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Using Middle School Test Scores to Predict Success in Ninth Grade Biology

Abstract

Success in ninth grade is essential to a student's success throughout high school. Many high schools retain the traditional science course sequence of teaching biology first to ninth graders who may or may not be cognitively ready for today's biology content. A few school districts in Georgia are offering a flexible science course sequence in the ninth grade, using test scores or other data to determine the course in which a student will be most likely to be successful. This study used regression analysis to determine whether seventh grade life science Criterion-Referenced Competency Test (CRCT) scores are an effective predictor of success in ninth grade biology as measured by the biology End-of-Course Test (EOCT). The analysis indicated a strong positive correlation between life science CRCT scores and biology EOCT scores. The regression equation provides a method to predict students' estimated biology EOCT score and academic success in that course. This gives educators the ability to guide students to the course of science study at which they are likely to be most successful.

Introduction

Student achievement in science is an issue that plagues our educational system. The National Science Foundation (2010) reported that high school students in the United States have fallen behind other economically advanced countries in science achievement. Although math scores have increased in the past decade, the National Science Foundation also reports that science scores have not. In high schools specifically, student achievement in science needs to be improved. In 2011, only 68% of public high school students in Georgia passed the biology End- of-Course Test (EOCT), and only 76% passed the physical science EOCT (Georgia Department of Education).

Keywords: academic achievement, high school biology, criterion-referenced competency test (CRCT), end-of-course test (EOCT), predicting student success, science course sequence.

According to the National Science Teachers Association (NSTA), 72% of states teach biology to ninth grade students (Petrinjak, 2012) with physical science/ physics, chemistry, and science electives taught in subsequent grades. This tradition is based on the National Education Association's 1893 report from The Committee of Ten (Vasquez, 2006), that recommended natural science be taught before physics and chemistry in secondary school. Others disagree with this interpretation of the report, arguing that the different course names do not specify biology (Sheppard & Robbins, 2007). The Committee named natural science as the beginning course with zoology, botany, and physiology suggested as subsequent electives. Nonetheless, the sequence with biology first has been the foundation of secondary science course sequences throughout the years.

The recent trend of performance-based curriculum standards and the upcoming Next Generation Science Standards require students to use critical thinking skills and apply knowledge to problem-solve. This is especially true in today's biology, based mainly on cellular concepts. No longer do students memorize the classification of plants and animals by rote (Lederman, 2008). Cellular and molecular concepts are difficult to relate and internalize. Egocentric adolescent students have a hard time understanding and then applying concepts that are not a part of their immediate lives (Waller, 2007).

Most ninth grade students are between the ages of 14 and 15 years. Although Piaget theorized that humans move to the formal operational stage where they can solve abstract problems or hypothetical tasks around age eleven, neuroscience and brain development studies show that the formal operational stage is being reached much later (Bessent, 2008; Rita & Martin-Dunlop, 2011; Shayer, 2008). With this information, it makes sense that ninth grade students may not be cognitively ready for the critical thinking and problem solving needed for the biology curriculum. The level of emotional maturity at this age can also be a deterrent to the self-motivation needed in the more complex curriculum (Lipschitz-Elhawi & Itzhaky, 2008; Waller, 2007).

While placing emphasis on curriculum and delivery methods, many school districts, e.g., Florida, Illinois, and New Jersey, have begun to rearrange the course sequences. General science courses are now being taught at the ninth grade level and only honors or high achieving students take biology. These general courses will provide background knowledge and prepare students for the more advanced concepts of biology, physical science/ physics, and chemistry.

Many school districts in Georgia have opted to change the sequence of secondary science courses, one reason being the low percentage of students passing the biology EOCT. In Georgia, there are no guidelines given by the state Department of Education (DOE) as to the correct sequence of secondary science courses. The Georgia DOE stipulates that four science courses, including biology and physical science, are required for graduation and both include a state implemented End-of-Course Test (EOCT). Georgia does mandate that middle school physical science be taught in the eighth grade. One avenue of thinking is that students will perform better taking high school physical science in ninth grade because of the back-to-back courses. Other districts choose to teach environmental science or other electives in the ninth grade that are not EOCT

courses and biology in either tenth or eleventh, believing that students will be more successful in an EOCT course at a later developmental stage.

There are school systems in Georgia that teach biology only to honors or high achieving students and non-EOCT courses to others. The school system that was studied uses scores from middle school Criterion-Referenced Competency Tests (CRCT) to determine in which science course each student is most likely to be successful. This information is utilized to assign students to the science class deemed most appropriate. The Georgia CRCT is designed to measure how well students learn and complete the knowledge and skills set forth in the Georgia Performance Standards (Georgia DOE). Students are tested at the end of each school term in reading/language arts, math, social studies, and science. Since physical science is taught in eighth grade, scores from the seventh grade test, which includes life science, are used to predict success in ninth grade biology.

