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ABSTRACT

A study was conducted at California's Orange Coast College (OCC) to determine if students who completed college algebra at OCC or at another college prior to enrolling in the college's calculus for business, management, and social sciences (CBMSS) course performed significantly better than students who had not previously completed college algebra. Questionnaires were distributed to all 131 students taking one of six CBMSS course sections in fall 1996, determining that 70 had completed college algebra and 61 had not. Final semester grades were obtained and compared for the students, while students receiving withdrawal or audit grades were not included in the comparison. The study found that the students who had completed college algebra performed significantly better than those who did not. When students' course grades were converted to the standard 4-point system, students who completed algebra received a mean grade of 3.014, compared to 2.541 for students who did not. It was recommended that college algebra be established as a prerequisite for CBMSS and that the results of the study be disseminated to the members of the administrative personnel and the OCC Curriculum Committee. Contains 31 references. Appendixes provide the CBMSS course outline and the student questionnaire. (HAA)

COMPARISON OF THE FINAL GRADES OF STUDENTS IN CALCULUS FOR BUSINESS, MANAGEMENT, AND SOCIAL SCIENCES WITH AND WITHOUT A PRIOR COLLEGE ALGEBRA COURSE

Research Methodology

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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

Nova Southeastern University

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by

E. J. Arismendi-Pardi

March, 1997

The problem under investigation was students who enrolled in Calculus for Business, Management, and Social Sciences (BMSS) after completing Intermediate Algebra were earning poorer grades than those students who enrolled after completing College Algebra at Orange Coast College (OCC) or at another college. The purpose of this study was to determine if students who complete College Algebra at OCC or at another college prior to enrolling in Calculus for BMSS perform significantly better in Calculus for BMSS than those students who did not complete College Algebra prior to enrolling in Calculus for BMSS.

There was one research question for this study: "Do students who complete College Algebra at OCC or at another college prior to enrolling in Calculus for BMSS perform significantly better in Calculus for BMSS than those students who do not complete College Algebra prior to enrolling in Calculus for BMSS?" The procedures used to answer the research question included: A review of the literature on prerequisites in general and mathematics

prerequisites for success in calculus in particular. Students were selected from all sections of Calculus for BMSS during the Fall 1996 semester and placed into two groups. Those students who completed College Algebra at OCC or at another college were placed in group A; those students who did not complete College Algebra were placed in group B. The final semester grades were obtained, and the letter grade earned by each student was converted to the standard 4-point number system. A one-tail t-test of hypothesis at an $\alpha = 0.01$ level was used to reject the null hypothesis since the calculated t-value of 3.200 exceeded the critical t-value of 2.326. The results demonstrated that students who completed College Algebra at OCC or at another college performed significantly better than those students who did not complete College Algebra.

It was concluded that there was a statistical significant difference in the performance of Calculus for BMSS between students who completed College Algebra at OCC or at another college and those students who did not complete College Algebra. It was recommended that College Algebra should be established as a prerequisite for Calculus for BMSS. It was further recommended that the results of the study be disseminated to the members of the administrative personnel, and to the Curriculum Committee in order to take the appropriate steps to establish College Algebra as a mandatory prerequisite for Calculus for BMSS.

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Chapter 1

INTRODUCTION

Orange Coast College is a public 2-year institution offering the Associate in Arts (A.A.) degree, certificates of completion, vocational education programs, community services, and college transfer programs for students whose majors require four or more years of college education. Orange Coast College (OCC) is one of three colleges in the Coast Community College District and was founded in 1947. The college is known as Southern California's leading transfer institution (Orange Coast College, 1996, p. 3).

Nature of the Problem

According to the Dean of the Division of Mathematics and Sciences at OCC, professors of Calculus for Business, Management, and Social Sciences (BMSS) are concerned that students who enroll in the Calculus for BMSS course after completing Intermediate Algebra are earning poorer grades than those students who enroll after completing a College Algebra course at OCC or at another college (S. N. Johnson, personal communication, December 2, 1996). The Chair of the Mathematics Department states that the concern of the faculty is that students are not prepared to meet the rigorous mathematical content of Calculus for BMSS (B. C. Denton, personal communication, January 22, 1997). The course outline describing the topics and contents of Calculus for BMSS is included in Appendix A.

