THE RELATIONSHIP OF MATHEMATICS PREREQUISITES AND OTHER ACADEMIC FACTORS TO STUDENT ACHIEVEMENT IN TWO VIRGINIA COMMUNITY COLLEGES

by

Edward N. Chernault

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APPROVED:

Patrick A. O'Reilly, Chairman

John K. Burton

Glen I. Earthman

Marion F. Asche

Kurt K. Eschenmann

Paul D. Stapleton

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Patrick A. O'Reilly, Chairman

Department of

Vocational and Technical Education

(ABSTRACT)

The purpose of this study was to identify relationships between selected academic variables and student achievement and time of matriculation for students enrolled full-time at two Virginia community colleges; and to ascertain from those relationships the potential for predicting community college achievement. Data were collected, with permission from the VCCS Office of Research and Planning, on students (N = 287) enrolled at either Central Virginia Community College in Lynchburg, Virginia, or Southside Virginia Community College in Alberta and Keysville, Virginia, from the fall semester of 1988 through the summer semester of 1995. Persons were enrolled in either drafting and design technology, electronics technology, or engineering technology.

The dependent variables used in this study were: (a) achievement in college level mathematics courses, (b) overall occupational/technical program achievement, and (c) time required to finish an occupational/technical AAS degree. Independent variables were: (a) high school curriculum (i.e.,
general or academic), and (b) high school program participation (i.e., traditional articulation, dual enrollment, or no participation in either). The covariates were: (a) high school GPA, (b) scores on math portion of entrance placement test, (c) algebra I GPA, (d) geometry GPA, and (e) algebra II/trigonometry GPA.

The analysis used in this study was developed in several stages. Tests of assumptions were conducted to assure normality and homogeneity of data as well as the elimination of any possibility of multicollinearity between math achievement and overall program achievement. All tests were satisfied and no significance was found at the $p < .05$ alpha level between math and program achievement. A 2x3 MANCOVA was conducted to ascertain any statistical relationship between the dependent variables and the independent variables. Because only persons participating in an academic high school curriculum ($n = 88$) had all three math prerequisites, a one-way MANCOVA was then conducted to determine statistical significance, regression models were developed for the purpose of predicting community college math achievement, overall program achievement, and time required to finish an AAS degree.

The study concluded that the significant predictor of time was high school GPA. The significant predictors of college math achievement were high school GPA, placement test scores, and algebra I. Significant predictors of college
program achievement were high school GPA, algebra I, participation in traditional articulation and dual enrollment.
Dedication

This dissertation is dedicated to the source of my inspiration and will to achieve, my dad. His love and encouragement for the first sixteen years of my life has given me the insight to better understand how valuable life really is.
Acknowledgements

I wish to express my sincere appreciation and gratitude to Dr. Patrick O’Reilly, advisor, chairperson of the dissertation committee, and friend. His guidance, encouragement, and patience have made my studies and this dissertation a very challenging but rewarding experience. I am also very grateful to Dr. Marion Asche for his guidance in the design of the study. Special appreciation is extended to Dr. Kurt Eschenmnan, Dr. John Burton, Mr. Paul Stapleton, and Dr. Glen Earthman for their contribution to the success of this study.

I would like to thank Dr. Belle Whelan President, Central Virginia Community College, Mr. Jesse Worsham, Institutional Research, and Mrs. Barbara Thatcher, Student Records (CVCC).

Finally, I wish to thank Mr. Keith Waugh, Mr. Ray Jones, and Patti Tolar for their diligence and understanding without whom this study would not have been possible.
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CHAPTER I
INTRODUCTION

Purpose of the Study

The purpose of this study was to determine the relative importance of selected variables in predicting academic performance and length of matriculation required for completion of an occupational/technical associate in applied science degree program for students enrolled full-time in one of two Virginia community colleges. At present, it is not known to what extent these variables may contribute to academic performance for community college students nor what relationship these variables have to the length of time required to finish an occupational/technical degree program. Thus, by determining these relationships one may better predict the probability of graduation from an occupational/technical program and the time required to complete such a program.

Significance of the Study

Central to the theme of the community college mission is the importance placed on serving anyone who can benefit from its programs. Community colleges traditionally serve a diverse student population with varied backgrounds, prior educational experiences, and preparation for college level work. That is because, Virginia's community colleges adhere
to an open admissions policy to maximize educational opportunities.

Emphasis placed on reducing, or in some cases, eliminating entrance requirements for college programs could, however, create a situation where students lacking adequate skills needed to meet minimum acceptable scores on entrance placement tests are required to enroll in developmental courses to eliminate deficiencies. Enrollment in non-degree credit developmental courses requires the student to lengthen time of matriculation to program completion. Requiring students to pass mathematics prerequisites, prior to enrolling as a full-time student, may lessen the probability that developmental course work would be required.

Another option for students, prior to enrolling full-time in a community college, is participation in an articulation program. Traditional articulation or dual enrollment/dual credit are two programs that serve to give the prospective student a head start on college level work thus creating a situation which may lessen the time required for degree completion. These programs offer students an opportunity to receive college credit and high school credit concurrently and facilitate the transition to college requirements.

This study raises questions about whether or not completion of prerequisites in mathematics, passing math placement tests, or being involved in articulated programs prior to
enrollment in associate of applied science (AAS) degree programs increase the likelihood of students completing programs and contribute to student achievement in required college mathematics and/or achievement in occupational/technical programs. Information gained from this study will be applicable to student assessment activities and the evaluation of course subject matter and sequencing and will produce evaluative information on the efficacy of students completing math prerequisites and passing math placement tests before taking regular college mathematics courses.

According to the "Plan For Dual Enrollment," created in 1988 between Virginia's public schools and community colleges, plans for evaluative measures were needed to ensure adequate levels of instruction for all students involved in such programs. This study will meet that criterion by investigating relationships formed between participation in articulated programs and achievement in specific courses and overall program achievement in the occupational/technical areas, as well as going a step further by investigating mathematics prerequisites, placement test scores, and high school grade point average as a means of predicting student achievement and the length of time for matriculation.