Purpose of the Study

The purpose of this study is to examine the extent to which the life science score from a student's seventh grade Criterion-Referenced Competency Test is an effective indicator of the student's success in a ninth grade biology course as measured by the biology End-of-Course Test. If there is a significant relationship, the life science CRCT score can be seen as an accurate predictor of a student's success in ninth grade biology and can possibly be used to assign students to specific science classes.

Research Questions

Is there a significant relationship between a student's score on the life science portion of the seventh grade Georgia Criterion-Referenced Competency Test and the student's success in ninth grade biology as measured by the Georgia End-of-Course Test?

Hypothesis

It is predicted that there will be a significant relationship between a student's score on the life science portion of the seventh grade Georgia Criterion-Referenced Competency Test and the student's success in ninth grade biology as measured by the Georgia End-of-Course Test, indicating that the CRCT score is an effective predictor of the student's success in ninth grade biology.

Piaget's theory of cognitive development holds that humans' cognitive abilities develop in predetermined stages. Brain development theory (Gurian, 2006; Steinberg, 2012) states that areas of the brain develop at different times and in specific sequences, and those areas control distinctive aspects of cognition. According to Bessent (2008), adolescent students at the age of 15 have not yet developed cognitively to Piaget's formal operational stage and have not developed emotionally past being egocentric, rebellious, risk-takers.

Method

Participants

The study took place in a ninth grade academy in a public school district in Southwest Georgia. It is the only ninth grade in the school system. Participants were selected from all ninth grade students completing the biology End-of-Course Test in May 2012. Student test scores were compared after the test was taken, with no direct contact with students. There were 233 students who took the Spring 2012 biology EOCT. Of those students, 200 took the Georgia CRCT IN 2010 when in the seventh grade. This test includes life science. Both scores from all 200 students were considered. All students whose scores were used were taught by one of two biology teachers. These teachers have very similar educational backgrounds, earning undergraduate and graduate degrees from the same institutions. The graduate degrees were earned in the same program at the same time. Although they differ somewhat in teaching styles, they develop lesson plans together and administer common formative and summative assessments throughout the school year.

Setting

The site for the study was a rural school district in the United States in the geographic area of Southwest Georgia. The county population is approximately 32,500 with an average income of $24,500. The school district consists of seven county public schools with 385 teachers, and 5,330 students. The participants were selected from all ninth grade students enrolled in biology in the 2011 to 2012 school year, taking the biology EOCT in May 2012. The demographic breakdown of the schools mirrors the local community with 74% of the students enrolled being African-American, 18% white, 6% Hispanic, 1% Asian, and 1% multi-racial. The school is a Title I school, meaning the school receives federal funds for public schools with high numbers or percentages of poor or disadvantaged children. All students receive free breakfast and lunch, an indicator of the low socioeconomic level of the majority of the students.

Research Design

Non-experimental quantitative research methods were used to determine whether seventh grade Criterion-Referenced Competency Test scores can be used as a predictor of biology End-of-Course Test scores. A bivariate linear regression analysis was conducted to evaluate the prediction of biology EOCT scores from life science CRCT scores. Linear regression analysis not only shows whether an independent variable (CRCT scores) can predict a dependent variable (EOCT scores) but also shows how well the independent variable predicts the dependent.

The CRCT and the EOCT are both standardized achievement test mandated by the state of Georgia. The CRCT, that includes a life science portion, is taken at the end of the seventh grade year, after students have completed life science. The biology EOCT is taken at the end of the biology course, which is, in this study, at the end of the ninth grade. The test is designed to measure student academic achievement in the course and is set up according to the Georgia Performance Standards curriculum. Content validity is established by the Georgia Department of Education. All items are written specifically for Georgia, are reviewed by panels of Georgia educators, are field tested prior to administration, and are reviewed again in light of field

test data. This process ensures that all items align to the curriculum, are free of bias, and give students the best opportunity to demonstrate ability. Because this is a standardized test administered by the Georgia Department of Education, it is considered highly valid for this particular interpretation and for this particular group. The reliability coefficients for the Spring 2012 biology EOCT and the 2010 CRCT were both .90.

Results

A bivariate linear regression analysis was conducted to test the null hypothesis that students' ninth grade biology End-of-Course Test scores cannot be predicted by their seventh grade life science Criterion-Referenced Competency Test scores. Figure 1 shows a scatterplot with regression line that was used to test the assumptions of bivariate normality, linearity and homoscedasticity. Although possible outliers exist at the EOCT score of 523 and the CRCT score at 771, analysis shows that all assumptions are tenable. The linear regression analysis also shows that there is a strong positive relationship between the two variables, r = .72: a high life science CRCT score indicates a high biology EOCT score. The regression equation for predicting the biology EOCT score is

$$Biology\ EOCT\ Score = .89\ X_{CRCT} - 313.47$$

The 95% confidence interval for the slope was .77 to 1.01, therefore the life science CRCT score is significantly related to the biology EOCT score. There was significant evidence to reject the null hypothesis and conclude that the life science EOCT score (M = 823.23, SD = 26.56, n = 200) was a significantly predictor of the EOCT scores (M = 420.79, SD = 32.95, n = 200), $F(1,198) = 211.92$, $p < .01$, and $t(198) = 14.56$. Table 1 provides a summary of the regression analysis for the variable predicting final exam scores. Approximately 51% of the variance in the biology EOCT score was accounted for by its linear relationship with the student's life science CRCT score.