Intermediate Algebra is the only prerequisite at present for Calculus for BMSS, whereas, College Algebra is not currently a prerequisite for the Calculus for BMSS course. Since College

Algebra is only recommended as a preparation for Calculus for BMSS, many students opt not to enroll in College Algebra prior to enrolling in Calculus for BMSS (S. N. Johnson, personal communication, December 2, 1996). The majority of the professors of mathematics at OCC have requested that a mandatory prerequisite of College Algebra be placed on the Calculus for BMSS course (S. N. Johnson, personal communication, January 23, 1997). This would change the prerequisite for Calculus for BMSS from Intermediate Algebra to College Algebra. According to the Dean of Academic Counseling at OCC, many students have indicated that they do not wish to enroll in the College Algebra course as an additional prerequisite to the Calculus for BMSS course (D. R. Low, personal communication, January 31, 1997). Furthermore, no student has complained of a grade problem in the Calculus for BMSS course (B. C. Denton, personal communication, January 22, 1997).

The administration at OCC does not wish to place an additional prerequisite on the Calculus for BMSS course anticipating that the College Algebra prerequisite would reduce class enrollment in Calculus for BMSS. The administration would, however, consider adding the College Algebra prerequisite to the Calculus for BMSS course if data were available to support the faculty's belief that a College Algebra prerequisite would improve student grades in Calculus for BMSS.

Purpose of the Study

The purpose of this study was to determine if students who complete College Algebra at OCC or at another college prior to enrolling in Calculus for BMSS perform better in Calculus for BMSS than those students who do not complete College Algebra prior to enrolling in Calculus for BMSS.

Significance to the Institution

It was anticipated that if the study concluded in favor of establishing College Algebra as a mandatory prerequisite for Calculus for BMSS and the faculty indeed establishes the prerequisite, it would enhance student performance in Calculus for BMSS. It was further anticipated that the establishment of a College Algebra prerequisite for Calculus for BMSS would also enhance student performance in subsequent business or economics courses requiring calculus that students majoring in business, management, social science or economics are required to complete.

Relationship to Seminar

This practicum was directly related to the Research Methodology seminar in that the principles of research methodology were used in the comparison of grades of students who completed College Algebra at OCC or at another college prior to enrolling in Calculus for BMSS and those students who did not complete College Algebra prior to enrolling in Calculus for BMSS. McMillan and Schumacher (1993) state that "the most common statistical procedure for determining the level of significance when two means are compared is the t-test" (p. 345). The completion of this project required in-depth study of research methodology. Research hypothesis, null and alternative hypotheses, and the use of statistical inference are among the major criteria required for conducting experimental research (Grizzle & Rankin, 1996, p. 29).

Relationship to Concentration

The study is related to the mathematics education concentration because instruction and research on undergraduate mathematics curriculum are essential components of mathematics education. There is an interrelationship between the nature of this practicum and the selected area of concentration.

Research Question

There was one research question for this study: "Do students who complete College Algebra at OCC or at another college prior to enrolling in Calculus for BMSS perform significantly better in Calculus for BMSS than those students who do not complete College Algebra prior to enrolling in Calculus for BMSS?"

Research Hypothesis

Students who complete College Algebra at OCC or at another college prior to enrolling in Calculus for BMSS perform significantly better in Calculus for BMSS than those students who do not complete College Algebra prior to enrolling in Calculus for BMSS. The independent variable is the prerequisite mathematics course and the dependent variable is the final grade in Calculus for BMSS.

Definition of Terms

For the purposes of this practicum, the following terms needed clarification.

Applied function. An applied function is the one-to-one relation that exists between numbers and points in a given 2-dimensional coordinate plane as it applies to quantitative problems in business, management, and social sciences.

BMSS. A calculus or Precalculus course with applications in business, management, and social sciences is defined as Calculus for BMSS or Precalculus for BMSS.

Calculus. Calculus is a mathematics course of study that deals with change and motion.

Calculus for BMSS. Calculus for BMSS is a mathematics course of study that deals with change and motion as it relates to mathematical applications to solve quantitative problems in business, management, and the social sciences.

College Algebra. College Algebra is a mathematics course of study covering a wide range of topics in advanced algebra that are prerequisite for the study of Business Calculus or Calculus for BMSS. The term College Algebra is sometimes referred to as Precalculus in the mathematics literature.

Exponential function. Any function in which the variable, or variables, occur as powers is defined as an exponential function.

Function. A function is the one-to-one relation that exists between numbers and points in a given 2-dimensional coordinate plane.

Geometric progression. A geometric progression is defined as a series in which each term is formed by multiplying the previous term by the same quantity, called the common ratio.

Intermediate Algebra. Intermediate Algebra is a developmental course of study that presents definitions, theorems, applications, and generalizations of arithmetic designed to serve the needs of students whose mathematical proficiency may have declined during their years away from formal education.

Mathematical model. A mathematical model is a generalized algorithm or formula used to simulate and forecast the behavior of physical, managerial, economic, and social systems.

Piecewise function. A piecewise function is a special kind of function whose definitions involve more than one formula.

