inventory consists of statements about your attitude toward mathematics. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Enter the letter that most closely corresponds to how each statement best describes your feelings. Please answer every question.

PLEASE USE THESE RESPONSE CODES:

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

1.	Mathematics is a very worthwhile and necessary subject.	
2.	I want to develop my mathematical skills.	
3.	I get a great deal of satisfaction out of solving a mathematics problem.	
4.	Mathematics helps develop the mind and teaches a person to think.	
5.	Mathematics is important in everyday life.	
6.	Mathematics is one of the most important subjects for people to study.	
7.	High school math courses would be very helpful no matter what I decide to study.	
8.	I can think of many ways that I use math outside of school.	
9.	Mathematics is one of my most dreaded subjects.	
10.	My mind goes blank and I am unable to think clearly when working with mathematics.	
11.	Studying mathematics makes me feel nervous.	
12.	Mathematics makes me feel uncomfortable.	
13.	I am always under a terrible strain in a math class.	
14.	When I hear the word mathematics, I have a feeling of dislike.	
15.	It makes me nervous to even think about having to do a mathematics problem.	
16.	Mathematics does not scare me at all.	
17.	I have a lot of self-confidence when it comes to mathematics.	
18.	I am able to solve mathematics problems without too much difficulty.	
19.	I expect to do fairly well in any math class I take.	
20.	I am always confused in my mathematics class.	
21.	I feel a sense of insecurity when attempting mathematics.	
22.	I learn mathematics easily.	
23.	I am confident that I could learn advanced mathematics.	
24.	I have usually enjoyed studying mathematics in school.	
25.	Mathematics is dull and boring.	
26.	I like to solve new problems in mathematics.	
27.	I would prefer to do an assignment in math than to write an essay.	
28.	I would like to avoid using mathematics in college.	
29.	I really like mathematics.	
30.	I am happier in a math class than in any other class.	
31.	Mathematics is a very interesting subject.	
32.	I am willing to take more than the required amount of mathematics.	
33.	I plan to take as much mathematics as I can during my education.	
34.	The challenge of math appeals to me.	
35.	I think studying advanced mathematics is useful.	
36.	I believe studying math helps me with problem solving in other areas.	
37.	I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.	
38.	I am comfortable answering questions in math class.	
39.	A strong math background could help me in my professional life.	
40.	I believe I am good at solving math problems.	

Appendix G

RSE

Please record the appropriate answer for each item, depending on whether you Strongly agree, agree, disagree, or strongly disagree with it.

1 = Strongly agree
2 = Agree
3 = Disagree
4 = Strongly disagree

_____ 1. On the whole, I am satisfied with myself.

_____ 2. At times I think I am no good at all.

_____ 3. I feel that I have a number of good qualities.

_____ 4. I am able to do things as well as most other people.

_____ 5. I feel 1do not have much to be proud of.

_____ 6. I certainly feel useless at times.

_____ 7. I feel that I'm a person of worth.

_____ 8. I wish I could have more respect for myself.

_____ 9. All in all, I am inclined to think that I am a failure.

_____ 10. I take a positive attitude toward myself.

BIBLIOGRAPHY

Jennifer Akers

Candidate for the Degree of

Master of Science Mathematics

Thesis: SELF-ESTEEM, ATTITUDES TOWARD MATHEMAITCS, AND MATHEMATICS ACHIEVEMENT IN A RURAL APPALACHIA HIGH SCHOOL

Major Field: Mathematics

Biographical: High school mathematics teacher since 2005 at Huntington High School in Chillicothe, Ohio.

Personal Data: Resides in Waverly, Ohio. Married with four children.

Education: (prior degrees) 2005 BS in Mathematics Shawnee State University

2013 MAT Curriculum, Instruction and Assessment Marygrove College

Completed the requirements for the Master of Science in Mathematics, Portsmouth, Ohio in August 2022.

8/8/2022

ADVISER'S APPROVAL: Douglas Darbro