Figure 1

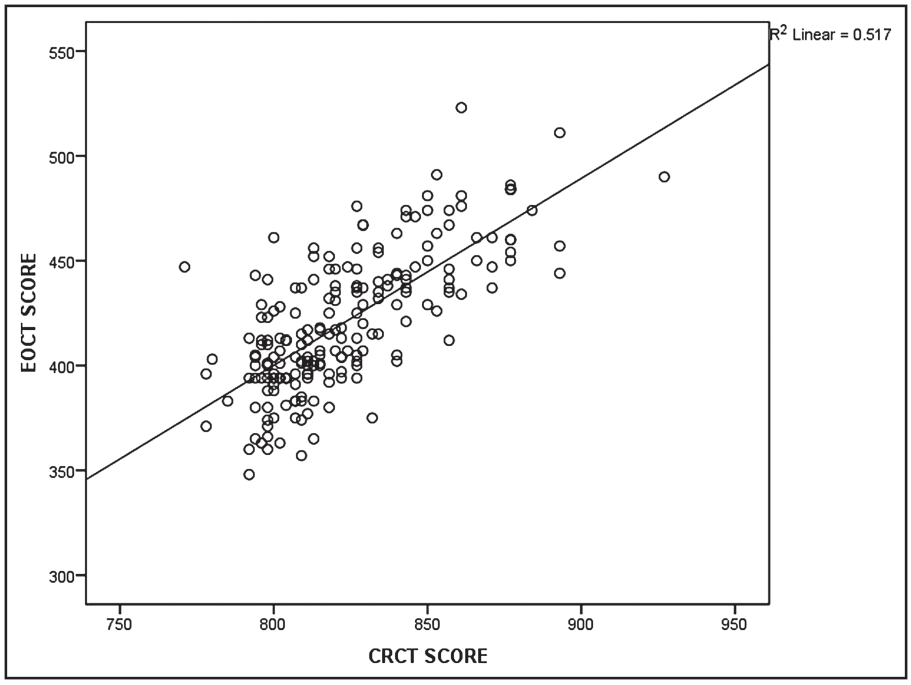

Figure 1: Scatterplot and regression line. Relationship between CRCT scores (M = 823.23, SD = 26.56, n = 200) and EOCT scores (M = 420.79, SD = 32.95, n = 200). Analysis shows assumptions of normality, linearity, and homoscedasticity are tenable.

Table 1: Summary of regression analysis

Variable	B	SE B	B
CRCT	.89	.06	.72

Discussion

The analysis of students' seventh grade life science Criterion-Referenced Competency Test scores and ninth grade biology End-of-Course Test scores showed that CRCT scores can be used to predict students' success in biology as measured by their EOCT scores. The regression analysis gives a method for predicting the estimated EOCT score by way of the regression equation. The analysis shows that there is a strong positive relationship between the scores. The higher a student scores on the seventh grade life science CRCT, the higher the student is likely to score on the biology EOCT.

These findings show that the use of a student's seventh grade CRCT score can be a valuable tool to determine into which science discipline the student should be placed when entering ninth grade to increase likelihood of student success. As the literature shows, there is debate over the most beneficial course sequence for secondary school science. Although many school systems remain on the traditional sequence of biology first, some researchers believe that this may not always be the best for student success (Lederman, 2008).

Studies have shown that many students' cognitive development (Bessent, 2008; Rita & Martin-Dunlop, 2011; Shayer, 2008) and emotional development (Waller, 2008) does not reach beyond that of early adolescence until well into the teens. Delaying enrollment in biology, a course that concentrates on molecular and cellular applications, could be a constructive step in assuring the academic success of those students as most fifteen year olds have not developed the determination and resolve needed to be successful when faced with academic difficulties (Schmidt, Shumow, & Kackar, 2012).

The ability to predict students' outcomes in biology in the ninth grade is

important because academic success in ninth grade is critical to the overall success of adolescent students. Studies show that students who fall behind academically in the ninth grade are more likely to drop out of school than in any other grade (Bornsheuer, Polonyi, Andrews, Fore, & Onwuegbuzie, 2011; McCallumore & Sparapani, 2010). As educators, it is our responsibility, first and foremost, to ensure the success of all students. Using the information at hand to predict where a student is most likely be successful is vital to the student's entire academic future.

Additional research in this area will be indispensable in safeguarding the educations of upcoming ninth grade students. It is important to extend this research to a larger sample of students, including more schools and different areas of the state of Georgia. Evaluating other assessments widely used in different parts of the country to find similar correlations will open the door for more flexibility in secondary science course sequencing. Students will be successful as long as we support and guide them. Flexible course sequencing is one of many ways that we can accomplish this goal.

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