Effects of STEM Education on Student Scale Scores on State Standardized Algebra, Biology and English End-of-Course Tests

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ABSTRACT

Texas Science Technology Engineering and Math (T-STEM) academies are being formed to provide 21st century learning opportunities for Texas students. After going through an exhaustive evaluation period schools are being recognized as T-STEM academies. The number of these academies is increasing every year. Texas Education Agency (TEA) provides professional development and support for the schools which are determined as a T-STEM academy. T-STEM academies are particularly focused on transforming schools into academies which engage teachers and students in STEM with the goal of improving schools and the college readiness of students. This study investigates if students who enrolled in T-STEM academies in 2016 are scoring better in state standard algebra, biology and English tests which are called STAAR End-of-Course Tests. This study involves 2.5 million students' data and utilizes quantitative data mining processes to gain results. A number of t-tests, correlation analysis, ANOVA, and regression analysis will be done.

Keywords

STEM education, quantitative methods, secondary education

1. INTRODUCTION

Different STEM education initiatives have been developed and utilized by different states to empower 21st century education by incorporating science, technology, engineering and math. STEM education involves hands-on, project-based activities where students take control of their own learning and teachers have more of a guiding role. Since more states and countries are adopting STEM education initiatives into teaching every year, the effectiveness of these programs on test scores becomes the rising question. This study is investigating how STEM education affects state standardized tests in Texas schools. The purpose of this study is to explore if STEM education creates an environment in which students gain more in-depth content-matter knowledge to make an upward change in their scores for three different majors; algebra, biology and English.

State standardized tests are used to measure the achievement levels of students. However, these tests can be non-indicative when students are compared internationally. When we look at satisfactory levels of Texas students in Spring 2016 only 19% of the students received unsatisfactory scores in Algebra 1 and similarly, the unsatisfactory score percentage in the summary report was 9% for biology based on the State of Texas Assessments of Academic Readiness (STAAR) test summary report published in Summer 2016 by the Texas Education Agency (TEA).

However, when we compare the achievement levels of American students to the overall world we don't see a positive trend which is in favor of U.S. students. The Organisation for Economic Co-operation and Development (OECD) is an intergovernmental economic organization with 35 member countries today, founded in 1961 to stimulate economic progress and world trade. OECD runs a worldwide study on member and some non-member nations' 15-year-old students' scholastic performance on mathematics, science and reading. This study is called the Programme for International Student Assessment (PISA) and it takes place once every three years. According to Schleicher (1999) the focus and main question for PISA to answer is "What is important for citizens to know and be able to do?"

PISA assesses the extent to which 15-year-old students have acquired key knowledge and skills that are essential for full participation in modern societies of math, science and reading (Schleicher, 1999). PISA does not only test what students know, it also tests what students can do with this knowledge and how they can apply the knowledge into different situations (Schleicher, 1999).

35 member and 31 partner countries participated in PISA in 2012. Based on the PISA 2012 scores, the United States ranked 36th among 65 countries in Math, 24th in reading and 28th in science. It is obvious that the United States was surpassed by more than half of the attending countries in math and by 30% in science and reading. The scores that the US gained were even below OECD averages in all three majors. So, the current situation of American education is not great. When the top performers are analyzed it is not hard to see the success of Asian countries such as China, Singapore and Vietnam.

2. THEORETICAL FRAMEWORK

Discovery learning theory stands on a strong foundation built by constructivist learning. Jerome Bruner, the founder of discovery learning theory, is considered as one of the pioneers of constructivist learning with John Dewey, Jean Piaget and Lev Vygotsky. Bruner proposed modes of representation, importance of optimal structure, spiral curriculum and acts of discovery in order to rearrange and transform what is learned in such a way that one is enabled to go beyond the evidence so reassembling to gain additional new insights (Bruner, 1961).

In Bruner's understanding the teacher needs to encourage students to discover the principles of the concept to interest themselves. The teachers' duty is to keep the student in an active dialogue and prepare the content or turn the content into a format that students can understand through hands on activities which is the foundation of STEM education.

3. RESEARCH DESIGN

This part of the paper is explaining the statistical approaches that will be utilized for data analysis. Both descriptive and inferential statistic procedures will be used. Descriptive information includes variable, variable descriptions, and distributions of variables. Bivariate correlations will be conducted to uncover if any of the variables are highly correlated. Multiple regression analysis will be conducted to explore the influence of a number of variables on students' STAAR test scale scores.

This study also analyzes how STEM education affects each learning objective assessed by each test. So Manova will be conducted for each testing subject's objectives based on the data levels. According to Baker (2010) educational data mining usually utilizes multiple levels of meaningful hierarchy in educational data. This study considers the data at the student level, school level, campus level, district level, and region level.

3.1 Descriptive Analysis

Data obtained from the TEA will be downloaded to a computer to analyze via R software. The proportion of the total number of test questions answered correctly to the total number of questions in each reporting category was used to measure student scale scores in each test. To summarize the data, descriptive analysis will be used through t-tests. Distributions of students in each variable such as age, sex, grade, ethnicity, at risk and disadvantaged groups will be reported along with first time test takers and retest takers.

3.2 Bivariate Correlations

Bivariate correlations will be used to uncover multicollinearity between the independent variables. In multiple regression, the researcher tries to separate the effects of each independent variable because highly correlated variables make it hard to separate these effects (Ott & Longnecker 2015). Each of the highly correlated two independent variables will bring the same results and either one of them can be chosen for analysis. So, it is important to identify if multicollinearity is present and it is done by bivariate correlation analysis. Also, algebra, biology and English scale scores will be analyzed to see if there is a correlation between the test scores.

3.3 Multiple Regression

The modeling of the relationship between a dependent variable and a set of independent variables is one of the most widely used statistical techniques (Ott & Longnecker 2015). Multiple regression analysis uncovers if there is a relationship between a dependent variable and multiple independent variables and it helps to see which of these independent variables have an effect on a dependent variable. Regression analysis also allows the researcher to see how the dependent variable changes when each of the independent variables have a certain amount of change. The following regression equation will be used for the analysis modeling:

$$\hat{y} = a0 + b1x1 + b2x2 + b3x3 + \ldots + bkxk + e$$

Where:

a0 = constant

$\hat{y}$ = Algebra 1/Biology/English scale scores

bk = slope

x1 = STEM program

x2 = grade

x3 = sex

x4 = at risk status

x5 = disadvantage status

x6 = ethnicity

Regression analysis was chosen for this study because human beings are complex so that there is almost no human action that emerges from a single cause. Even students scale scores in STAAR tests go up when they are in a STEM program so there must be other factors affecting this situation. Multiple regression analysis undertakes value of each effect and shows how higher a student's score would be if they were in a certain group or they scored a certain grade in a test while isolating the effect of other independent variables. Statistical controlling will allow the researcher to identify what the real effect of each independent variable is while controlling for the other independent variables. Controlling will suppress the effects of other independent variables and only take each variable's effect into consideration alone and calculate the effect of each.

4. REFERENCES

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