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ABSTRACT

A study was conducted at the Community College of Allegheny County, in Pennsylvania, to compared the level of preparedness in an intermediate algebra course for students who placed directly into the course and those who had tested into and completed a basic algebra course. Placement test scores, algebra course grades, and repeat status were determined for the 390 students enrolled in 19 sections of the intermediate algebra course in spring 1993, resulting in a final sample of 248 students who were not repeating and who passed the course. The sample consisted of 35 non-developmental students (i.e., those who had tested directly into the course) and 213 developmental students (i.e., those who completed the basic algebra course). Twelve of the non-developmental students received an "A" in the course, compared to 34 students from the developmental group. Similarly, grade point averages (GPA's) calculated for the groups based on course outcomes indicated that the developmental group had a GPA of 2.183, with a standard deviation of 1.242, while the non-developmental group had a GPA of 2.571, with a standard deviation of 1.481. The z-test used to test the research hypothesis indicated that no significant differences existed between outcomes for the two groups. The study concluded that the developmental students showed no advantage over other students and that the college's mathematics placement test was properly screening students based on algebra skills. (KP)

COMPARISON OF THE GRADE POINT AVERAGE IN INTERMEDIATE ALGEBRA OF DEVELOPMENTAL AND NONDEVELOPMENTAL STUDENTS

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A practicum report presented to Programs for Higher Education in partial fulfillment of the requirements for the degree of Doctor of Education

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All students at the Community College of Allegheny County are required to take the Mathematics Placement Test, and to complete any developmental courses before enrolling in college level mathematics courses. The purpose of this study was to determine if the students taking the developmental algebra course were as adequately prepared for Intermediate Algebra as students identified by testing as having sufficient background. The basic research hypothesis was that there is no difference in the grade point average of the developmental students and the nondevelopmental students in Intermediate Algebra. The research

methodology used was an inferential study. Necessary information was obtained from the college database for the Spring 1993 term to calculate the grade point average of both groups. The z-test was used to test the research hypothesis at the 0.05 level of significance. The grade point average of the developmental group was 2.183 with a standard deviation of 1.242 and the nondevelopmental group had a grade point average of 2.571 with a standard deviation of 1.481. This provided a z value of 1.468.

The results of the study showed no statistical difference between the grade point average of the two groups. The conclusion of the study was that the developmental algebra was effective at correcting academic deficiencies in algebra. Recommendations were made to continue testing all students, to directly communicate the results of the study to the students affected, and to research the reasons many students who enroll do not complete the course.

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Chapter 1

INTRODUCTION

Background

Students enrolling at the Community College of Allegheny County are required to take developmental courses indicated by the Placement Tests. These tests determine placement in either Fundamentals of Algebra, MAT090, or Intermediate Algebra, MAT108. The course descriptions of both courses can be found in Appendix A. The MAT090 course provides the skills usually learned in the first year of high school algebra. This course leads into MAT108 which is considered a college level course.

The course Intermediate Algebra, MAT108, contains two groups of students. The first group was placed in the developmental mathematics course Fundamentals of Algebra, MAT090, by a placement Test. These developmental students have completed MAT090 with a minimum grade of C. The second group of students (nondevelopmental) are those admitted to MAT108 by scoring higher than 17 on Part Two of the Mathematics Placement Test.

Purpose of the Study

The purpose of this study was to determine if the

students taking the developmental algebra course are as adequately prepared for Intermediate Algebra as those students identified by testing as having sufficient background.

Significance to the Institution

The Community College of Allegheny County is in a period of self-study in preparation for Middle States re-accreditation. This is resulting in a renewed interest in program effectiveness. This study will provide information on how well developmental students are succeeding in college level algebra in relation to non-developmental students. The Dean of Instruction stated that there are 30 sections of MAT090 offered each term representing a large resource commitment to developmental education. The results of this study will be helpful in student advisement to demonstrate the importance of the developmental course. The results will also be useful in demonstrating the importance of the resources invested in developmental mathematics education. Since students at CCAC are required to complete developmental courses specified by the Placement Tests, evidence is needed that taking these non-degree courses is worth the cost in both time and money to these students.

Relationship to the Applied Educational Research and Evaluation Seminar

The seminar Applied Educational Research and Evaluation presented several techniques in statistical analysis and interpretation. These techniques are structured to assist in making sound decisions based on numerical measures of success, or failure, of a particular topic. This study used the calculation of the two-tailed z-test presented in the seminar to test the null hypothesis at the 0.05 level of significance.

