DOCUMENT RESUME

ED 466 644 TM 034 255

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TITLE Selecting Students for Pre-Algebra: Examination of the Relative Utility of the Anchorage Pre-Algebra Screening Tests and the State of Alaska Standards Based Benchmark 2 Mathematics Study. An Examination of Consequential Validity and Recommendation.

INSTITUTION Anchorage School District, AK.
PUB DATE 2002-04-00
NOTE 16p.
PUB TYPE Numerical/Quantitative Data (110) -- Reports - Research (143)
EDRS PRICE EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS *Algebra; Benchmarking; Comparative Analysis; Criteria; *Middle School Students; Middle Schools; *Selection; Student Placement; *Test Use
IDENTIFIERS Alaska; *Alaska Statewide Assessment Program

ABSTRACT

This study examined the relative efficacy of the Anchorage (Alaska) Pre-Algebra Test and the State of Alaska Benchmark in 2 Math examination as tools used in the process of recommending grade 6 students for grade 7 Pre-Algebra placement. The consequential validity of the tests is explored in the context of class placements and grades earned. The Pre-Algebra examination was developed as an element of the selection process, since about one third of the district's students enroll in Pre-Algebra in grade 7. Original cut scores were informally validated through the experience of middle school teachers and no need was found to modify the examination or change the cut scores. To compare the Anchorage test and the state's test, data were used for 3,352 Anchorage students in grade 7 and correlations with the tests' results and grade 8 grades overall were also determined. Scores on the examinations are highly related with a correlation of greater than 0.8 even though the Anchorage examination consists entirely of multiple choice questions and the Alaska Benchmark examination includes short-answer and extended response questions. Recommendations based on the two examinations would be highly similar. The Anchorage examination that was actually used to place students was only slightly better in predicting actual placement than the Alaska Benchmark examination. Results support the consequential validity of either examination for selection of students for Pre-Algebra. (Contains 12 tables and 3 references.) (SLD)

Selecting Students for Pre-Algebra:

Examination of the Relative Utility of the Anchorage Pre-Algebra Screening Tests and the State of Alaska Standards Based Benchmark 2 Mathematics Study

An Examination of Consequential Validity and Recommendation

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April 2002

Acknowledgements

This study could not have been completed without the support of the Assessment and Evaluation Staff: Tom Straugh, Sarah Hotchkiss, Cindy Goggins and Neil O'Leary. Substantial additional support was provided by Dale Cope, Executive Director of Curriculum, Assessment, and Support Services; Sandy Schoff, Curriculum Coordinator for Mathematics; and Dr. Carol Mell, Supervisor of the ASD Information Technology Department.

Introduction

This study examines the relative efficacy of the Anchorage Pre-Algebra Test and the State of Alaska Benchmark 2 Math exam as tools used in the process of recommending grade 6 students for grade 7 Pre-Algebra placement. The consequential validity of the tests is explored in the context of class placements and grades earned.

Moving students forward to success in advanced mathematics is a goal of the Anchorage School District. The Anchorage School Board has called for an increase in the percentage of students who complete Algebra by the time they finish grade 8, and the development of Algebra skills in all students (Anchorage Board Goals, 2001-2002). This goal is consistent with Alaska State Standards in Mathematics and the inclusion of Algebra problems on the Alaska High School Graduation Examination (Alaska Department of Education, 2000).

The high standards set by the State of Alaska and the ambitious goals of the Anchorage School Board have encouraged the development of a mathematics sequence that allows and encourages students to enter Pre-Algebra in grade 7 and to complete Algebra I in grade 8. Not all students, however, are ready for the cognitive demands of Pre-Algebra in grade 7 and the Anchorage School District is committed to the ongoing success of students as they move through the mathematics sequence to reach the level of proficiency needed for high school graduation.

The Anchorage School District Pre-Algebra Exam was developed by a group of Anchorage Mathematics teachers with the support of the Anchorage Assessment and evaluation department to serve as one element in the selection process of students for Pre-Algebra in grade 7. The 40-item examination includes questions that were selected both to reflect the Anchorage 6^{th} grade curriculum and to assess math reasoning and problem solving. The multiple choice test was administered to a group of students to establish a performance baseline in 1998 and a committee of teachers used a modified Angoff process to establish cuts scores. The exam is administered in late April and early May.