At the present time, there is not enough information available on occupational/technical programs to make the decisions needed to ensure students reach their potential in
community college programs. By using the information gained from this study as a means of predicting student achievement, school faculty and administrators will be better equipped to advise prospective students, to plan more efficient programs, and thus to create an environment for success.

Virginia Community College System

Development of Community College System

On April 6, 1966, the General Assembly created the State Board for Community Colleges, as well as a Department of Community Colleges. The law defined a comprehensive community college as:

'Comprehensive Community College' means an institution of higher education which offers instruction in one or more of the following fields:

1) Freshman and sophomore courses in arts and sciences acceptable for transfer to baccalaureate degree programs,

2) Diversified technical curricula including programs leading to the associate degree,

3) Vocational and technical education leading directly to employment,


In January 1967, the proposed master plan for a statewide system of community colleges was published. Under the direction of Eric Rhodes, the plan called for the
establishment of twenty-two community colleges across the state in order that a community college would be within commuting distance of each citizen. Governor Harrison accepted the proposal with the stipulation that more colleges could be added as the need arose. As of 1994, there were twenty-three schools in the Virginia Community College System (VCCS), several of which had multiple campuses to bring the total to thirty-two campuses.

Table 1 explains the development and subsequent growth of the VCCS along with status of origin for each school.

**Community College Mission**

The mission of the Virginia Community College System is as follows:

The Virginia Community College System functions within the educational community to assure that all individuals in the diverse regions of the Commonwealth of Virginia are given a continuing opportunity for the development and extension of their skills and knowledge through quality programs and services that are financially and geographically accessible.

The Virginia Community College System, through comprehensive community colleges, provides leadership in determining and addressing both the needs of individuals and the economic needs of the colleges’ service areas.

Occupational/technical education, transfer education, development studies, continuing education, and community services are the primary avenues through which the mission is fulfilled. To assure that all students have the opportunity for success, each college shall provide a comprehensive
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program of student development services. (Virginia Community Colleges System, 1981)

Purpose of VCCS

The purpose of the VCCS states:

The community college program shall be designed to serve the educational needs of qualified post-high school age youth and adults to prepare them for employment, for advanced collegiate education, and for improved citizenship. (VCCS Policy, 1992)

Program Goals

With adoption of this mission statement by the State Board for Community Colleges in November 1981, the following Educational Program Goals were developed:

1. To offer Associate Degree Programs to prepare individuals for careers as technical and paraprofessional workers.

2. To offer Associate Degree Programs to prepare individuals for transfer, as upper-division students, to baccalaureate degree programs in four-year colleges.

3. To offer Diploma and Certificate Programs to prepare individuals for careers as technicians, skilled and semiskilled workers.

4. To offer Developmental Programs to prepare individuals for other instructional programs.

5. To offer Student Development Services which, through counseling and guidance, shall assist individuals with decisions regarding occupational, educational, and personal goals.
6. To offer Industrial Training Programs where specific employment opportunities are available in new or expanding businesses, industries, and professions. Such programs shall be operated in cooperation with the individual community colleges.

7. To offer Continuing Education Programs to provide educational opportunities for individuals who wish to continue and expand their learning experiences. Such programs may include credit and non-credit courses, seminars, and workshops.

8. To offer Community Services to provide cultural and educational opportunities which are in addition to other programs of the college. (VCCS POLICY MANUAL, 1990)

Admission Criteria

Open Door Policy

As an integral part of the community college purpose, an "open door" policy was developed and instituted, in an attempt to create equal opportunity for participation. Specifically the policy states, "The community college shall be designed to serve all youth and adults who can benefit from one of its programs" (VCCS POLICY, 1990). In general, persons eligible for general admission to the community college are high school graduates, or the equivalent, or anyone at least eighteen years of age and anyone able to benefit from a program at the community college. According to Katsinas (1994), community colleges today represent the largest delivery system of formal education to adults in the United States. Through their community service efforts, community colleges have worked to
fulfill their mission of democratizing a large portion of today's society (p. 4). Harlacher (1969) reflecting on results of a national study of community services for the American Association of Community and Junior Colleges (AACJC) wrote:

The philosophy that the community college campus encompasses the length and breadth of the college district, and that the total population of the district is its student body, makes it possible for the community college, in a massive and untraditional way, to broaden the base for higher education, to ease the problems of access to higher education by taking college to the people, and to free itself from the traditional image of the American college and university which sees college primarily, if not entirely, as an institution concerned with educating youth. (1969, pp. 3-4)

The nontraditional student, as described in the literature, is an adult, age 25 or older, who returns to school, usually on a part-time basis while still working (Holtzclaw, 1988; Seidi and Santer, 1990, pp. 13-19). Many adult students are parents whether married or divorced. Recent literature suggests that adult students achieve higher GPA's and are successful despite these multiple responsibilities (Seidi and Santer, 1990, pp. 13-19; Tompkins and Harkins, 1990, pp. 615-624; Wold and Worth, 1990, pp. 84-89). The "open door" policy was intended to increase opportunity for persons seeking skill enhancement who would not normally meet entrance requirements at a traditional four-year university. Another purpose was to offer instruction to persons interested in seeking employment after
one or two years of technical training.

According to the American Association of Community and Junior Colleges (AACJC 1987), open admissions is an ever broadening aspect of the community college mission. The expectations placed on community colleges in providing access to quality education and services represent a challenge which must withstand constant reaffirmation if the process is to supply effective programs and be maintained.

**Potential Problems**

A possible drawback to the open door policy may be the lack of adequate preparation on the part of the prospective student to pass college level course work. In anticipation of that problem most technical curriculums require program prerequisites in mathematics as a basis for admission. These prerequisites may be completed while the student is in high school or through developmental courses offered at the college. In addition, failing to meet minimum passing scores on math placement test also requires the student to enroll in developmental courses which, as a result, may extend associate degree program completion beyond two years.

Although the VCCS advocates an open door policy to allow equal opportunity for all persons interested in benefiting from community college programs, admission to specific programs may require satisfaction of specific requirements.
Often senior institutes tend to view an open-door policy with suspicion believing that programs have been "watered-down" to accommodate students with limited academic abilities. The lack of such skills would limit the community colleges' ability to require courses of equal credibility with those offered during the first two years at four-year colleges and universities. However, persons who do not meet admission requirements for a specific program or course are advised to enroll in preparatory studies or may be advised to enroll in another program (VCCS policy, 1990).