Research Question

The research question is, "Do students with C or better in MAT090 have comparable success in MAT108 as students entering the course directly from the Placement Test?"

Research Hypothesis

The research hypothesis is that from the departmental perspective students completing MAT090, Fundamentals of Algebra, have comparable success in MAT108, Intermediate Algebra, as those students allowed entry to MAT108 based on the Mathematics Placement Test. Student success is defined as a course grade of A, B, or C.

Chapter 2

REVIEW OF LITERATURE

Need for Placement Testing

"More and more students will be enrolling in community colleges in need of increased and better support and structure than ever before..." (Roueche & Roueche, 1994, p. 6). Part of that better support and structure should be mandatory testing and placement in basic skills courses. As part of this effort the student outcomes must be evaluated regularly and the results disseminated (Roueche & Roueche, 1994).

The Middle States publication Characteristics of Excellence in Higher Education calls for courses leading to degrees to be organized in an increasingly complex manner (1982). The Community College of Allegheny County tries to establish this sequence through both placement testing and prerequisites. In Assessing Institutional Effectiveness in Community Colleges, Doucette and Hughes (1990) propose several questions to assess the effectiveness of the community college in meeting the developmental education goals. Two questions are relevant to this study. First, are students progressing and succeeding at the next level of education? Second, are students from different

subgroups succeeding at the next level of education? Roueche and Baker (1987) also raise two questions regarding placement testing related to overall outcomes. These questions relate to both the accuracy and effectiveness of the testing and to the perception of these tests by the students and faculty. The first of these concerns is similar to that posed by Doucette and Hughes. The question of faculty and student perception has received no study at CCAC.

Outcome measures of Success

Astin (1991) states that "... the basic purpose of assessing students is to enhance their educational development" (p. 4). The most common form of assessment is the course grade. However, the course grade is not always used to enhance educational development but rather to rate or screen students. The practice of grading on a curve does not allow the grade to necessarily reflect the value added by the instructional process. The course grade is often an indication of the student's performance on a series of test instruments in relation to other students. The selection of an outcome measure is influenced by the perception of who is doing the assessment. Astin (1991) defines several perspectives such as

departmental, disciplinary, professional, employer, state, student and societal. Each perspective would require different outcome measures. From the perspective of the mathematics department, the course grade can be considered an outcome measure (Astin, 1991). If students receive a grade of A, B, or C, they would be judged successful. Astin (1991) further argues that from a societal prospective, all students should be allowed to develop their talents to the maximum, to achieve this development, the students must be correctly placed in a course in which they can be successful.

Success of Developmental Students

Assessment of the success of developmental students has taken place at several schools. In a study of Colorado community college students, the success rate was found to be significantly high for those students taking the developmental courses suggested by placement testing (Richards, 1986).

At a Maryland Community college a study of 27 entering students showed that developmental students had significantly higher quality point averages than the nondevelopmental students in finite mathematics. The test used for placement was the Stanford Diagnostic

Mathematics Test (Kraska, Nadelman, Maner, & McCormick, 1990).

Miami Dade Community College reports that developmental students are more likely to dropout of college than those who take no developmental courses. Comparison of these developmental students on a state mandated exit exam showed that students who took developmental courses did not do as well as non developmental students on an exit exam. The weak areas appear to remain weak (Roueche & Baker, 1987).

Local Studies

At CCAC the algebra sequence is Fundamentals of Algebra, MAT090, followed by Intermediate Algebra, MAT108. A Mathematics Placement Test is used to determine the initial algebra course in which the student may enroll. Little study has been done at CCAC on the success of students following their initial placement in mathematics. A study has been done that examines the effectiveness of adding computer aided instruction to MAT090 and MAT108. This study showed that students using the computer in MAT108 showed no significant differences in success rate (A, B, C versus D, W, F) over those not using the computer. However,

the dropout rate was lower in those classes using the computer (Bluman, 1991).

Summary

These studies would suggest that students placed in developmental courses by placement testing will achieve success as measured by letter grades equal to or higher than the nondevelopmental students. However, even though these students achieve acceptable course grades, they may still have weakness not shared by the nondevelopmental students.