Precalculus. Precalculus is a mathematics course of study that encompasses topics in advanced algebra, analytical trigonometry, probability theory and elementary functions which are prerequisite for the study of calculus. A precalculus course that excludes the study of analytical trigonometry is referred to as College Algebra.

Chapter 2

REVIEW OF THE LITERATURE

A review of the literature on prerequisites in general and mathematics prerequisites for success in calculus in particular was conducted. The investigation of the literature provided a theoretical foundation for this research practicum. This chapter presents (a) prerequisites for success in academic courses, and (b) mathematics prerequisites for success in calculus courses.

Prerequisites for Success in Academic Courses

According to Mustafa (1986), the lack of prior study to a subsequent course makes the educational process difficult (p. 12). Dean (1991) concurs with Mustafa (1986) in that Dean's research indicates that students who successfully complete a prerequisite course with high standards have a 0.83 probability of successfully completing the succeeding course (p. 7). Students need to acquire specific skills in prerequisite courses in order to succeed in subsequent courses (Shanker, 1997, p. 5). Furthermore, the low success rate in specific academic subjects such as geometry or American history may be attributed to the lack of necessary information that would have been obtained in previous [prerequisite] courses (Shanker, p. 5).

Economic education researchers Anderson, Benjamin, and Fuss (1994, p. 111) point out that adequate prerequisites reduce the probability that a student will drop a subsequent course during a given semester. Kalina, Phillips, Dunlap, and Lervold (1995) concur with Anderson et al. (1994) in that their research revealed that "students with requisite skills were more successful and were less likely to withdraw [from a given course] than were students without the requisite preparation" (p. 30). Furthermore, according to Rotman (1991) skills in a prerequisite course are needed before a student can master a subsequent course (p. 3).

A study conducted at Cottey College in Boston, Massachusetts by Callahan (1993) indicates that students who bypass a prerequisite course have a lower success rate in completing a succeeding course than those students who complete a prerequisite course (p. 5). Furthermore, Satterlee (1990) provides statistical evidence to indicate that the difference between the mean final grade scores of students with requisite skills and those without requisite skills was statistically significant at the 0.01 alpha level (p. 22). Finally, several authors indicate that prerequisite courses play an important role in the determination of student success as well as grades in subsequent courses (Anderson, Benjamin, & Fuss, p. 116; Bauman, & Martin, 1995, p. 217; Rejto, 1994, p. 4).

Mathematics Prerequisites for Success in Calculus Courses

Dubisch (1993) states that "the subject of [college] algebra . . . is an indispensable tool in other branches of mathematics, such as calculus, and in almost every [aspect] of applied mathematics" (p. 1). According to Swenson (1996), the purpose of a college algebra or precalculus course is to help students to make a smooth transition to calculus (p. 6). This transition can be easily made by providing the appropriate mathematical experiences to enable students to succeed in learning abstract mathematical concepts (Jones & Bush, 1996, p. 721). Several authors report that a college algebra course provides a repertoire of techniques and symbolic manipulation necessary to prepare students for success in calculus (Flynn, 1995, p. 291; Freund, 1995, p. 106; Harver & Turbeville, 1991, p. 227).

Barnett and Ziegler (1993) point out that success in understanding calculus depends on a student's understanding of the function concept which is one of the most important ideas in mathematics beyond the elementary level (p. 168). In addition, research in mathematics education conducted by Toom (1993) indicates that success in business calculus depends on strong algebraic skills such as exponential functions and geometric progressions that are usually developed in a precalculus [or college algebra] course (pp. 12-13). Nichols (1988) concurs with Toom (1993) in that her research has indicated that algebraic skills are the foundation for further study in mathematics (p. 236). Furthermore, Garofalo and Durant (1991, p. 52) state that "knowledge of applied functions and graphs are important prerequisites [for success in business calculus] . . . in 'typical' precalculus [or college algebra] courses." Mathematics education researchers Bridgeman and Wendler (1995) suggest that performance patterns in college algebra are correlated with performance patterns in calculus (p. 277).

Willoughby (1993, p. 1) states that "the goal of [calculus] is to encourage the use of precise and accurate thinking to solve problems" and Laughbaum (1996) agrees with this view and recommends that college algebra students be exposed to mathematical modeling and to working with piecewise defined functions as requisite for success in calculus (p. 27). Furthermore, Dancis (1995) theorizes that success in calculus courses is correlated to student understanding of mathematical concepts and mathematical modeling (p. 11). In addition, students should also be trained to derive formulas (Dancis, p. 11). From a broader perspective, Rejto (1994) concurs with Dancis (1995) in that he believes that success in mathematics depends on a commitment to "an emphasis on logical thinking and problem solving skills [as well as an understanding] to functions and their graphs" (p. 5).