Another potential problem for community colleges and their open-door admissions policy is the agencies' ability to create equal opportunity for all students in an environment of limited financial resources and ever tightening fiscal restraints. A large portion of these limited resources are often spent maintaining developmental programs for students with the least ability to benefit from college level instruction, who ultimately make up the largest percentage of the college's population of dropouts or non-completers. The problem resulting here is one of whether the community college is best suited to conduct activities in remediation or one of occupational/technical skill enhancement ultimately leading to an associate degree, as well as preparing students to transfer to senior institutions. Even though community colleges try to accommodate as many potential students as possible, they may
fall short facing the reality that not all persons are capable of benefiting from college level instruction.

Community College Programs

According to the mission developed by community colleges and central to its educational philosophy is the associate degree program. It serves as an important guide for students, and requires commitment and dedication on the part of the student for program completion.

A recent article in the Chronicle of Higher Education (Collison, 1991) reports that traditional students (recent high school graduate) are enrolling in community college programs in increasing numbers because of the escalating costs of attending four-year institutions and a growing recognition that a quality education can be obtained within their own communities. Many community colleges are experiencing a 13 percent to 17 percent increase in the traditional student population (p. A1). In a study conducted by W. N. Grubb (1991) data concurred that the community college transfer student in the class of 1980 was almost as likely to have completed a vocational associate degree as an academic associate degree (Grubb, 1991, p. 202).

According to Palmer (1986), approximately two-thirds of all associate degrees are awarded in vocational-technical areas. Cetron and Gayle (1991) predicted continued growth for
both high school and community college vocational-technical education. Their prediction is based on the continued advancement of technology and on a growing shortage of technically trained workers available for employment. According to Cetron and Gayle (1991):

"Fully three out of four people who hold down technical jobs are either technicians or blue-collar workers. For would-be data processing specialists, medical technicians, and similarly skilled workers, a good vocational education can be a surer route to a career than traditional academic [studies]." (p. 69)

Banks (1990) stated that, "In any given state, community colleges offer vocational training, remedial education, adult and continuing education, as well as a starting point from which many students can continue on to four-year colleges and universities" (p. 53).

A primary issue within the overall debate concerning the community college's mission is the relative role and importance of the academic (transfer) and vocational-technical education functions (Brint and Karabel, 1989; Cohen and Brawer, 1982; Dougherty, 1987; Pincus, 1980; and Shearson, 1989).

Types of Programs

The five types of community college programs discussed in this study are college transfer, occupational/technical, developmental, traditional articulation, and dual enrollment.
The focus of this study is on students enrolled in occupational/technical programs seeking an AAS degree. Emphasis placed on developmental programs is in regard to how they may assist students in reaching their goals of program completion.

The State Board of Community Colleges sets the criteria for programs/curriculums to be taught at each institution. These criteria take into consideration the needs of students and opportunities available in the regions served by each college. The State Board also sets standards for minimum completion requirements for each of the community colleges degree, certificate, and diploma programs. Current VCCS policy does not require advanced levels of mathematics for admission to occupational/technical degree programs, rather it relies on developmental courses to correct any deficiencies. Individual institutions, however, often stipulate program prerequisites based upon the belief that completion of prerequisites will result in a more smooth transition between high school and college as well as enhanced achievement.

**College Transfer Program**

The objective of the associate in applied science (AAS) degree is to enhance employment opportunities, and to lead directly to a specific career upon completion. However, many senior institutions have developed programs which offer transferability for credits earned at a community college.
The transfer function has traditionally served as a means of implementing a fundamental part of the community college mission. Many community colleges were originally junior colleges or branch campuses of major institutions and served as feeder institutions to the major universities and four-year colleges. Community colleges routinely use their ability to prepare quality students for the purpose of transferring to senior institutions as an evaluative measure of how the community college fairs in terms of meeting that crucial function.

Articulation agreements formed between agencies insure transferability for students aspiring to enhance their educational preparation. The recent upsurge in community college transfers to four-year colleges and universities is partially due to increased administrative selectivity of students, increased tuition rates, and a national trend toward increased numbers of high school students being ill-prepared for regular college admission (Barry and Barry, 1992, p. 37).

The college transfer programs tend to differ in terms of stated prerequisites required for entrance from that of the occupational/technical programs. Thus, program entrance requirements for college transfer programs are more specific in nature. Because all college transfer programs are designed to prepare students for at least two additional years at senior institutions, the following courses are required for
admission to transfer programs at all colleges in the VCCS: 2-3 units of college preparatory math (Algebra I, Algebra II and Trigonometry, and Plane Geometry).

**Occupational/Technical**

Occupational/technical education programs are designed to meet the ever-rising demand for technicians, semiprofessional workers, and skilled craftsmen for employment in industry, business, the professions, and government. These programs, which usually require two years or less of training beyond high school, may include preparation for industrial, health and medical, agricultural, engineering, service, business, and other technical and occupational fields (see Appendix B, C, and D). The curriculums should be planned primarily to meet the needs for workers in the region being served by the community college (VCCS Policy Manual, Section 2A, p. 4).

Community Colleges work closely with business and industry to develop quality programs and curriculums that meet changes in technology. As cited by Parnell (1985) and according to Young (1985):

> The growing pervasiveness of technology--and the certainty of ongoing technical advances--demands that we provide our young people with the solid base of scientific knowledge they will require. It is not only those who create technology who should have a competency in math and science. Those who use technology should also have a degree of understanding about the tools they use. They must also be able to adapt to changes in technology and the new skill requirements they bring with them. (p. 138)
Entry requirements for specific occupational/technical programs differ between and within colleges in the VCCS. The prerequisites for the Drafting and Design/Engineering Technology and Electronics/Electricity programs vary from two units of high school mathematics (DCC, 1992) to Algebra I, Geometry, and Algebra II and Trigonometry (CVCC, 1994). The colleges provide developmental courses to allow students with deficient backgrounds in mathematics, as revealed by the Comparative Guidance and Placement Test, the opportunity to satisfy prerequisite requirements while enrolled at the community college.

