Integrating Applied Mathematics and Vocational Education

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Abstract

This paper reports on a study a colleague and I conducted to ascertain the achievement level on selected algebra competencies by high school students who had completed a two-course sequence in Applied Mathematics and students who had completed a traditional beginning Algebra course.

A 36-item Algebra competency examination was administered to 167 students who completed two Applied Mathematics courses and 340 students who completed a traditional beginning Algebra course during the final two weeks of the 1996–1997 school year. The data were statistically analyzed using two-tailed t-tests.

A statistically significant difference between scores for the Applied Mathematics and beginning Algebra groups was revealed by statistical analysis of the mean percentile scores obtained on an Algebra competency examination. The mean percentile score for students completing the Applied Mathematics courses was statistically significantly higher than the mean percentile score of students completing a traditional beginning Algebra course.
Introduction

Historically, the emphasis of vocational education was placed on students' acquiring occupational skills to master jobs in the workplace. Vocational courses, as a consequence, placed little emphasis on learning the disciplines of science, mathematics, and English, except as those disciplines related to specific occupational pursuits.

As society has become technologically complex, information and information processing have taken on greatly increased importance for workers. In turn, this brings new challenges to educators. Levels of learning formerly acquired by only a few students are now deemed necessary for all students to enable them to function effectively on the job and in society.

Central to the issue of educational achievement is the recognition that the traditional education system in general is weighted heavily in favor of abstract learners (Hull & Parnell, 1991). The abstract learner is able to receive and process information in conceptual form within the mind and without reference to physical surroundings. Reading, lectures, individual homework, and other traditional educational methods appeal to the abstract learner. Abstract learners may perform well in the traditional four-year college setting. Until recently, high schools had two major curriculum paths: abstract learners took academic, college preparation courses, and non-abstract or concrete learners took non-academic courses which often had low standards. The two curricula were mutually exclusive. The latter system locked an entire population of concrete learners into only vocational opportunities and denied this population access to higher education.

Consequently, major concepts underlying mathematics skills which are necessary for the traditional college degree and also for highly skilled technical training were lacking in a whole generation of vocational-technical students. Algebra skills are a necessary foundation for becoming a technician. Reese, Miller, Mazzeo and Dossey (1997) stated that, "a nation's mathematical expertise represents a critical filter for the future success of its economic, technological, and scientific growth" (p. 17).

Statement of the Research Problem

A major goal of the applied mathematics courses of the Tech Prep curriculum is to provide completers of the two-year sequence with quantitative skills equivalent to students completing a traditional beginning Algebra course. There is a paucity of information related to the attainment of selected algebra competencies of students completing the applied mathematics courses as compared with students completing a traditional Algebra course. The lack of information related to the attainment of beginning Algebra competencies by students completing the applied mathematics courses and those completing the traditional algebra course provided the focal point for this study.

Purpose of the Study
The purpose of this study was to ascertain the achievement level on selected algebra competencies by high school students who had experienced two different curricular approaches to the study of mathematics. Specifically, the study was designed to answer the following research questions:

**Research Questions**

1. What is the level of achievement related to selected algebra competencies of students who completed the applied mathematics sequence?
2. What is the level of achievement related to selected algebra competencies of students who completed a traditional beginning Algebra course?
3. To what extent are there statistically significant differences in test scores of students who have completed the applied mathematics courses and test scores of students who have completed the traditional Algebra course on an Algebra competency examination?

**Statement of Hypothesis**

\[ H_0: \text{There is no statistically significant difference between mean scores for students who have completed the applied mathematics sequence and those who have completed a traditional beginning Algebra course as measured by the CORD Algebra Exit Exam.} \]

**Significance**

The results of this study may be utilized by State Departments of Education personnel to ascertain the mathematics courses required for high school graduation. For example, the results of this study may provide evidence of the effectiveness of the Applied Mathematics courses to present selected algebraic concepts to students who do not complete a traditional Algebra course.

In addition, results of this study could be utilized to encourage vocational education students to enroll in higher level mathematics courses, such as the second Algebra course, geometry, trigonometry, and calculus, during their high school careers.

**Methods and Procedures**

**Sources of Data**

The population for this study was 507 high school students who were in grades 9 through 12 and who were enrolled in the second Applied Mathematics course or a traditional beginning Algebra course in six high schools in East-Central Alabama during the 1996-1997 school year. Three hundred and forty of the subjects were enrolled in a traditional beginning Algebra course and 167 students were enrolled...
in the second Applied Mathematics course. Four schools were in a rural system and two were in a city system.

The Applied Mathematics students were described by guidance counselors and applied mathematics teachers at their respective schools as predominantly noncollege-bound students with low to medium grade-point-averages. The majority of the students were vocational education students who had been encouraged to enroll in the Applied Mathematics courses because of their enrollment in vocational education programs and their poor performance in academic courses.

**Instrumentation**

A 36-item Algebra competency examination developed by the Center for Occupational Research and Development (CORD, 1993) was the assessment instrument used in this study to measure the level of achievement related to selected algebra competencies of students who had completed the two-course sequence in Applied Mathematics or a traditional beginning Algebra course. Users of the Applied Mathematics courses questioned whether a student who had completed Applied Mathematics with a satisfactory grade could move into the second Algebra course without an inadequate mathematics background. The Algebra Exit Exam consists of a mixture of typical textbook drill problems and real-world word problems similar to items on the University of Chicago School Mathematics Project (UCSMP) Algebra Test.