In a recent mathematics education study, researchers Porter and Masingila (1995), report that 51.25% of the errors found in midterm examinations and final examinations were not specific to calculus and involved the mathematics content taught in prerequisite courses (p. 5). Kasten, Suydam, and Howe (1988) state that "the preparation of many students taking calculus is inadequate" (p. 4). In order to provide an adequate preparation for a course that requires a prerequisite, a college will need to provide additional sections of the needed course to thus better serve students (Callahan, p. 6). These needed courses must comply with the recent changes in Title V of the California Education Code which require that if a course has a prerequisite, it must be necessary for success in the target course, enforced equitably and fairly for all students, and that the prerequisite course be approved through procedures established by the College Curriculum Committee. (Spar, 1996, p. 1).

Finally, Sim (1995) states that

> if the intent is to use a specific course as a prerequisite, one must match up the exit skills from the prerequisite course with the entrance skills identified in the content review of the requisite course. In other words, there needs to be a content review to specify what specific skills or knowledge students need to have in order to successfully complete the course (success identified as grades of A, B, C, or credit). . . Faculty who teach the prerequisite courses should have a list of exit skills which ought to provide the entrance skills for the requisite course. (p. 6)

Summary

The literature review on prerequisites for success in academic courses revealed that lack of a prerequisite course to a subsequent course makes the educational process difficult. One author indicated that the students who complete a prerequisite course have a high probability of successfully completing a subsequent course. In addition, specific skills are needed in order to succeed in courses that require a prerequisite preparation.

Adequate and appropriate prerequisites reduces the likelihood that a student will withdraw from a subsequent course since students with the adequate preparation are less likely to withdraw from a given course. Students need skills in a prerequisite course before they can master a subsequent course. Furthermore, students who bypass prerequisite courses have a lower probability of success in succeeding courses than those who do not. In fact, there is statistical evidence that indicates that there is a significant difference between the mean final grade scores of students with requisite skills and those without requisite skills. The review of the literature on prerequisites for success in academic courses also revealed that many authors hypothesized that prerequisite courses play an important role in the determination of student grades in subsequent courses.

The investigation of the literature on mathematics prerequisites for success in calculus courses revealed that college algebra is an indispensable course for success in calculus and for further study in mathematics. The purpose of a college algebra course is to assist students in making a smooth transition to calculus. According to the literature, the content of a college algebra course provides the necessary algebraic skills needed to succeed in calculus. Furthermore, success in calculus depends on a student's understanding of various algebraic concepts such as the function concept. In addition, success in calculus depends on strong algebraic skills which are usually learned in a precalculus course. One author points out that these algebraic skills are the foundation for further study in mathematics.

Since the goal of calculus is to encourage students to use precise and accurate thinking, a college algebra course should expose students to mathematical modeling and other mathematical concepts. There needs to be an emphasis on logical thinking and problem solving skills in a college algebra course since many of the errors that occur in calculus examinations are specific to previous courses.

Finally, in order to adequately assist students in their educational experience, a college needs to provide additional sections of the needed prerequisite courses. The establishment of these courses, however, must comply with Title V of the California Education Code.

Chapter 3

METHODOLOGY AND PROCEDURES

Procedures

A review of the literature on prerequisites in general and mathematics prerequisites for success in calculus in particular was conducted. A quasi-experimental research methodology was used for this study, and the following specific procedures were used.

Data Collection

Population and Sample

The population for this experimental research consisted of all students who have taken Calculus for BMSS at OCC. The sample for this experimental research consisted of students enrolled in all sections of Calculus for BMSS during the Fall 1996 semester. There were six sections of Calculus for BMSS courses offered during the Fall 1996 semester. Four out of the six Calculus for BMSS courses were offered during the day, and the remaining two were offered in the evening. The researcher telephoned each of the Calculus for BMSS professors and requested permission to visit each of their classes. The researcher's request was granted by each of the professors assigned to teach those courses. Furthermore, the researcher explained to the students from each of the six classes the differences between Intermediate Algebra, College Algebra, and Precalculus. Each student was asked by the researcher to complete a questionnaire that inquired if they had completed College Algebra at OCC or at another college. A copy of this questionnaire is included in Appendix B.

Any student who did not complete the questionnaire was interviewed by the researcher to ensure a 100% response from all students enrolled in Calculus for BMSS.

The sample was divided into two groups. Those students who completed College Algebra at OCC or at another college were placed in group A; those students who did not complete College Algebra were placed in group B.

The final grades were obtained from the semester final grades transmittal sheets completed by the professors who taught Calculus for BMSS during the Fall 1996 semester. Students receiving withdrawal grades or audit grades were not included in the sample. The letter grade earned by each student was converted to the standard 4-point number system of A=4.0, B=3.0, C=2.0, D=1.0, and F=0.0. A grade of "credit," that is, "CR", was equivalent to 2.0 points. A grade of "no credit," that is, "NC", was equivalent to 0.0 points. The mean of each group was computed and the mean scores were compared using the t-test. The MINITAB Version 8.0 statistical software package was used to test the null hypothesis.