This practicum addresses the questions posed by Doucette and Hughes relating to progress through increasing levels of education. The measure of success in this study is taken from the departmental perspective of acceptable grade levels. It is proposed that this information will provide useful outcomes in the assessment of the developmental mathematics program.

Chapter 3

METHODOLOGY AND PROCEDURES

The research methodology used in the study is an inferential study. The null hypothesis was tested with the z-test at the 0.05 level of significance.

Data Collection

To select a group of students for the study the Spring 1993 semester enrollment was selected. This was the most recent regular semester available for study. The assumption was made that this group reasonably represents the student body of South Campus. No sampling was done since the total number of students was deemed manageable. Copies of the grades submitted for the spring term were provided by the Dean of Instruction. The additional data necessary for this study was available within the student database of the college central computer system. Permission to acquire this information for research purposes was granted by the Dean of Instruction with the stipulation that student identity be protected.

Information Gathering Process

The information gathering process began by obtaining copies of the final grades issued in MAT108 in the Spring of 1993 from the Dean of Instruction.

Also an account and password for access to the college database was obtained from the registrar's office.

The information collected from the college database was:

1. Social Security Number
2. Score on Part Two of the Placement Test
3. MAT090 grade
4. MAT108 grade
5. Repeat Status

Item two, the score on Part Two of the Mathematics Placement Test, was not available for each student. In some cases, only the resulting course placement was listed. Since the study depended on the course placement and not the exact score, the database was modified to accept the course placement. The Social Security number was used to obtain the information above from the college computer system. To access the information, two commands were used on the student database. The command TSTINQ followed by the social security number provided a computer screen containing the test score results and the recommended course placement. The command TSCINQ followed by the social security number provided a semester-by-semester display of the student transcript. From these screens it was

possible to determine the MAT090 grade and the number of attempts at the MAT108 course. These commands were used to obtain the needed information for each of the 390 students. Once the information was assembled from the college computer system, it was entered into the Microsoft Access database program. A sample input screen is shown in Appendix B. The Access program allowed easy checking and grouping of the data.

Sample Selection

Grade Distribution

The student grades in MAT108 used in this study are A, B, C, D, and F. These letter grades were assigned to a numerical scale based on A=4, B=3, C=2, D=1, and F=0. There are four other recorded grades possible. The N grade indicates the student never attended the course. The I grade indicates the student is still working on the course. The W grade indicates the student withdrew after the third week and before the tenth week of the semester. The P grade indicates the student was graded on a pass/fail basis.

Study Groups

Since they have neither succeeded or failed at the course, the N, I, and W grades were excluded from this study. Since the P grade does not allow continuation

to additional math courses, these students were also excluded.

The intent of this study was to gauge the success of first time attempts at MAT108. Some students were repeating the MAT108 course and were also excluded from the study. This was done to reduce any repeat learning factors from the results. Additionally, some students were found not to meet the stated prerequisites and were also excluded from the study groups. The remaining students were divided into two groups. Group one, the non-developmental students, consisted of those students gaining entrance to MAT108 by achieving an acceptable score on the CCAC Mathematics Placement Test. Group Two, the developmental students, consisted of those students with a C or better in the developmental course MAT090.

Data Analysis

Based on the numerical scale, the grade point average, GPA, of the two groups, developmental and non-developmental, was computed. The variance and standard deviation of each average was also calculated.

The two-tailed z-test was selected as the appropriate measure. This selection was made for two reasons. First the degrees of freedom was larger than

30, and second, the z test is appropriate for independent samples as represented by the two groups (Barton, 1989).

Null Hypothesis

There is no difference in the grade point average in MAT108 of developmental and non-developmental students.

Ho: X1 = X2

Alternate Hypothesis

There is a significant difference in the grade point average in MAT108 of developmental and non-developmental students.

Ha: X1 = X2

Level of Significance

The level of significance selected will influence the amount of tolerable error. For this study the 0.05 level of significance was selected as an appropriate amount.

Region of Rejection

The two tailed z-test was selected to test if the two grade point averages were different. This required two critical z values. For the two means to be significantly different at the 0.05 level of significance, the z value must exceed 1.96 in

magnitude. The null hypothesis is rejected if the z value calculated exceeds the critical z of -1.96 or +1.96. The region of rejection is, therefore, the regions of the normal curve having a z greater than 1.96 or less than -1.96.

