

The Relationship between Algebra and Reading Skills

Dr. Boris Costa-Guerra

New Mexico State University

7208 Vuelta de la Luz, Santa Fe, NM 87507

United States of America

Abstract

This study investigated middle school students in a public school setting to determine whether short cycle summative assessment reading scores influenced algebra math scores on a state standardized assessment. The data was then analyzed for the differences between Hispanic students and Non-Hispanic students.

Keywords: Assessment, Language, Mathematics, Diversity

1. Introduction

The purpose of the Standardized Based Assessment (SBA) is to determine the level at which students perform on a state content standards, and to measure the progress of students over time. In order to increase the validity and reliability of the assessment, examiners must administer the sections of the assessment according to protocol (NMSAP, 2007). The different assessment sections are: Reading, Writing, Mathematics, Science and Social Studies. According to the Northwest Evaluation Association (2007), the State Based Assessment has created accountability data for administrators and educators, thereby enhancing awareness regarding each school system's strengths and weaknesses.

Due to the increased pressure on teachers and administrators to improve performance on state mandated assessments. Many districts have implemented additional assessment instruments that offer a preview of how their students might perform on state mandated standards based assessments. With the preview instruments, areas needing improvement can be addressed. This study was located in Southern New Mexico (NM) and concerned with the NMSBA as the high stakes mathematical assessment and the short cycle assessment Measuring Academic Progress (MAPs) as the means for previewing student strengths and weaknesses in mathematics prior to the SBA.

2. Theoretical Framework

This study finds deep roots in the correlation between math and reading skills. According to Pierce and Fontaine (2009), "language and reading skills have become increasingly important in mathematics classrooms. Students need to be able to explain their problem solving methods orally and in written form, both in the classroom and on high-stakes tests" (p. 239). Bratina and Lipkin (2003) reiterate the idea that mathematics includes reading features by stating that math curricula uses language that can factor into how students use and learn language. For example, the word "sum" in mathematics differs from the word "some" used in everyday language, which may cause confusion for students.

3. Statement of the Problem

SBA, MAPs and student reading skills are all thought to correlate to the overall success of a student in the school system. Since No Child Left Behind (NCLB) has implemented state mandated assessments (Roach & Frank, 2007), New Mexico has been utilizing MAPs math and reading assessments to become informed as to student progress. MAPs is a computer based assessment that is aligned with the standards and benchmarks for the state. The assessment is conducted three times a year to create a model of growth and retention for academic knowledge. Administrators and teachers rely only on the MAPs assessment to identify the students who need facilitation in order to achieve passing scores on the SBA. The MAPs is therefore considered a key predictor, or preview assessment, although there have been minimal studies to support this statement. In addition, the value of reading skills as a predictor of NMSBA mathematics score is not well defined.

4. Purpose of study

This study investigated correlations among MAPs reading scores, MAPs Algebra scores, to the SBA Algebra scores in an effort to understand the relationship between the variables. The goal of this study was to determine whether MAPs Algebra and/or Reading scores contribute to proficient scores on the SBA Algebra standardized assessment. To be more specific, the study employed path analyses using regression models to determine how much unique and total variance in SBA Algebra scores is explained by the two independent factors.

4.1 Research Questions

The following research questions were investigated:

1. Will MAPs scores in Algebra be an effective predictor of the SBA Algebra scores, and will adding MAPS reading scores to the prediction equation substantially enhance its accuracy in Hispanic versus non-Hispanic students?
2. Are the path analyses models for the prediction of SBA Algebra scores from MAPS Algebra and reading scores similar for Hispanic and Non-Hispanic students?

5. Literature

5.1 Assessment

Assessment is typically used to examine student progress in a specific subject. The purpose of assessment in a school environment is to gather information that can be used to provide feedback, diagnose strengths and weaknesses and to develop a profile on each student in order to improve learning (Brown, Bull & Pendlebury, 1997). According to Sattler (2009), assessment should incorporate not only quantitative but also qualitative methods. For example, observations and communication within home environments offer a more complete view of a student's educational status than test scores alone. In addition, Brown and Knight (1994) state that assessment itself can affect school experiences for students.