The original cut scores were informally validated through the experience of middle school teachers and no need was found to either modify the exam or change the cut scores. There is some anecdotal evidence that the exam became a motivation for 6^{th} grade teachers to work through the entire 6^{th} grade curriculum to assure that students would be prepared for the end-of-year examination.

The State of Alaska introduced a new Comprehensive Student Assessment System in 2000. The system is consists of standards-based exams for grades 3, 6, and 8 followed by the High School Graduation Qualification exam at the end of grade 10. The Mathematics Examinations are keyed to the Alaska State Standards and include multiple choice, short answer, and one extended response items. The Alaska Benchmark exam is administered in early March.

The examinations differ in three salient features.

- The Anchorage examination was developed to reflect the Anchorage 6th grade curriculum and includes some questions selected to show underlying mathematical ability.
- The Alaska examination was developed to reflect the Alaska State Standards and includes a variety of response formats.
- The Alaska examination is given approximately six weeks earlier than the Anchorage examination.

This study examines the relationship of the two examinations given to grade 6 students in the spring of 2001 and the math grades earned by the same students in grade 7 during the 2001-2002 school year. All students who had examination scores and grades reported at the end of the first semester on Anchorage Report Cards are included.

Equipercentile equating was done to match the two tests. The cut scores established for the Anchorage Pre-Algebra test were applied based on the percentiles established for all students taking both tests. All analysis was completed using the Statistical Package for the Social Sciences for Windows version 11.0 (SPSS, 2001).

Primary Research Question

The primary research question is: To what extent do the Anchorage Pre-Algebra and Alaska State Benchmark Exam result in the same recommendations as to the placement of students.

The secondary research questions is: To what extent do the Anchorage Pre-Algebra and Alaska State Benchmark Exam correctly predict the actual placement and performance of students in their 7th grade mathematics courses.

Findings

Who were the students and how were they doing in mathematics at the end of the first semester of grade 7 mathematics?

All grade 7 students are assigned to some mathematics course. For the purposes of this study students were organized into three groups based on course numbers. Group 1 is mostly made up of students enrolled in Math 7 though some in pre-Math 7 level courses are included. Group 2 includes only students enrolled in Pre-Algebra. Group 3 is small and includes students enrolled in Algebra 1 and Geometry. About 1/3 of Anchorage students enroll in Pre-Algebra and are on track for Algebra 1 in grade 8.

Table 1
Grade 7 Math Enrollments
First Semester 2001-2002

Course Type		Students Enrolled	Percent Enrolled
Math 7 & Below		2,221	67%
Pre-Algebra		1,042	31%
Algebra 1 & Above		76	02%
Total		3,352	100%

Grades are complex indicators of performance that are used by teachers to both reflect some objective level of performance and to reward students for their effort. The selection of students for the various levels of courses and the differences in course content mean, of course, that students in the three groups are doing different levels of work to attain grades. While the content may be easier to master in Math 7, the Math 7 student may have to put in as much hard work to get an "A" grade as the gifted student in Algebra 1. In some schools, counselors report that they feel that students with grades of "D" or "F" should not be advanced to Algebra from Pre-Algebra as the low letter grades demonstrate that the student lacks sufficient mastery of the content to be successful in an even more difficult course.

Table 2
Grades Earned All Grade 7 Math Courses
First Semester 2001-2002

Grade	Number Combined	Percent Combined
A	772	23%
B	987	29%
C	706	21%
D	368	11%
F	281	08%

How do the Anchorage Pre-Algebra and the State Benchmark 2 tests relate to each other?

A commonly used statistical indicator of association is the correlation coefficient. This indicator relates the relative position of scores when ordered from highest to lowest. A strong correlation of .7 or better indicates a strong relationship. In the social sciences, a correlation of .3 or better is generally significant and considered to show a real relationship. In measurement, a correlation of .9 or better generally means that two tests are very strongly related.

The overall correlation of .81 found between the Anchorage Pre-Algebra test and State Benchmark 2 indicates that the tests produce highly similar scores but are not a perfect match. A .81 correlation between the two tests is made more substantial when you consider the differences in test format and the time of test administration.

The Anchorage Pre-Algebra and State Benchmark 2 Math tests organize student scores in almost the same order from high to low. This makes the two tests almost equivalent as instruments for making a recommendation about the placement of students based on their mathematics performance.