Statistical Test

The z value was calculated using the formula

$$z = \frac{X1 - X2}{\sqrt{\frac{S1^2}{n1} + \frac{S2^2}{n2}}}$$

The variables X1 and X2 represent the grade point averages of each group. $S1^2$ and $S2^2$ are the variances of those averages, and n1 and n2 represent the sample size of each group (Barton, 1987:61). The calculated z was used to test the null hypothesis.

Definition of Terms

The following terms have specific definitions as used in this study:

1. Developmental Student is a term used to describe a student diagnosed by the college Mathematics Placement Test as needing additional academic skills to succeed in freshman level college algebra courses.
2. Nondevelopmental Student is a term used to describe a student achieving a sufficient score on the

Mathematics Placement Test to gain entry to college level algebra courses.

Assumptions

The students enter the course MAT108 by satisfying either Placement Testing or course prerequisites. The students in the MAT108 course during Spring 1993 are representative of the students taking the course in any semester at South Campus.

Limitations of the Study

Students drop the course for many reasons unrelated to academics, such as changes in work schedules, conflicts with the instructor, or illness. In the total sample, 34 students satisfied the prerequisites but withdrew from the course. The effect of these withdrawals on the unsuccessful group was unknown. A second factor limiting the study would be any effect from a time lag between taking the test and taking the courses. Time lags of up to three years were observed in the sample.

The external validity of the study relates to the generalizability of the study. Since the Spring 1993 term was in no way different from any other term, the results should apply to all South Campus students. Also, since the Mathematics Placement Test is the same

at all campuses of CCAC, and the courses MAT090 and MAT108 are common to all campuses, the results should be generalizable to all CCAC students. However, because of the specifics of the Mathematics Placement Test, the results should not be generalized beyond CCAC.

Chapter 4

RESULTS

Group Selection

The total enrollment of the course MAT108 in the Spring 1993 term was selected as the study population. This group consisted of 390 students in 19 sections. Once all the information for these students had been collected as outlined in Chapter Three, the students were sorted into three groups. In Table 1 the number of students in each group is shown. These groups are

Table 1

Grouping of Students in MAT108

	Number in Group
1. Group One (non-developmental)	35
2. Group Two (developmental)	213
3. Excluded Students	142
4. Total in MAT108	390

sorted based on the study procedures discussed in Chapter Three. Group One consisted of those students who were placed in the MAT108 course based on the Mathematics Placement Test score. These students are referred to as the non-developmental students. This was the smaller group consisting of 35 students. Group Two, the developmental students, was made up of those students who had completed the developmental algebra course, MAT090, with a C or better grade. This group was the largest with 213 students. The third group of students was excluded from the study. They were excluded for one or more of the following reasons; (a) the grade received in MAT108 was a P, I, W, or N; (b) they were repeating the course MAT108; (c) they did not meet the prerequisites for MAT108.

Grade Distribution in Groups

Groups One and Two were further sorted based on the grade earned in MAT108. This grade distribution is displayed in Table 2. In Group One 12 students received an A grade, and 11 students received a B grade. Three students received a C, and another three received a D grade. In Group One six students received an F grade. In Group Two there were 34 A grades. The grade of B and C was received by 56 students. A grade

of D was received by 38 students, and 29 students failed the course. These groups, Group One consisting of the non-developmental students, and Group Two, consisting of the developmental students, were the groups compared in this study.

Table 2

Grade Distribution of Developmental and Non-Developmental Students in MAT108

Grade	Group 1	Group 2
A	12	34
B	11	56
C	3	56
D	3	38
F	6	29

Calculations

To provide a group measure of the success of these two groups the grade point average, or GPA, and the standard deviation was calculated based on the 4.0 system presented in Chapter Three. The calculations were done by a spreadsheet program and the results are shown in Table 3. For Group One the GPA was 2.571 with

a standard deviation of 1.481. While Group Two had a GPA of 2.183 and a standard deviation of 1.242. The

Table 3

Group Grade Point Average and Related Measures

	Number n	Grade Point Average	Variance S^2	Standard Deviation S
1. Group One	35	2.571	2.193	1.481
2. Group Two	213	2.183	1.543	1.242

GPA of each group was different. To determine if this difference was significant, a statistical test was performed. The two-tailed z test was selected. The degrees of freedom for this test were calculated from the equation

$$df = n1 + n2 - 2 \qquad \text{(Barton, 1987:60)}$$

$$df = 35 + 213 - 2 = 246.$$

Since this exceeded 30, the z-test is an appropriate test.