Data Analysis

Null Hypothesis

There is no statistical significant difference between the mean score in Calculus for BMSS of students who completed College Algebra at OCC or at another college and the mean score in Calculus for BMSS of students who did not complete College Algebra.

Alternative Hypothesis

Students who complete College Algebra at OCC or at another college will have a higher mean score in Calculus for BMSS than those students who did not complete College Algebra.

Level of Significance

The level of significance used for this study was $\alpha = 0.01$ with a one-tail rejection region since the administration requires significant evidence of difference before a division policy to add College Algebra as a prerequisite to Calculus for BMSS would be considered.

Statistical Test

A one-tail t-test of hypothesis was used to test the means of independent samples. This statistical test was used because it was hypothesized that there was no statistical significant difference between the mean score in Calculus for BMSS of students who completed College Algebra at OCC or at another college and the mean score in Calculus for BMSS of those students who did not complete College Algebra. Furthermore, the statistical assumptions or conditions for hypothesis testing concerning the difference between the means of independent samples are that (a) random and independent samples are selected from normally distributed populations, and (b) the variability of the measurements in the two populations is the same and can be measured by a common variance.

Assumptions

For this practicum, it was assumed that the samples for this study were obtained from normally distributed populations with equal variances and hence a one-tail t-test was used to test the means of independent samples. It was also assumed that students gave truthful answers to the question of whether or not they completed College Algebra at OCC or at another college. This assumption may be a threat to the internal validity of the study on the basis of subject effect or behavioral change in that students had an idea of the purpose of the study and could have altered their behavior to respond more favorably to the question of whether or not the student completed College Algebra at OCC or at another college.

Another assumption was that students who completed a College Algebra course at another college were comparable in mathematical ability to the students who completed a College Algebra course at OCC. It was further assumed that students who withdrew from Calculus for BMSS did not significantly affect the results of the study. However, student attrition may affect the internal validity of the findings since it was possible that students could have withdrawn from the course during the investigation.

Furthermore, it was assumed that the selection of the sample for this study was representative of the population of students of Calculus for BMSS at OCC. However, this assumption is a possible threat to the internal validity of the research because it is plausible that student performance between semesters may vary depending on various factors such as mathematical ability, and student characteristics. Finally, the teaching methodology may also affect the internal validity of the findings since it is probable that teaching methodology may not consistent between professors.

Limitations

The study had one major limitation. The results obtained in the study were specific to the field of mathematics, the Department of Mathematics, and the college. This limitation may be a threat to the external validity of the study in that the results of the findings relate to community college students in general and to students at OCC in particular. Furthermore, the results of the study may also be a threat to the population external validity since the results of the research are limited in generalizability to other community college students with similar characteristics such as age, gender, race, and mathematical ability.

Finally, the generalization of the results of the study may me a threat to the ecological external validity since it is plausible that students may differ in mathematical performance depending on various factors such as time of day, semester or year in which courses are being offered.

Chapter 4

RESULTS

This study was conducted to determine whether students who completed College Algebra at OCC or at another college performed better in Calculus for BMSS than those students who did not complete College Algebra. The following Table records the statistics and t-test calculations that were obtained by using the MINITAB Version 8.0 statistical software package to compare the means of the grade point averages of two group of students who had completed Calculus for BMSS at OCC: (a) those students who completed College Algebra at OCC or at another college, and (b) those students who did not complete College Algebra.

Table

t-Test Comparison of Mean Differences of Independent Samples

Group	Mean	Standard Deviation	# of Students
A: College Algebra	3.014	0.843	70
B: No College Algebra	2.541	0.848	61

Level of Significance = 0.01

Degrees of Freedom = 129

Critical t-value = 2.326

Calculated t-value = 3.200

Since the calculated t-value exceeds the critical t-value at the 0.01 level of significance, the null hypothesis was rejected and the alternative hypothesis was accepted. There was a statistically significant difference between the mean scores in Calculus for BMSS of students who completed College Algebra at OCC or at another College and those students who did not complete College Algebra.

Chapter 5

DISCUSSION, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Discussion

This study was conducted to determine whether or not College Algebra should be established as a required prerequisite for Calculus for BMSS at OCC. The literature clearly indicated that prerequisites play an important role in the determination of student success as well as grades in courses such as Calculus for BMSS. The literature also indicated that College Algebra should be a prerequisite for Calculus for BMSS, and that a college should take the necessary steps to ensure that prerequisite courses be offered in order to better serve the student population. The literature also pointed out that prerequisite courses must comply with Title V of the California Education Code.