How do the Anchorage Pre-Algebra and State Benchmark 2 tests relate to the grades earned by students in grade 8?

Grades and scores on tests based on academic knowledge are generally not as strongly associated as scores on two similar tests. While tests are good measures of knowledge and the ability to perform tasks such as solving a specific problem, they are very different from grades. Grades are generally issued to students based on performance over time and include many elements beyond the knowledge and skill measured on paper and pencil tests. For example, teachers often take into account effort, homework completed, and class participation. A student who makes a substantial effort in class will often be rewarded with a grade that might not be expected from that student's test score. Correlations between grades and test scores are often in the .25 to .40 range. The more of a grade that is based on test-like performances, the higher the association.

For the purposes of this analysis, letter grades on Anchorage report cards were assigned points: "A" = 5, "B" = 4, "C" = 3, "D" = 2, and "F" = 1. No additional points were given to differentiate grades earned in honors or advanced placement classes. The average Grade Point across all 7th grade math courses was 3.26 or just a little above a "C."

The overall correlation between test scores on both the Anchorage Pre-Algebra test and the State of Alaska Benchmark 2 exam and GPA is .32. This reflects a moderate but statistically significant relationship.

Table 3
Correlation of Grade 6 Test Scores and Grade 7 Math Grades

Test	Correlation	Significance Greater Than
State Benchmark & ASD Pre-Algebra Test Correlation	.81	.01
Test and GPA Correlations		
ASD Pre-Algebra & GPA	.32	.01
State Benchmark Total & GPA	.32	.01
State Standard 1	.28	.01
State Standard 2	.28	.01
State Standard 3	.31	.01
State Standard 4	.31	.01
State Standard 5	.31	.01
State Standard 6	.32	.01
State Standard 7	.32	, 01

Those Alaska State Standards that deal with more advanced skills (Standards 3 through 7) are slightly more closely related to grade 7 performance than those standards that deal with number sense and arithmetic.

What is the pattern of student recommendations for placement that were derived from the Anchorage Pre-Algebra tests and would be derived from the Alaska Benchmark 2 exam?

The comparison of the classifications of the two exams is based on equating the Alaska Benchmark 2 exam with the Anchorage Pre-Algebra exam. After teachers set the cut score on the Anchorage exam, it was decided to report results in three rather than two categories to reflect the error found in any test. This assures that the students just above and just below the cut score were given careful consideration for inclusion in Pre-Algebra classes based on the recommendations of their teachers. Students are classified as Pre-Algebra, review, or Math 7.

The standard error of the State Benchmark exam score is smaller than that found for the Anchorage Pre-Algebra exam. If the cut score setting process were done with a group of Anchorage teachers setting a cut score on the Benchmark 2 exam, there would be fewer students in the review category. By projecting the existing Anchorage Pre-Algebra test cut scores onto the State Benchmark Exam, more students are included in the review category than would be if the State Benchmark Exam standard error were used.

There might also be some difference in student effort expected on the two tests. While the State of Alaska Benchmark 2 has no direct consequences for the 6th grade student, the Pre-Algebra test is known by the student to affect grade 7 math placements. The common experience with student tests is that there is a motivational effect when the student feels that the test scores will affect him. If the Benchmark 2 math test was sued for Pre-Algebra placement, one could safely assume a positive motivational effect that could raise overall Benchmark 2 math test performance for Anchorage.

Table 4
Grade 6 Pre-Algebra Recommendations
Anchorage Pre-Algebra Placement Test

Group	Number	Percent
Math 7	1,848	57%
Review	523	16%
Pre-Algebra	848	26%

Table 5
Projected Grade 6 Pre-Algebra Recommendations
State of Alaska Benchmark 2 Math Exam

Group	Number	Percent
Math 7	1,774	55%
Review	482	15%
Pre-Algebra	962	30%

Without a change in the cut scores, it appears that there would be a slight increase in the proportion of students recommended for Pre-Algebra if the State of Alaska Benchmark 2 math test were used rather than the Anchorage Pre-Algebra exam.

How do actual placements relate to the recommended placements?