The z value was calculated based on the formula in Chapter Three. The resulting value was $z = 1.468$. Since the calculated value of z for this study was between the critical z values of $-1.96 < z < 1.96$, the null hypothesis was not rejected. Therefore, there is no significant difference between the grade point average of developmental students and non-developmental students in MAT108.

Chapter 5

DISCUSSION, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Disscussion

The assessment of the college developmental education program depends on the students progressing successfully from one level of education to another (Doucette and Hughes, 1990). The results of this study support the statement that developmental courses in basic algebra adequately prepare students for college level courses. The two groups of students studied performed equally in the same course. The developmental students were at no disadvantage in their college level work. Previous studies suggested that students taking the developmental course had a high rate of success (Richards, 1986) (Kraska et al., 1990). In this study developmental students showed no advantage over the other students. However, by college policy, course enrollment is not freely open. Students must satisfy prerequisites. Those students who did not satisfy the prerequisites were excluded from this study. This group represented about a third of the starting group. This process may have reduced any differences from those factors.

Conclusions

The Mathematics Placement Test is properly screening students into MAT090 and MAT108 based on algebra skills. Further, those students who were placed in MAT090 and successfully completed the course with a C or better are doing as well as the students entering the college with more preparation. In other words, the MAT090 course has served to remediate their academic deficiency in algebra. Unfortunately, in the screening process many students, developmental and nondevelopmental, are not successfully completing MAT108.

Implications

The Community College of Allegheny County schedules large numbers of developmental sections each term and expends resources to test every student prior to enrollment in any mathematics course. The results of this study support the value of that effort. Since the developmental students do as well in MAT108 as the non-developmental students, the time and expense is justified. In these times of increased accountability for program requirements, measurable outcomes of the success of those requirements assists the

administration in justifying and providing the needed resources.

Accordingly, the large number of dropout students from MAT108 would suggest that MAT108 does not meet the needs of everyone. This study says nothing about the reasons students do not successfully complete the MAT108 course. When students are no longer in the course, it is difficult, as Astin proposes, to enhance their development. Further research is needed to learn the reasons that students do not complete the course. Because of the large number of these students, it is worthwhile identifying the reasons the course is not meeting their needs. The college should determine what can be done to improve the success ratio.

Roueche and Roueche (1994) recommend that communication of the results of outcomes measures be disseminated to students and faculty. At CCAC each student must complete the Mathematics Placement Test and speak to an advisor prior to registration in their first mathematics course. The advisor should use this opportunity to inform the students of the implications of these outcome measures to their success.

Recommendations

The implications of this study suggest that the developmental algebra course (MAT090) does remediate academic deficiencies identified by the placement test. The college is acting responsibly when it allocates sizeable resources to this developmental process.

Recommendation 1. The college, through the enrollment and advisement process, continue to test every student for mathematics placement.

Recommendation 2. The Director of Learning Assistance, who is charged with the administration of the placement testing program, should develop a small pamphlet for use by the advisors encouraging students to complete their developmental mathematics course and explaining the implications of this project. When the results of their tests are presented to them, this pamphlet could be given to the students. Additionally, copies should be given to the faculty of the developmental courses for their use in class.

Recommendation 3. The Director of Institutional Research, in cooperation with the Department of Mathematics, should develop a research questionnaire to examine the root causes students do not complete the MAT108 course.

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APPENDIXES

Appendix A

Course Descriptions

MAT090 Algebra Fundamentals (4 credits)

Prerequisite: MAT080 or Placement Test

A course in the fundamentals of algebra. Included are such topics as the real number system; operations on polynomial expressions containing variables; word problems; special products and factoring; solution sets of equations and inequalities in one variable. Included also may be radical expressions involving square roots and an introduction to the rectangular coordinate system.

MAT108 Intermediate Algebra (4 credits)

Prerequisite: MAT090 or Placement Test

A course in Intermediate Algebra. Included are such topics as operations with linear, quadratic, rational, absolute value and higher degree polynomial equations and functions; exponents, radicals and complex numbers; Cartesian coordinate system including lines and conic sections; systems of equations.

Appendix B

Access Database Input Screen