5.2 New Mexico Standards Based Assessment

The New Mexico Standards Based Assessment (NMSBA) is the state mandated assessment for students in the K-12 schools. NMSBA is administered once a year and is intended to determine proficiency in mathematics, reading, and science. Every year the NMSBA proficiency scores should improve, according to NCLB, at least up to 2014 (Department of Education, 2001). The assessments are intended to evaluate student proficiency to determine whether each student has mastered the New Mexico state standards and benchmarks for the academic year. The State of New Mexico Department of Education has set this process. The state standards and benchmarks consist of content and skills a student should learn within each specific academic year. After the students take the state mandated assessment with paper and pencil, the results are reported to the schools by the end of the academic year in order to help identify the areas of focus for the following school year.

Due to the pressure of demonstrating proficiency, the state has attempted to gauge the progress of schools as they move through each academic year. A computer -based assessment, Making Academic Progress (MAPs), is mandated to be administered to all students three times per academic year in New Mexico. Results on the MAPs are intended to be employed as indicators of strengths and weaknesses in student achievement that point to future outcome on the NMSBA.

5.3 Measuring Academic Progress

Technology-based assessment (TBA) is designed to allow teachers and administrators to more easily observe student individual and group achievement (Wirth & Klieme, 2003). MAPs has been aligned to the state standards and benchmarks, which supposedly include the NMSBA. This technology-based assessment is administered in a place that contains computers, preferably in a computer lab. Students are assessed in mathematics, reading, and science three times per year, in order to provide fast results to the teachers and thus target students who are below proficiency. Remedial lessons, programs, or classes can be provided.

5.4 Reading Skills

Most subjects taught in the school system are geared toward the premise that students know basic language and reading skills. Assessments are no different. In order for students to be able to participate in assessments addressing subjects taught in school, students should be able to have the foundation for language and reading skills, upon which all subjects are based (Sattler, 2009). If for some reason those skills are not adequately acquired by students, assessment scores, grades and participation in the classroom may be consequently affected.

A student's reading ability significantly impacts scores obtained on assessments because of the demand for language skills when interpreting, analyzing and synthesizing mathematical concepts. According to Hooper et al. (2010), there is a relationship between early reading skills and math skills. Many assessments utilize reading skills to communicate math abilities. Likewise, Sattler (2009) posed that a student's reading skills impact math scores for several reasons which include: the student may not have vocabulary to support math concepts on assessments, the student may have other linguistic influences which impact the understanding of assessment questions, for example code switching of terminology. The student may not have the ability to describe or question terms that are unclear because of language and reading influences (Valenica, 1997).

6. Methods

The design of the study was a quantitative correlational design. The examiner used quantitative measures of compilation and statistical analysis to analyze the participant assessment scores. Data was organized according to participant results. Path analysis using multiple regression was then utilized. The study utilized an alpha of .01 for all the tests.

6.1 Participants/Sampling Procedure

There were 298 students in the eighth grade who participated in this study, which were provided by a public school district by random sample. The participants were further sub-divided into two categories: Non-Hispanic and Hispanic. For the students who were placed in the Non-Hispanic category there were 82 students total. For the students who were placed in the Hispanic category there were 216 students total. Mathematics Algebra assessments and reading scores were retrieved from the school district in order to predict the correlation of the short cycle assessment MAPs and the State Standard Based Assessment (SBA).

6.2 Instrumentation

The study examined two variables to determine if they offer a statistically significant correlation of the SBA Algebra assessment scores. The instruments that were utilized in this study were the MAPs Algebra, MAPs reading assessments and the SBA Algebra assessment.

The MAPs development process utilized a test /re-test design that has consistently yielded statistically valid correlations between multiple test events for the same student (Shields, 2008). MAPs test/re-test studies have typically correlated scores from the same students after a lapse of several months. The Pearson coefficient was between .83 and .94 for the test/re-test reliability. Internal reliability (reliability between test items) has also been addressed. The internal reliability coefficient was calculated to be between .89 and .94, and therefore statistically significant (Shields, 2008).

6.3 Data Collection

The district gave permission to the researcher performing the study to review the scores and analyze the data. The school district allowed access to SBA Algebra and MAPs reading and Algebra scores which were archived. The SBA is administered annually and then data is compiled and analyzed. The data is then sent to the district. The district provides the data to the school administrators, who in turn communicate the assessment scores to teachers, students and parents.