Developmental

Students may be advised to enroll in developmental courses offered by the colleges for two primary reasons: first, when specific program entrance requirements dictate completion of specific mathematics prerequisites prior to formal acceptance into a technical curriculum and such requirements have not been met; secondly, when placement tests scores indicate remediation in mathematics is necessary prior to enrolling in college level math courses required for program completion. Developmental programs aid students in overcoming disadvantages which limit their academic progress (VHCC, 1992).

In 1950, high schools graduated 52 percent of high school
students; in 1986, they graduated 86 percent of the students (Povlosky, pp. 1-3). The potential problems associated with increased access to community colleges have led schools to deal with a wide array of problems. Many colleges face the problem that high schools are graduating students who "do not possess basic skills" necessary to achieve at the college level (Polonio and Williams, p. 51). A basic need for developmental programs is a major challenge for community colleges while preparing at-risk and low-to-moderate achieving students. While developmental courses allow the opportunity to correct deficiencies before proceeding on to college courses, the question of what level of remediation is the responsibility of the community college remains.

Participation in developmental courses allows students with deficiencies in academic preparation the opportunity to enroll in specific programs while providing the means by which they can ultimately succeed in their individual programs of study. Developmental courses do not count toward degree requirements thus creating the situation that may require students to matriculate beyond the two year program requirement.

The AACJC has defined developmental programs as the following:

Programs that provide educational experiences appropriate to each student's level of ability, ensure standards of academic excellence, and build the academic and
personal skills necessary to succeed in subsequent courses or on the job. (p. 115)

Traditional Articulation

Articulation is a planned process linking two or more educational systems within a community to promote transition from one level of education to another by minimizing delays or loss of credit (Bushnell, 1978). Articulation agreements may be formed between almost any number or levels of institutions. A portion of this study deals with agreements formed between public secondary schools and two community colleges regarding students transferring into technical programs. Kirkbride (1988) states:

The underlying purpose of articulation is to provide recognition of excellence in technical education. This recognition of excellence is intended to encourage career-oriented students to continue their educations at the community college.

Articulation provides students with strong technical interest to be identified early, thus encouraging long-range planning. (p. 2)

Other purposes of articulation were to minimize duplication of programs and program content, to facilitate program completion, to reduce operating expenses, and to reduce the number of student drop outs attributed to repeating course content (Kirkbride, 1988). Different forms of educational articulation have existed in American education since the early 1900’s. In its earliest years, articulation was used to
ease the transition for students from the elementary schools to the secondary level. The term "articulation" has recently been used to describe relationships which exist between all sectors of the educational system.

**Types of Articulation**

Carr (1974) identifies several types of articulation. Formal and informal articulation partnerships are two types that exist between many educational agencies today. The formal type of articulation may exist between community colleges and other elements of the educational process such as secondary schools, senior institutions, and local industry. Formal articulation is a contractual agreement between the institutions involved to ensure adequate coordination of efforts at each level. These efforts allow for formal acceptance of credit for satisfactory work completed at one level as meeting requirements at the next level. Informal articulation, however, may only be institutional attitudes toward eliminating problems in coordination from one level to another with no legal justification or consistency for the individual student with regard to transferring credits.

**Advanced placement**

Currently, various types of articulation programs exist
in the Commonwealth of Virginia. The type investigated in this study is an agreement between public secondary schools and the VCCS which offers coordination between introductory level classes in drafting and electronics/electricity where students receive advanced placement (AP) for work successfully completed at the high school. The credit earned by participating in such a program applies to persons enrolled at the community college in one of the two curriculums. Students are instructed according to format and curriculum agreed upon by both the high school and community college faculty. Community colleges may award advanced placement credit for learning achieved outside secondary school settings based upon any of the following: a) CLEP (College Level Examination Program), b) locally developed examination, c) prior learning, or d) military learning experiences.

**Classifications of Articulation**

Classifications of articulation, according to Carr (1987), are vertical and horizontal. Vertical articulation suggests an upward movement in terms of matriculation from one educational institution to another. 2+2 articulated programs indicate involvement with curriculum alignment, to include a predetermined course sequence for the first two years, acceptable with regard to credit transfer at the next level. This configuration may be started at the 11th and 12th grades.
in high school and continue to the community college, or in some instances may begin at the community college and move on to a senior institution. Another form of vertical articulation is 2+2+2, where the student’s involvement begins at the secondary level and continues through the university level with continuous program coordination. Although horizontal articulation is not as well known, Carr indicates that students participating in this form of program may experience lateral movement from one school or institution to another of the same category (i.e., one public high school to another, community college to another community college, or one four-year institution to another). He also suggests that horizontal articulation would encompass a student’s movement from a community college to business or industry (1974).

**Dual Enrollment/Dual Credit**

Another option for persons wishing to receive college credit while enrolled as a full-time high school student is dual enrollment. This option ensures maximum coverage of subject material with less duplication of instruction at the college level for simultaneous high school and college credit. Dual enrollment allows students to apply credit earned at the community college toward both high school and community college graduation requirements. While in college, students have the potential to complete their program of study at an
accelerated rate as well as having the option of choosing to add additional electives and/or specialized courses to their selected major earlier in their college career. A possible benefit for participation in dual enrollment is it may offer students additional time for other demanding courses once they are in college on a full-time basis. Reduced tuition as a result of shared payments paid by the county or city where the student attends high school can also benefit the dual enrollment student and may, in some cases, determine whether or not the person becomes involved in community college level studies.

Polonio and Williams (1991) suggest that high schools are responding to changes in the work force; however, those needed changes may not be appropriate to meet the demands because students produced by today's educational system are not adequately prepared for the entry level skills needed to compete for jobs created in today's world due to a lack of computational and language skills (p. 45). Advances in technology require workers to commit to "lifelong" formal education (Findlen, p. 33).

Dual enrollment opportunities for students enrolled in Virginia community college technical courses began in the fall of 1989 following the signing of an agreement between the VCCS and the Department of Education in 1988. Offering dual enrollment opportunities in Virginia's public secondary
schools and community colleges is a means by which the VCCS is able to meet the need for higher education not being met by traditional colleges and universities. (See Appendix E for Virginia Plan for Dual Enrollment Between Virginia Public Schools and Community Colleges).