Content and face validity for the Algebra Exit Exam were established by classroom teachers of mathematics and mathematics consultants under the auspices of CORD. The Guttman Split-Half reliability coefficient computed for this study was .80 (Shavelson, 1988).

The Stanford Achievement Test (SAT), 1997, mathematics subtest scores were used to determine homogeneity of variance between the Applied Mathematics and Algebra groups. The Kuder-Richardson Formula #20 Reliability Coefficient was reported as .94 for the SAT mathematics subtest. The percentile scores obtained on the mathematics subtest of the SAT were used in this study.

**Data Collection**

Prior to administration of the Algebra Exit Exam, the researcher conducted a test administration training session with the participating teachers of the Applied Mathematics and Algebra courses at each high school participating in this study. The Algebra Exit Exam was administered and proctored by the mathematics teacher of each respective course to all participating students enrolled in Applied Mathematics or Algebra courses in the six schools. The Algebra Exit Exam was administered during one 55-minute class period. Students’ responses were recorded on a commercial Scantron answer sheet.

The researcher obtained SAT mathematics subtest scores from individual permanent records of participating students. The SAT mathematics subtest raw scores and percentage scores were recorded
Data Analysis Procedures

A t-test comparing the mean percentile ranking on the SAT mathematics subtest for the Applied Mathematics group and the Algebra group was performed to determine the validity of the assumption of homogeneity of variance related to mathematics ability between the groups.

A t-test comparing the mean percentile rankings on the Algebra Exit Exam of students who completed the Applied Mathematics courses or a traditional beginning Algebra course was conducted to ascertain whether the researcher would reject or fail to reject the null hypothesis. Data for this ex post facto study were analyzed using the Statistical Program for the Social Sciences (SPSS).

Results

The t-test comparison of mean percentile ranking on the SAT mathematics subtest for the Applied Mathematics students and the Algebra students indicated that there was no statistically significant difference between the two groups.

The Algebra students' mean percentile ranking was 55.4 and the standard deviation was 19.40 on the SAT mathematics subtest. The Applied Mathematics students' mean percentile ranking was 52.15 and the standard deviation was 20.59 on the SAT mathematics subtest. Computation of a two-tailed t-test with 505 degrees of freedom indicated the difference between the two groups was not statistically significant at the .05 level.

Based on results of a t-test comparing the mean percentile ranking on the Algebra Exit Exam for the Applied Mathematics group and the traditional Algebra group, the null hypothesis was rejected. The Applied Mathematics students obtained a mean percentile ranking of 46.07 on the Algebra Exit Exam. The Algebra students' mean percentile ranking on the Algebra Exit Exam was 41.20. The mean difference was 4.87 points. The performance of a two-tailed t-test with 505 degrees of freedom indicated that the difference was statistically significant at the .001 level.
Conclusions

Based on the results of this study, the following conclusions may be drawn. Since there was no pre-existing statistically significant difference in mathematics achievement between students enrolled in Applied Mathematics courses and students enrolled in a traditional Algebra course as measured by the students' mean percentile ranking on the SAT mathematics subtest, it may be concluded that the Applied Mathematics course could provide vocational education students or contextual learners with a mathematical foundation of selected algebra competencies. Further, such competencies could encourage the enrollment of vocational education students, as well as other students, in higher-level mathematics courses such as the second Algebra course, trigonometry, pre-calculus, and calculus. However, based on results of this study, one could not predict performance or success of these students in advanced mathematics courses. Moreover, based on the results of this study, it may be concluded that students' anxiety associated with mathematics could be alleviated or reduced with an applied curriculum. Finally, increased algebra competency attainment provided by an applied mathematics curriculum may help to increase the Alabama high school graduation rate.

Recommendations

The following recommendations are based on the results of this study. There is evidence that applied mathematics courses warrant consideration for implementation by school districts which desire to provide an alternative mathematics curriculum to students who need and want a technical education with higher-level algebra competencies.

It is recommended that further research be conducted to investigate other variables such as gender, learning styles, and overall grade point average, that may affect students’ attainment of algebra competencies. Such variables as these and others could be tested for possible interaction.

In addition, investigations of the kinds of skills students have acquired and areas which need to be improved may be useful for program planning, course selection, and predictions of performance. Also, future studies could include test item analysis of specific competencies identified in the Algebra Exit Exam.

Investigations of alternative curricula related to students’ attainment of algebra competencies warrants further research. For example, other studies could focus on student outcomes upon completion of other commercially-prepared applied mathematics curricula and teacher-developed curricula. Studies which address teaching methods and student learning styles in an applied curriculum setting could contribute to the research knowledge base for the attainment of algebra competencies. Finally, studies to ascertain the extent to which applied mathematics students are successful if they continue their study of mathematics in traditional mathematics courses may be helpful in program planning for individual students.
References


Table 1
Mean Percentile Ranking for the Applied Mathematics and the Algebra Groups (N = 507).

<table>
<thead>
<tr>
<th>Mathematics Course Enrollment</th>
<th>N</th>
<th>Mean Percentile Ranking on 1993 Algebra Exit Exam</th>
<th>Standard Deviation</th>
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<tbody>
<tr>
<td>Applied Mathematics</td>
<td>167</td>
<td>46.07</td>
<td>16.30</td>
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<tr>
<td>Algebra</td>
<td>340</td>
<td>41.20</td>
<td>14.10</td>
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