The data from this study indicated that students who had completed College Algebra at OCC or at another college had a mean score of 3.014 in Calculus for BMSS which is roughly a grade of B. However, those students who did not complete College Algebra had a mean score of 2.541 in Calculus for BMSS which is roughly a grade of C. It is therefore clear that based on the findings of this research study there exists evidence to show that College Algebra does improve student performance in Calculus for BMSS. Since the calculated t-value of 3.200 exceeds the critical t-value of 2.326 at the 0.01 alpha level of significance, the null hypothesis was rejected and the alternative hypothesis was accepted. Hence, there is statistical evidence to suggest that a College Algebra course is an effective and adequate prerequisite in preparing students for the Calculus for BMSS course at OCC. However, the results of the findings are limited in that the sample selection was drawn from a single semester, and it is plausible that student performance between semesters may vary depending on various factors such as student characteristics and mathematical ability. This limitation may be a threat to the internal validity of the research. The results of the findings are also limited and specific to the field of mathematics, the Department of Mathematics at OCC, and the college. This limitation may be a threat to the external validity of the study in that the results of the findings relate to community college students in general and to students at OCC in particular.

Conclusions

The null hypothesis was rejected since the calculated t-value of 3.200 exceeded the critical t-value of 2.326 at the 0.01 alpha level of significance. Thus, it was concluded that there was a statistical significant difference between mean scores in Calculus for BMSS of students who completed College Algebra at OCC or at another college and those students who did not complete College Algebra.

Implications

The Department of Mathematics as well as the administration at OCC now have statistical evidence to begin the process to establish College Algebra as a mandatory prerequisite to Calculus for BMSS. Once the prerequisite is established and the students complete the prerequisite, it seems plausible that student success in Calculus for BMSS will increase.

Recommendations

It was recommended that the researcher forward the results of the study and a letter requesting to schedule a meeting with the dean of the Division of Mathematics and Sciences, the vice president of instruction, and the chair of the Curriculum Committee to discuss the appropriate steps for establishing College Algebra as a prerequisite to Calculus for BMSS. The vice president of instruction should be responsible for making sure that the next college catalog and college schedule of classes reflect the change of the prerequisite to Calculus for BMSS by the end of the Spring 1997 semester. The vice president of instruction should also be responsible for disseminating the information concerning the new prerequisite to the Dean of Counseling by the end of the Spring 1997 semester. The dean of the Division of Mathematics and Sciences should be responsible for disseminating the results of the study to the Department of Mathematics and to other departments affected by the new prerequisite by the end of the 1997 Spring semester. The chair of the Curriculum Committee should be responsible for disseminating the findings of the research to the various members of the committee at the next scheduled Curriculum Committee meeting or by no later than the 1997 Spring semester.

It was recommended that the researcher contact the college newspaper to disseminate the information to students who may be affected by the new mandatory prerequisite for Calculus for BMSS and when the new prerequisite will be in effect. The researcher should be responsible for accomplishing this recommendation after it has been decided that a prerequisite will be established.

It was recommended that further research be conducted by the author one year after the prerequisite has been established in order to modify, if need be, either the College Algebra course, the Calculus for BMSS course, or both in order to ensure student success in Calculus for BMSS. Finally, it was recommended that further research be conducted with a larger sample drawn from several semesters as opposed to a sample drawn from a single semester. The researcher should be responsible for collecting the data for the next three years and conduct the study by the Spring semester of the year 2000.

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APPENDIXES

Appendix A

Course Outline in Calculus for Business, Management, and Social Sciences at Orange Coast College

ORANGE COAST COLLEGE COURSE OUTLINE OF RECORD

Course developer: Math Faculty Course static ID: 1553
TOP No. 1701.0000 CIP No. 27.0101 Course adoption: 5/76
Date revised: 1/97 Revised by: Dave Nasby, Bob Denton
Semester(s) offered: Fall/Spring/Summer

COURSE MASTER DICTIONARY DATA

Title 5 credit status:
Associate degree credit course X Nondegree credit course ____ Noncredit course ____
Course name/number: MATH 157 Division: Mathematics & Sciences
Course title: Calculus for Business, Management & Social Sciences
Department: Mathematics Units: 5.0 Total course hours: 90
Course length: 18 Weeks Weekly hours configuration: 5.0 LHE: 5.000
Grading method: Graded ____ CR/NC ____ Student option X Noncredit __
Method of Instruction: 10 (2 digit no.) Basic skills status: N (P, B or N)
Materials fee: No X Yes ____ $ ____

Justification:

COURSE PREREQUISITE/COREQUISITE/ADVISORY:

See Mathematics Assessment Requirement.