**Program Entry Requirements**

**Prerequisites**

In today's rapidly changing educational environment, students are faced with an ever increasing demand to achieve in a highly technological society. Competition for jobs require people to understand and to be able to use a wider array of skills than ever before. Although community colleges, through their open admissions policy, create a means for anyone wishing to develop or to upgrade personal skills the opportunity for further knowledge enhancement, students must be made aware of the importance of adequate preparation prior to attending a post-secondary institution. In many cases, placement test scores indicate that community college students are lacking skills required to succeed in college entry level mathematics courses, thus requiring the need for participation in a developmental program. While beneficial in preparing students for college mathematics, participation in developmental courses require students to lengthen the time of matriculation to degree completion.
A portion of this study focuses on the relationship between mathematics prerequisites and achievement in college math courses as well as investigates the relationship of math prerequisites to overall occupational/technical program achievement.

**Placement Tests**

In addition to meeting program requirements for satisfying prerequisites, minimum acceptable scores on placement tests must be met in order for prospective students to enroll in college level courses. Students entering the community college differ greatly in mathematics achievement. Because colleges offer different levels of courses required for program completion, the placement program should work toward identifying the appropriate level of study for each prospective student. The evaluative measure used for this purpose is the Comparative Guidance and Placement Program (CGP) test. The assessment and placement testing services used by the two colleges investigated in this study are drawn from the CGP.

One great advantage to the placement test is that students can be compared against a common standard. However, high school GPA's can not be compared to a standard because of potential differences between school divisions. Another advantage to the placement test is the consideration given to non-traditional students who do not enter college directly
after high school. A realistic assessment of knowledge and retention is needed for the most efficient placement in college level courses. The tests are designed to provide predictive information about probable performance.

The following model, as shown in Table 2, suggests possible scenarios for students planning to enter the community college.

Situation 1 is the most desirable situation for prospective students. Based on a pass/fail criteria, students having satisfied both the mathematics prerequisites and placement test requirements would move directly toward participation in the first college level math course required for the occupational/technical AAS degree.

Situation 2 points to students having satisfied the mathematics prerequisites but not meeting the minimum passing score on the placement test, thus, requiring the prospective student to enroll in developmental courses to eliminate deficiencies. By requiring students to enroll in developmental courses, the time required for program completion could extend beyond two years.

Situation 3 illustrates the possibility of students seeking admission to a community college with no prior experience in mathematics courses required as prerequisites;
Table 2

Typical Placement Test Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Pass/Fail</th>
<th>Pass/Fail</th>
<th>College</th>
<th>Level Math</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prerequisites</td>
<td>Placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sit. 1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sit. 2</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Sit. 3</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sit. 4</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

27
however, having satisfactory scores on the mathematics placement test which qualifies the student for participation in the first semester college level math course.

Situation 4 illustrates how the lack of successful participation in math prerequisites and a below minimum acceptable score on the math portion of the placement test would require the student to enroll in developmental courses prior to taking college level mathematics.

Research Questions

This research investigated selected academic variables. Those variables were: (a) achievement in college level mathematics courses required for an occupational/technical AAS degree, overall occupational/technical program achievement, and (b) time required to graduate from an occupational/technical degree program.

Other factors which were included in this research were: (a) relationships between participation in a dual enrollment program and achievement at the community college, (b) relationships between participation in an articulation program for the purpose of receiving advanced placement in college level courses and achievement at the community college, (c) individual student high school grade point average (HSGPA), (d) scores obtained from Mathematics Placement Test, and (e) the type of high school curriculum completed.
The research questions were as follows:
1. Which of the selected academic variables are statistically significant in predicting achievement in mathematics courses required for occupational/technical associate degree programs?
2. Which of the selected academic variables are statistically significant in predicting program achievement for full-time occupational/technical associate degree students?
3. Which of the selected academic variables are statistically significant in predicting length of time to program completion for full-time occupational/technical community college students?

Delimitations

The following are delimitations of this study:

1. Only full time students enrolled in Electronics/Electricity and Engineering Technology/Drafting and Design Technology students seeking the associate in applied science degree programs were included in the research population.

2. The population used in this study only includes students enrolled at two Virginia community colleges:

   Central Virginia Community College and
Southside Virginia Community College.

3. Students earning part-time college credit after high school graduation and at anytime while seeking an AAS degree were excluded from this study, and/or persons earning college credit in other disciplines other than those awarding credit through participation in dual enrollment or traditional articulation programs.

Limitations

The study did not account for differences in:

1. Students' characteristics such as age, sex, race, socio-economic status, and/or time between prior formal education experiences and community college enrollment;

2. Student motivation, goals, and/or career aspirations; and

3. Institutional differences in student population, location, and program or instructor differences.

4. Neither a random sample of students nor of institutions was used in this study. Therefore the results cannot be generalized to any other population of students.

5. Support for appropriateness of college level math courses as a means of predicting program achieve-
ment (i.e., differences in mathematics course numbers, differences in content, or differences in instructors methods).

6. The study focuses only on selected academic variables.

Definitions Of Terms

1. **Articulation**--A planned process linking two or more educational systems within a community to help students make a smooth transition from one level of instruction to another without delays or loss of credit (Bushnell, 1978). For the purpose of this study, the definition which is most representative of the literature and provided by Opachinch & Linksz (1974).

   The multi-dimensional process of dovetailing institutional operations and responsibilities to enhance progression of students in curricular areas from one level (high school) to another (community college) and maximize resources. Articulation must be an on-going process which may be carried out in concert with initial program planning but also after programs are already operational. (p. 7)

2. **Dual enrollment (concurrent enrollment)**--A program which allows students enrolled in the 11th or 12th grade at a public or private secondary school to be concurrently enrolled in a course or courses in a post secondary institution either not offered by the secondary school or for the benefit of receiving college credit prior to
graduation from high school.

3. **Advanced placement**—College credit given for prior participation in and successful completion of courses offered at the high school level while under the coordination of a community college.

4. **Dual credit**—High school and college credit received simultaneously for work successfully completed through the community college.

5. **Degree program**—Associate in Applied Science (AAS) is a two year program designed to prepare students for employment immediately upon graduation or for transfer to a senior institution.