6.4 Analysis of the Data

For the study, multivariate analysis using path analysis models was employed to determine possible pathways of relationships between the variables. After the appropriate single and multiple regressions were completed, each was converted to standard form, thus indicating standardized beta weights for each predictor variable. These values were then inserted into the path diagram as path coefficients. The value of a path coefficient indicates the change in terms of standard deviations of the dependent variable predicted by a change of one standard deviation in the independent variable, holding all other predictor variables constant. In a sense it represents variance in the criterion variable explained uniquely by a predictor variable.

7. Results

The multiple regression models employed to build the path analysis models utilized the SAS PROC REG program. The correlations between the MAPs and SBA variables were evaluated using path analyses developed from appropriate multiple regressions. For both Hispanic and Non-Hispanic populations, a statistically significant amount of variance in SBA Algebra scores was explained by the MAPs Algebra and reading scores.

7.1 Hispanic Students

As displayed in both Table 1.0, Table 1.A and Figure 1.0, the two predictor variables of MAPs Algebra and MAPs Reading account for 53% of the variance in SBA Algebra scores. Both predictors also account for a significant amount of unique variance in the SBA Algebra scores. For MAPs Algebra $sr^2=16\%$ and for MAPs Reading $sr^2=5\%$. Figure 1.0 reveals that the simple correlations squared (r^2) between MAPs Algebra and SBA Algebra and between MAPs Reading and SBA Algebra are $(.689)^2 = .475$ or 47.5% and $(.609)^2 = .371$ or 37.1% respectively. Therefore, although both predictors offer a statistically significant amount of variance explained singularly, they do the best job when working in tandem, and reading scores provide a significant portion of the predictability. If actual predictions were to be made, the following equation would be appropriate (see Table 1A, 1B and Figure 1):

$$\text{SBA Algebra Score} = 0.16 (\text{MAPs Algebra Score}) + 0.11 (\text{MAPs Reading Score}) - 51.32$$

Prediction of SBA Algebra scores for Hispanic Students

Table 1.0: Regression of MAPs Algebra score and MAPs Reading score on SBA Algebra scores for Hispanic Students

Prediction Variable	b	t-value	p	Beta	Sr^2
Intercept	-51.32	-12.48	.0001	0	
MAPs Math	0.16	8.40	.0001	0.51	0.16
MAPs Reading	0.11	4.88	.0001	0.30	0.05

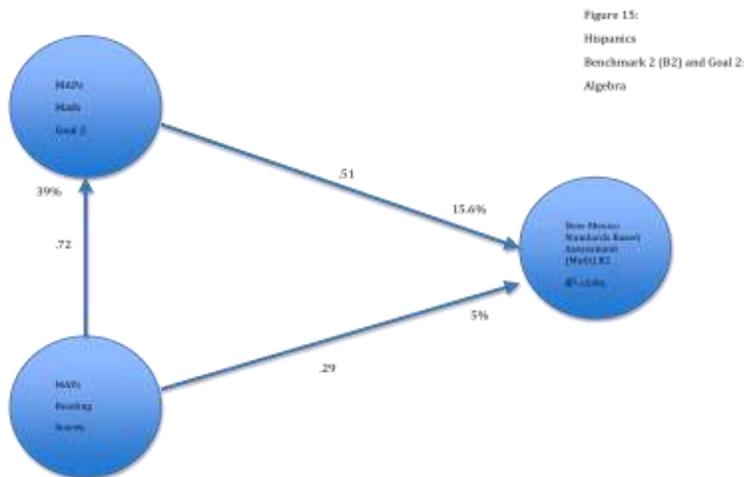
$$R^2 = 0.53$$

Table 1.A: Regression of MAPs Reading score on MAPs Algebra score for Hispanic Students

Prediction variable	b	t-value	p	Beta
Intercept	68.10	5.03	.0001	0
MAPs Reading	0.73	11.70	.0001	0.62

$$R^2 = 0.39$$

FIGURE 1.0



In looking at the results from a path analysis approach, Table 1.A indicates that MAPs Reading score is a significant predictor of MAPs Algebra score, accounting for 39% of the variance. Referring to Figure 1.0, the path coefficient for this relationship is .62, and when multiplied by .51, the path coefficient from the MAPs Algebra to SBA Algebra ($.62 \times .51$), we obtain an indirect effect of .316. When added to the direct effect of .29, the total effect of MAPs Reading on SBA Algebra is $.316 + .29 = .606$.

This value is greater than the direct effect of MAPs Algebra on SBA Algebra (.51). This result implies that reading scores are a key influence on Algebra scores, both directly and indirectly.