When Pre-Algebra and Algebra+ placements are combined, accuracy on the State Benchmark 2 math test is 77%. Accuracy on the ASD Anchorage Pre-Algebra test is 69%. The similar figures for Math 7 placement are 82% for the State of Alaska test and 77% for the Anchorage Pre-Algebra test.

This high level of agreement between scores and actual placement is a strong recommendation for both of the tests and confirms of the utility of the Anchorage test even if the State Benchmark 2 exam has slightly better agreement between the test performance and the actual classification of students.

Table 6
Anchorage Pre-Algebra Placement Test
Actual vs. Test Recommended Placement

Recommended/Actual	Math 7	Pre-Algebra	Algebra +
Math 7	1,625	140	0
	77%	14%	00%
Review	297	184	1
	14%	18%	02%
Pre-Algebra	186	671	69
	09%	67%	98%
Total (100%)	2,108	995	70

Table 7
Alaska Benchmark 2 Math Test
Actual vs. Test Recommended Placement

Recommended/Actual	Math 7	Pre-Algebra	Algebra +
Math 7	1,723	113	0
	82%	11%	00%
Review	269	254	0
	13%	25%	00%
Pre-Algebra	117	654	76
	05%	64%	100%
Total (100%)	2,109	1,021	76

How do predicted placements relate to actual placements?

A statistical procedure, multiple discriminate analysis, allows the grouping of individuals based on a variable such as a test score to see how well the actual placement matched the placement that would be done if only the score had been used for placement. This analysis is slightly complicated by the fact that the Anchorage Pre-Algebra test was only used to consider placement in Math 7 or Pre-Algebra when some students went into Algebra I or Geometry. In most cases, students who were assigned to the more advanced classes had previously taken some advanced mathematics course work and possessed substantial math ability. These students are included as a separate group in the tables below though their test scores would have qualified them for Pre-Algebra.

Table 8
Accuracy of Predicted Placements
ASD Pre-Algebra Test Performance used to Predict Math Placements

Actual/Predicted	Math 7	Pre-Algebra	Algebra +
Math 7	1704	301	4
	85%	15%	.02%
Pre-Algebra	143	662	171
	15%	68%	18%
Algebra +	0	20	50
	00%	29%	71%

Table 9
Overall Accuracy of Predicted Placement
ASD Pre-Algebra Test and State Benchmark 2 Path Test

Test/Course Placement	Math 7	Pre-Algebra
Anchorage Pre-Algebra	72%	78%
State Benchmark 2 Math Test	71%	69%

The Anchorage Pre-Algebra test that was actually used as part of the assignment process only has a slight advantage over the State Benchmark 2 Math Test when used to predict the actual math class placement of students. This is a demonstration of the substantial equivalence of the two tests in their relationship to the math placement of students in 2001-2002.

How strong is the relationship between the State and Anchorage test scores and the grades that the students earn in the three levels of courses?

The general expectation here, based on the overall test to grade point average, is that the overall relationship would be about .28. A stronger relationship would suggest that grades have more to do with math performance and a weaker relationship would suggest that grades may have more to do with effort and class participation than math performance.

The differences displayed in Table 8 are notable and significant. The low weak relationship (.16 and .17) found between grades and test scores for Math 7 may be due in part to the inclusion of a few pre-Math 7 special education classes in the Math 7 group while almost no Special Education students are found in either the Pre-Algebra or Algebra 1+ groups.

Table 10
Correlation of Grade 6 Test Scores to Grade 7 First Semester Grades
Anchorage Grade 7 Math Courses

Test/Course	Math 7	Pre-Algebra	Algebra +
Anchorage Pre-Algebra	.16	.27	.34
State Benchmark 2 Math	.17	.24	.36

The correlations mask notable differences in average scores among of students who earn the various letter grades in the three levels of math classes. Table 9 shows the average scores on the Anchorage Pre-Algebra Test and on the State Benchmark 2 Math tests. The consistent pattern of scores supports the validity of the two tests as indicators of math outcomes for students. The differences in the average scores related to the three levels of classes are statistically significant in all cases for both tests.