6. **Prerequisite**—Introductory mathematics courses offered usually at the high school level for the purpose of preparing students for advanced courses in college. The prerequisite courses used in this study are: Algebra I, Algebra II/Trigonometry, and Geometry.

7. **Open door policy**—Admission criteria used by the Virginia Community College System (VCCS) which states:

   Any person who has a high school diploma, its equivalent, or who is 18 years of age, and is able to benefit from a program at the community college may be admitted.

8. **Developmental courses**—Introductory courses offered on the basis of placement test scores, high school grades, or lack of prior participation in prerequisite courses
for the purpose of developing basic skills and understanding necessary for success in college-level courses.

9. **Curriculum**—A designated program of study or set of courses. Programs involved in this study are the Drafting and Design Technology, Engineering Technology, and Electronics/Electricity Technology programs.

10. **Program completion**—

   Associate Degree - To be eligible for graduation with an associate degree from the college, a student must (1) have fulfilled all of the course and credit-hour requirements of the degree curriculum as specified in the college catalog with at least fifteen (15) semester hours acquired at the college, (2) have been certified for graduation by his/her advisor, the Provost, and Director of Admission and Records, (3) have earned a GPA of at least 2.0 in all studies attempted which are applicable towards graduation in his/her curriculum. (SVCC Student Handbook, 1994-96)

11. **Mathematics achievement**—A student’s level of accomplishment in mathematics. In this study, mathematics achievement will be measured by pass/fail criteria at the high school level and by individual grade point average, calculated on a 4.0 scale at the community college level. Mathematics achievement was also measured using scores obtained from the mathematics portion of the placement test required prior to acceptance into an occupational/technical program at the community college.

12. **Occupational/Technical (O/T) Curriculum**—The Southside Virginia Community College Student Handbook states:
The occupational and technical education programs are designed to meet the increasing demand for technicians, semi-professional workers, and skilled craftsmen for employment in industry, business, the professions, and government. These programs, which normally require two years or less of training beyond high school, include preparation for entry into employment in agricultural, business, engineering, health and medical, industrial, public service, and other technical fields. The curricula are planned to meet the needs of employers in the service area. (SVCC Handbook 1994-1996, p. 4)

Summary

The open door policy, adhered to by the VCCS, is designed to allow all persons who can benefit from community college classes the opportunity to enhance personal and job related skills. Without rigid admission requirements to consider, some applicants may choose to take fewer advanced mathematics classes in high school while preparing for life after graduation. This chapter identifies the emphasis placed, on the part of the VCCS, in offering quality programs to all interested persons. However, not all applicants are adequately prepared for college level work and must consider other alternatives such as enrolling in developmental courses. Additional courses suggest a longer period of time required to complete an AAS degree.

Chapter 1 discussed program options for persons in high school which may potentially enhance achievement as well as helping to shorten time required for degree completion. Re-
search questions stated in this chapter create a focus for the study while addressing student achievement.
CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The purpose of this chapter is to review literature pertinent to factors associated with mathematics prerequisites and their relationship to student achievement at the post-secondary level. More specifically, the discussion focuses on selected mathematics courses at the high school level offered prior to admission to an occupational/technical AAS degree program. Those specific courses are: Algebra I, Algebra II/Trigonometry, and Geometry. Other factors for consideration reviewed in this chapter are: (1) the relationship between participation in traditional articulation programs, while in high school, and achievement for full-time occupational/technical community college students, (2) the relationship between participation in dual enrollment/dual credit programs, while in high school, and achievement for full-time occupational/technical degree seeking students at the community college, (3) the relationship between high school GPA and achievement at the community college, (4) the relationship between placement test scores and achievement in post secondary education, (5) the relationship between participation in articulated programs, prerequisites, and
length of time required to complete an associate in applied science degree program.

The following review of literature identifies and summarizes previous research conducted on factors pertinent to this study.

**History of VCCS**

In 1966, the Virginia General Assembly passed legislation which established a statewide system of public community colleges. The Virginia State Board for Community Colleges defines a community college as

...an institution of higher education offering programs of instruction generally extending not more than two years beyond the high school level, which shall include, but not be limited to, courses in occupational and technical fields, the liberal arts and sciences, general education, continuing adult education, pre-college and pre-technical preparatory programs, and specialized services to help meet the cultural and educational needs of the region. (VCCS, 1966, p. 1)

Several key events led to the development of the community college system in the Commonwealth of Virginia. The 1944 Virginia General Assembly passed a resolution "appointing a commission to make a thorough and complete study of the public school system of Virginia" (Virginia Public School System, 1945, p. 3). The commission recommended that vocational education should be made available to all persons who could benefit from its programs. The particular education
being proposed was post-secondary but not intended to lead to a college level degree.

In 1948, the General Assembly called for the Virginia Advisory Legislative Council to study higher education in Virginia. A major finding of that subcommittee was that educational needs existed in the Commonwealth which could be met through the establishment of a statewide community college system (Commonwealth of Virginia, 1950, pp. 1-3). Another subcommittee headed by Fred J. Kelly, Specialist in Higher Education, U.S. Office of Education, established in 1950 determined education in Virginia was in need of "short technical and semiprofessional courses to prepare students for the many types of vocations which require post-high school training but do not require four-year curricula" (Higher Education in Virginia, 1951, p. 5). However, the subcommittee did not advocate a statewide system of community colleges as it exists today, but rather proposed a network of branch colleges affiliated with well-established four-year universities in the state. Kelly reiterated that Virginia had a clear need for post-secondary vocational and technical training.

The General Assembly adopted legislation four years later in 1954, directing the Virginia Advisory Legislation Council to study the condition of extension services at the various four-year institutions in the state (Commonwealth of Virginia,
The study culminated in a report titled: *The Crisis in Higher Education in Virginia and a Solution*, that reported a major crisis in Virginia education to be the growing number of college-aged students and the lack of facilities needed to meet their needs. Proposed as a solution to the problem was the establishment of a statewide system of branch colleges.

With the creation of the State Council of Higher Education in Virginia (SCHEV) in 1956, the General Assembly intended "to promote the development and operation of a sound, vigorous, progressive, and coordinated system of higher education in the State of Virginia" (Code of Virginia, 1956).