Recommended/Advisory Courses (i.e., not a prerequisite): Math 130 (College Algebra), or Math 154 (Finite Mathematics), or Math 170 (Precalculus Mathematics)

Required Prerequisite: Math 030 (Intermediate Algebra)

CATALOG DESCRIPTION:

Analytic geometry and limits; introduction to differential and integral calculus with applications to include polynomial, rational, exponential and logarithmic functions and their graphs. Multivariate calculus to include partial differentiation, multiple integration. Introduction to the calculus of probability with applications. (CAN MATH 34)

SCHEDULE DESCRIPTION:

Analytic geometry and limits; introduction to differential and integral calculus with applications to include polynomial, rational, exponential and logarithmic functions and their graphs. Multivariate calculus to include partial differentiation, multiple integration. Introduction to the calculus of probability with applications. (CAN MATH 34)

COURSE CLASSIFICATION:

A	Liberal arts/AA	X	D-H	Community course	___
B	Remedial	___	I	Occupational required	___
C	Remedial	___	I	Occupational elective	___

COURSE TRANSFER: (Faculty developer's intent)

0	Non-transfer/Non-AA	2	Transfer CSU	X
1	Non-transfer AA	3	Transfer UC	X
			Private	___

JUSTIFICATION FOR THE COURSE:

Comparable to UC and CSU courses

COURSE CONTENT AND SCOPE/TOPIC OUTLINE:

It is imperative that instructors cover all topics (not identified as optional ■) in the outline in order to prepare the students for Math 182H (Honors Calculus), Math 260 (Probability Theory) and Math 270 (Computer Engineering Applications). The instructor may determine the order of topics. The department encourages the instructor to incorporate the graphing calculator wherever it is appropriate.

1. Manipulate polynomial, exponential and logarithmic functions.
   a. graph and evaluate exponential and logarithmic functions.
   b. solve exponential equations.

2. Find standard types of limits for rational, exponential and logarithmic functions.
   a. ■write descriptions for the terms limit and continuity.
   b. list the properties of limits and continuity.
   c. determine points of discontinuity or intervals of continuity for functions.
   d. evaluate limits (of all kinds) using
      i. graphs
      ii. properties of limits
      iii. algebra.
   e. determine and graph asymptotes
      i. horizontal
      ii. vertical
      iii. ■oblique

iv. ■nonlinear

f. use L'Hôpital's rule to evaluate indeterminate forms.

3. State the
   a. limit definition for the constant *e*
   b. the economist's interpretation of *e*.

3. Find derivatives of polynomial, rational, exponential and logarithmic functions.
   c. compute average rate of change or the slope of a secant line.
   d. compute instantaneous rate of change or the slope of a tangent line.
   e. find an equation of the line tangent to a function at a point.
   f. find the derivative of a function using the definition.
      i. low degree polynomial
      ii. very simple fraction
      iii. very simple square root
   g. use the definition of the derivative to prove basic differentiation formulae.
   h. ■discuss instantaneous rate of change and acceleration in terms of the derivative.
   i. determine points or intervals where functions are not differentiable.
   j. determine the derivative functions of constants, power forms and sums.

3. Use the product, quotient and chain rule to find derivatives of functions.
   k. determine derivatives of products and quotients of functions.
   l. determine derivatives of powers of functions using the general power rule.
   m. determine derivatives combining rules.
   n. find derivatives of logarithmic and exponential functions.
   o. ■prove $(\ln x)' = 1/x$
   p. state the general derivative rules
      i. power
      ii. chain rule
      iii. logarithmic and exponential
   q. find the derivative of functions or relations by implicit differentiation.

3. Use derivative rules to find maximums or minimums in applications.
   r. determine higher-order derivatives for explicitly defined functions.
   s. use the differential of a function
      i. find increments Δx and Δy
      ii. find the differential dy
      iii. evaluate approximations using differentials.
   t. determine intervals over which functions are increasing or decreasing.
   u. locate critical values of x.
   v. find local extrema.
   w. ■state and use the first-derivative test for local extrema.
   x. ■solve inequalities using continuity properties
   y. ■describe concavity and inflection points.
   z. ■determine intervals of concavity.
   aa. use the second-derivative to determine

i. ■concavity
ii. inflection points
iii. local extrema
bb. solve application problems
i. related rates
ii. compound Interest
iii. continuous compound interest
iv. population growth
v. marginal analysis

4. Use limits and derivatives to sketch rational, exponential and logarithmic functions.
a. demonstrate sound graphing strategy.
b. determine absolute maximum and minimum for functions.