Table 11
Average Scores by Course Type

Test/Course	Math 7	Pre-Algebra	Algebra+
ASD Pre-Algebra	17.1	28.0	34.3
N = 3,337	N = 2.109	N = 1.052	N = 76
State Benchmark	326	434	503
N = 3,273	N = 2.108	N = 995	N = 70

Table 12 further demonstrates the differences by looking at the actual letter grades earned by students and the associated average test scores on the ASD Pre-Algebra Test and the State of Alaska Benchmark 2 Math Test. The pattern of average scores related to letter grades for each type of course shows both the differences in performance levels of

students assigned to the classes and the differences between letter grades earned. While the letter grades are never the consequence of the test scores, it is clear that the association of grades and performance is strong and consistent.

Table 12
Average Performance
Anchorage Pre-Algebra Test and State Benchmark 2 Math Tests
Broken Down by Letter Grade in Three Levels of Math Courses

Grade	Course	Average Anchorage Test Score	Number Of Students	Average State Math Test Score	Number Of Students
A		25.3	751	409.1	727
	Math 7	19.7		354.6	
	Pre-Algebra	29.8		452.6	
	Algebra +	35.1		523.1	
B		21.7	959	373	941
	Math7	17.6		333.4	
	Pre-Algebra	28.0		435.0	
	Algebra +	33.7		523.1	
C		19.4	680	343.0	677
	Math 7	16.1		315.6	
	Pre-Algebra	26.2		414.8	
	Algebra +	32.4		477.0	
D		17.8	349	334.0	357
	Math 7	15.3		311.8	
	Pre-Algebra	26.3		410.2	
	Algebra +	37.0		418.0	
F		16.2	263	318.0	264
	Math 7	15.1		305.6	
	Pre-Algebra	24.1		402.2	
	Algebra +	33.0		491.0	

Conclusions

All Anchorage students take both the Anchorage Pre-Algebra Test and the State of Alaska Benchmark 2 Math exam in the spring of each year. The Anchorage Pre-Algebra exam was developed by Anchorage teachers to help select students for grade 7 Pre-Algebra. The State of Alaska Benchmark 2 Mathematics exam was developed to establish the extent to which Alaska students have met State benchmarks for mathematics performance at the end of grade 6.

The scores on the examinations are highly related with a correlation of greater than .8 even though the Anchorage exam consists of all multiple-choice questions while the Alaska Benchmark exam includes short answer and extended response questions.

Examination of the recommendations that might be made for student placement based on the two examinations following an Equipercentile equating process showed that the recommendations made based on the two examinations would be highly similar. The Anchorage Pre-Algebra Test resulted in the recommendation of 77% of the students for Pre-Algebra. A slightly higher percentage of students would have been recommended for Pre-Algebra (82%) using the State of Alaska Benchmark 2 Mathematics examination.

Examination of the accuracy of the prediction of placement based on test scores alone showed that the Anchorage Pre-Algebra exam that was actually used for placement of students was only slightly better in predicting actual placement than the State of Alaska Benchmark 2 Examination. The accuracy of predictions for placement for the Anchorage exam for Math 7 and for Pre-Algebra was 77% and 67% as opposed to predictions of 82% and 64% for the State of Alaska Benchmark 2 Math Exam.

The two examinations appear to be equivalent in their recommendations for placement and the predicted accuracy of placement of 2001-2002 students. Examination of the letter grades actually earned by students show that there is a moderate association of 6^{th} grade scores with letter grades for both examinations. However, the average scores on either exam consistently and significantly relate to the grades earned by students.

The evidence of similar recommendations, similar predicted placements, and similar patterns of grades earned relative to test scores all support the consequential validity of either examination when used as part of the process to select students for Pre-Algebra.

Recommendation

Since the two examinations appear to be highly related and substantially equal as tools for predicting the success of students in Pre-Algebra. it is suggested that the Pre-Algebra recommendation be based on the Alaska Benchmark 2 Mathematics examination. Use of the State examination for placement will do no harm to the recommendation process and will reduce the amount of testing required of grade 6 students.

The use of the State of Alaska Benchmark 2 Math test for Pre-Algebra placement has two other potential advantages. First, the use of the State test is recognition of the importance of Alaska State Standards and instruction that leads students to high levels of performance on the benchmark test as an indicator of mastery of the state standards. Second, the use of the test as part of the Pre-Algebra placement process has a potential to serve as a motivator for students who are interested in placement in Pre-Algebra who might not otherwise see a practical value in the State test.

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Author(s): Ray Fenton

Corporate Source: Anchorage School District

Publication Date: April 2004

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