The 1950s ended with a study authorized by SCHEV and conducted by S. V. Martorana in 1959 entitled *Needs, Policy and Plans for Two-year Colleges in Virginia*. By that time, the idea of a comprehensive community college system had gained support. The Martorana study did however, state "the emphasis of two-year institutions should be to provide educational services to persons in their various locations to broaden the base for higher education" (p. 8). Although the study proved to be influential in the eventual implementation of legislation which brought about the Virginia Community College System (VCCS) as we know it today, it did not produce any immediate major changes in the structure of higher education in Virginia.
The identification and specification of the economic value of higher education to the state was also an important factor in building support for the development of the VCCS. Joseph G. Hamrick, then Executive Assistant to the Governor of Virginia, stated there were not enough vocational/technical schools in the state (Hamrick, 1964, p. 5). He further added that "economic growth is no longer possible without educational growth which included expansion of curriculum as well as expansion of educational facilities. We must provide the kind of education that permits our young people to participate in our growing economy to the extent of their abilities," (Hamrick, 1964, p. 5).

The State Council of Higher Education biennial report for 1958-60 pointed to the shift from an agricultural economy to an industrial economy as well as an increasing growth in the state's population as a factor which created further need for higher education to "provide more post-high school education," (SCHEV, 1960). The report stated:

...the desirability of community colleges results from economies to be achieved for the State and the student, from their effectiveness in providing specialized training of local manpower, and from their positive impact upon the educational level of Virginia's citizenry. (p. 1)
Research Variables

Prerequisites

According to (Roueche & Roueche, 1993) students are leaving today's high schools, despite higher grade point averages, without the basic skills and competencies needed for completing thirty years prior, and in fact are the "lowest in American history" (p. 3). The National Center for Education Statistics reports "that in tests of mathematical progress, more than one-third of respondents tested performed at levels below the lowest identified level, and that more than 80% were thought to be performing at a level below their appropriate grade" (National Center for Education Statistics, 1991). Most community colleges insist that students be assessed prior to entering certain courses in order to ensure that the students have the basic skills and knowledge, including mathematics, needed for academic success (Barry & Barry, 1992, pp. 35-41).

Findlen (1994), in an article on technical colleges, questions whether today's institutions of higher learning should cling to past tradition or change to meet present, and more importantly, future demands created by an ever increasing surge in technology and foreign competition. He proposes that technical and community college students need the same high school preparation that traditional college-bound students are required to have in preparation for the more advanced college courses. Further he feels that operationally, technical and
community colleges should abandon the "we can work with anyone" philosophy and seek to require certain admission criteria for special programs as well as prerequisites for selected courses (p. 32). Findlen does not, however, advocate doing away with the open admission policies and mission presently in place in today's community colleges, but feels that requiring students to have appropriate high school courses needed to succeed in a given program of study will create a smoother transition to college level work. Finally, he proposes that community colleges, while changing to accommodate future needs, should require program and course prerequisites for students matriculating in today's educational environment.

In October 1989, a project between the Academic Senates of the California Community Colleges, California State University, and the University of California was initiated to ascertain competencies in mathematics expected of entering freshmen. While not fundamentally recommending changes in present curriculum, the study emphasized and encouraged students to experience mathematics throughout high school. The importance of mathematical power, the ability to discern mathematical relationships, reason logically, and use mathematical techniques to solve problems were enumerated as characteristics of mathematically mature students (p. 3). The study further concluded, sufficient mathematical maturity was
desired for students to be able to achieve success in first year college mathematics courses. Specific courses detailed as required for promoting the development of student characteristics were algebra, geometry, and a basic understanding of how various parts of mathematics e.g., algebra and probability, are interrelated (p. 4). The study reiterated that secondary schools must frequently review mathematics curricula to insure students are being adequately prepared for college mathematics (p. 52).

House (1993) investigated the predictive relationship between years of high school math taken and students subsequent achievement in introductory college courses. The results indicated that self-reportings of mathematical ability were significant predictors of college achievement in addition to the number of years of high school math taken. Several studies have found high school performance in college preparatory courses to be a significant predictor of later performance in college courses (Craney & Armstrong, 1985; Noble & Sawyer, 1987; Ozosogomonyan & Loftus, 1979; Pederson, 1975; Reiner, 1971). Ferrari and Parker (1992), also concluded that high school achievement was significantly related to first-year college achievement.

According to Gagne (1988), prerequisites may be classified as essential or supportive. Essential prerequisites must be learned if the total task is to be learned
and performed correctly. Supportive prerequisites aid new learning by making it easier or faster (p. 146). Satterlee (1990) reported a significant difference between the mean final grade scores of students with prior high school trigonometry achievement and those with no exposure to trigonometry at the high school level (p. 16). Rotman (1991) suggests a definite consistency of higher achievement in community college algebra courses when students complete algebra in high school (p. 5).

**Placement Tests and Grade Point Average**

According to American College Testing (ACT) numerous studies have examined the relationships between admission and placement test scores and subsequent college level achievement. Predictor variables used included ACT scores, SAT scores, and high school grades. However, data collected came from predominantly single institutions and examined achievement in single specific courses or from a small cluster of courses. None of the studies examined a full spectrum of courses representative of freshman curricula.