5. Find antiderivatives using properties of indefinite integrals and indefinite integral formulae.
a. algebraic functions
b. exponential and logarithmic functions
c. find definite and indefinite integrals by
i. direct
ii. substitution
iii. parts
iv. ■repeated use of parts
v. ■partial fractions
vi. ■integral tables
d. evaluate definite integrals using
i. the fundamental theorem
ii. definite integral properties.
e. find area under a curve by evaluating a definite integral.
f. evaluate improper integrals by substitution or parts.
g. find area between curves by evaluating a definite integral.
h. approximate the value of definite integrals using summations and rectangles.
i. ■find the exact value using summations and rectangles.

6. Apply integrals in applications.
a. differential equations
b. continuous compound interest
c. exponential growth
d. population growth.
e. ■prove the solution for the growth-decay model.

7. Apply calculus in applications involving probability distributions.
a. solve basic finite probability models
b. verify and use probability density functions.
c. from a given situation, find
i. sample space

ii. describe a random variable
iii. graph the probability distribution
iv. find the expected value (mean) of X
v. find the standard deviation of X.

d. apply calculus to binomial situations
i. construct a histogram.
ii. find the mean and standard deviation
iii. describe a binomial experiment
iv. evaluate binomial probabilities.

e. describe the conditions that make a function a probability density function.
f. evaluate $p(c \leq x \leq d)$ for a random variable from its probability density function.
g. verify that a function is a probability density function.
h. for continuous random variables, find
i. expected value
ii. median
iii. standard deviation

i. evaluate probabilities using standard normal distributions.
j. approximate a binomial distribution with a normal distribution.

8. Maximize, minimize and find volumes in three dimensions.
a. evaluate functions of several variables for numerical and variable replacements.
b. sketch & label geometrical interpretation of first partial derivatives.
c. find partial derivatives of first and second order.
d. find local extrema using the second partials test.
e. find extrema using Lagrange multipliers.
f. find the least squares linear approximation.
g. ■derive the least square line system.
h. evaluate double integrals over rectangular regions.
i. evaluate average value or volume under a surface.
j. ■evaluate double integrals over more general regions.

9. Apply numerical techniques to approximate
a. zeros of function using Newton's method
i. estimate zeros by Newton's method (root approximation).
i. find and simplify the recursion formula for x_n for a given value of n.

a. area under a curve.
i. evaluate definite integrals by numerical methods
(1) rectangles
(2) trapezoids
(3) Simpson's rule

INSTRUCTIONAL OBJECTIVES:

Manipulate polynomial, exponential and logarithmic functions.
Find standard types of limits for rational, exponential and logarithmic functions.
Find derivatives of polynomials, rationals, exponentials and logarithmic functions.

Use product, quotient and chain rule to find derivatives.
Use derivative rules to find maximums or minimums in applications.
Use limits and derivatives to sketch rational, exponential and logarithmic functions.
Find antiderivatives for rational, exponential/logarithmic functions
using substitution, and parts.
Use integrals in applications.
Maximize, minimize and find volumes in three dimensions.
Apply calculus in applications involving probability distributions.
Apply numerical techniques to find solutions to equations and area under a curve.

METHOD OF STUDENT EVALUATION:

Several written exams and a comprehensive final.

INSTRUCTIONAL METHODOLOGIES:

Lecture, discussion and written homework. Some instructors may use technological devices, multimedia, or cooperative learning groups.

WRITING ASSIGNMENTS/PROFICIENCY DEMONSTRATION:

Students are required to write essays or paragraphs to explain mathematical concepts. Students may also be required to construct basic mathematical proofs of various theorems.

REPEATABILITY:

Not repeatable

FEASIBILITY: Not a new course.

Math 157 (Calculus for Business, Management, and Social Sciences) Faculty:

E. J. Arismendi-Pardi, M.S., Chair of Adjunct Faculty
Valerie Hayward, M.A.
Bob Denton, M.A., M.Ed., Department Chair, and Chair of Calculus for BMSS
Dave Nasby, M.A.
Art Moore, M.A.
Mike Ortell, M.S., J.D.
Sandra Savage, Ed.D.

Classroom: Lewis Center, Chemistry Buiding, Science Building
Library Learning Resources:

EDUCATIONAL MATERIALS:

Barnett & Ziegler, Applied Calculus, 5th Edition, Pellen Publishing

Appendix B

Student Questionnaire

LAST NAME: ______________________________ FIRST NAME: _______________

YOUR STUDENT ID AT OCC: ____

I HAVE COMPLETED A COLLEGE ALGEBRA (OR PRECALCULUS) COURSE AT OCC OR AT ANOTHER COLLEGE.

YES ____________________ NO ________________

THANK YOU FOR YOUR COOPERATION.

E. J. ARISMENDI-PARDI
ASSISTANT PROFESSOR OF MATHEMATICS

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