7.2 Non-Hispanic Students

As displayed in both Table 2.0, Table 2.A and Figure 2.0, the two predictor variables of MAPs Algebra and MAPs Reading account for 68% of the variance in SBA Algebra scores. Both predictors also account for a significant amount of unique variance in SBA Algebra scores. For MAPs Algebra $sr^2=10.3\%$ and for MAPs Reading $sr^2=9\%$. Appendix I reveals that the simple correlations squared (r^2) between MAPs Algebra and SBA Algebra and between MAPs Reading and SBA Algebra are $(.774)^2=.60$ or 60% and $(.762)^2=.581$ or 58.1% respectively. Therefore, although both predictors offer a statistically significant amount of variance explained singularly, they do the best job when working in tandem, and reading scores provide a significant portion of the predictability.

If actual predictions were to be made, the following equation would be appropriate:

$$\text{SBA Algebra Score} = 0.16 (\text{MAPs Algebra Score}) + 0.21 (\text{MAPs Reading Score}) - 71.41.$$

Prediction of SBA Algebra scores for Non-Hispanic Students

Table 2.0: Regression of MAPs Algebra scores and MAPs Reading scores on SBA Algebra scores for Non-Hispanic Students

Prediction Variable	b	t-value	p	Beta	sr^2
Intercept	-71.41	-10.12	.0001	0	
MAPs Math	0.16	5.10	.0001	0.47	0.10
MAPs Reading	0.21	4.65	.0001	0.43	0.09

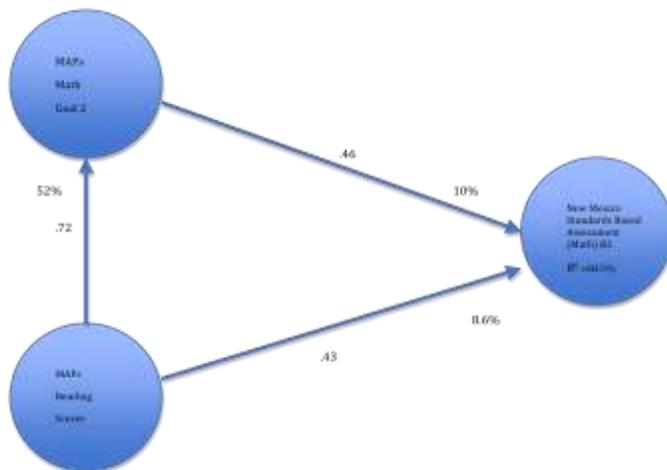
$$R^2 = 0.68$$

Table 2.A: Regression of MAPs Reading score on MAPs Algebra score for Non-Hispanic Students

Prediction variable	b	t-value	p	Beta
Intercept	-4.79	-0.19	.8505	0
MAPs Reading	1.06	9.35	.0001	0.72

$R^2 = 0.52$

FIGURE 2.0



In looking at the results from a path analysis approach, Table 2.A indicates that MAPs Reading score is a significant predictor of MAPs Algebra score, accounting for 52% of the variance. Referring to Figure 2.0, the path coefficient for this relationship is .72, and when multiplied by .46, the path coefficient from the MAPs Algebra to SBA Algebra (.72 X .46), we obtain an indirect effect of .331. When added to the direct affect of .43, the total effect of MAPs Reading on SBA Algebra is .331+ .43 = .761. This value is greater than the direct effects of MAPs Algebra on SBA Algebra (.46). This result implies that reading scores are a key influence on Algebra scores, both directly and indirectly.

7.3 Differences of Hispanics and Non-Hispanics

The path coefficients for reading were lower for all Hispanic students as compared to Non-Hispanic students, rather than higher, which implies that Hispanic students perhaps did not use reading skills in tandem with math skills as well as their peers. There may be several reasons for this result. First, one reason may be due to linguistic differences in the Hispanic population in the Southwestern United States. Because many Hispanic students have the influence of another language in this area, like Spanish, it may be possible that reading scores were lower on the standardized assessment due to the lack of experience with English.

Another possibility may be related to the vocabulary used on the assessments (Bratina & Lipkin, 2003). It is possible that the terminology on the assessments was not as familiar to the Hispanic students and was more familiar to the non-Hispanic students. Mathematical concepts utilize different jargon than everyday language use and so, perhaps, the Hispanic students did not use the appropriate language and reading skills when deciphering Algebra on these particular assessments.

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