Research published since 1970 using course grade as a criterion is illustrated in Table 3. Author(s), date published, predictor variables, sample size, and correlation coefficient are presented for each study. Represented in Table 3 are correlation coefficients ranging from .04 to .75
Table 3
Summary of Earlier Research on Predicting Specific Course Grades

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Course</th>
<th>Predictor(s)</th>
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<th>R</th>
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<tbody>
<tr>
<td></td>
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<td>SAT-M, DTMS</td>
<td>73</td>
<td>.21,.46</td>
</tr>
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<td>SAT-M, DTMS</td>
<td>198</td>
<td>.26,.47</td>
</tr>
<tr>
<td>Gussett (1974)</td>
<td>Mathematics</td>
<td>SAT-Verbal</td>
<td>142</td>
<td>.48</td>
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<td></td>
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<td>SAT-Math</td>
<td>142</td>
<td>.62</td>
</tr>
<tr>
<td></td>
<td>Mathematics</td>
<td>SAT-Total</td>
<td>142</td>
<td>.63</td>
</tr>
<tr>
<td>Kohler</td>
<td>Algebra</td>
<td>Cooperative Math Test</td>
<td>158</td>
<td>.53</td>
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<td></td>
<td>Algebra</td>
<td>ACT Math</td>
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<td>.52</td>
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<td></td>
<td>Algebra</td>
<td>ACT Comp</td>
<td>161</td>
<td>.40</td>
</tr>
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<td>Howlett (1969)</td>
<td>Analy Geom</td>
<td>ACT Math, HS Rank</td>
<td>397</td>
<td>.38</td>
</tr>
<tr>
<td></td>
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<td>ACT Math, HS Rank</td>
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<td>.47</td>
</tr>
<tr>
<td></td>
<td>Elem Algebra</td>
<td>SAT-M, HS Algebra Grades</td>
<td>162</td>
<td>.36</td>
</tr>
</tbody>
</table>
with the largest coefficients coming from placement tests designed specifically for mathematics.

**Articulation**

Education must be relevant to the learner. "Learning takes place when learners regard what one needs to know as relevant to their lives" (William T. Grant Foundation, 1988, p. 8). America's Choice supports the importance of relevancy by stating, "the lack of any clear direct connection between education and employment opportunities for most young people is one of the most devastating aspects of the existing system" (National Center on Education and the Economy, 1990, p. 72).

"The underlying purpose of articulation is to provide recognition of excellence in technical education" (Kirkbride, p. 103). This recognition is intended to encourage students wishing to further their education at the community college level by identifying technical interests and maximizing long-range planning. A major focus for community colleges today is to serve a diverse population demanding increased access to their institutions. In June 1985, there were 2,650,000 students graduating from U. S. high schools (Rothman, 1986) and in September 1985, approximately 50 percent of those students entered some type of post-secondary institution (Boyer, 1987, p. 61). Even if all the students at the top of their graduating class attended some form of college, there
would still be a large portion considered as low to moderate achievers wishing to gain from some form of post-secondary training. As past research indicates, the mean grade of C+ for that particular group (students entering college in 1985) would prevail throughout their freshman year (Ramist, 1984, p. 163). Additional research further concludes that other studies dealing with performance of moderate achievers in articulated programs (Greenberg, 1989; Tyler, et al., 1987) have found that this group generally does quite well in college level courses. Articulated programs offer students with low to moderate levels of prior achievement the opportunity to engage in college level work in high school. Whereas, traditionally, only high-achieving students were extended this privilege. "The traditional justification for excluding low and moderate-achieving students from college-level study in high school is that these students are not bright, skilled, and mature enough to cope with the demands of college course work" (Greenberg, p. 71).

The majority of articulation agreements currently in place in community college occupational programs are of the "2+2" or "advanced standing" format (Warmbrod, p. 29). Boyer (1987) recommends...at the post-secondary level, articulation is especially relevant to community, technical, and junior colleges whose missions frequently emphasize career planning and development. Given the fact that the community colleges
are no longer primarily transfer-oriented and have developed a very specific focus in the area of career education and development, the opportunity for broad-based articulation between cooperative education programs based at the secondary level with those at the community colleges offers a challenging opportunity (Parnell, 1985). Parnell further states, "in 1986, 66 percent of two-year college students were enrolled in occupational/technical programs."

A recent study of vocational education and curriculum articulation in North Carolina determined that articulation adds incentive for high school vocational education students to "aspire to advanced training" when they know that such instruction can be expanded at the community college level, leading to higher job level competencies and better job opportunities (Woelfer, p. 38). The initial project was intended to articulate automotive mechanics, business education, and drafting programs between the high schools of Duplin County and like programs at James Sprunt Technical College. An evaluation conducted at the college by a team of administrators determined, by the means of a follow-up on students previously involved in articulated course work, that those students did above average in courses related to courses for which advanced credit was awarded (Ibid, p. 41). Generally, advanced placement is available to those with high grade point averages or high scores on such placement tests as the
Advanced Placement Program administered by the College Examination Board. Another avenue is through successful completion of competency tests (Mabry, p. 49).

An articulated agricultural program developed by the Kern Community College district and the Kern High School district in California integrates the eleventh and twelfth grades in high school with two years at the community college to lead participants to immediate employment or an associate degree (Scott, pp. 14-18).

Two well-known and highly successful programs are La Guardia Community College's Middle College, and the International High School. The Middle College concept was primarily designed for at-risk students, however, success rates are high, more than 85 percent going on to higher education. In 1985, encouraged by retention rates and achievement of the Middle College students, La Guardia opened the International High School, geared at drawing students limited in English proficiency (Lieberman, 1988). Because of the great success enjoyed by the Middle College concept in California, the Ford Foundation awarded a grant to La Guardia Community College for the purpose of lending technical assistance to institutions nationally (Mabry, p. 50). Those institutions participating were: Shelby State Community College (Memphis, Tennessee), Illinois Central College (East
Peoria, Illinois), and Union County College (Cranford, New Jersey) (Randall, 1988).

The Virginia Community College System developed a master technician program in electronics/electro-mechanical technology about the same time, which combined two years of high school training with two years at the community college (Phillips & Kuchinsky, p. 9). Ohio State University, in an effort to develop both math and English skills in local high school students, worked to create a series of assessment measures which as a result increased enrollments in senior mathematics, decreased the number of students needing remedial math courses at the two-year colleges, and higher enrollments in college-preparatory English courses (Bordner, pp. 38-40).

In 1986, the Carnegie Foundation for the Advancement of Teaching issued a report entitled College: The Undergraduate Experience in America (Boyer, 1986). The author states that "the path from school to college is poorly marked" and that students find the process often "confusing" and "haphazard" (pp. 1-3). Research suggests that programs such as College Now, a collaborative program between City University of New York (Cuny) and four public high schools in New York City, brings motivation to fruition by leading to better-than-average credit accumulation and retention (Murtha, 1988).

A study of articulation practices between community colleges and local high schools in Minnesota add to the
support given to these types of programs. Minnesota's community colleges were originally operated and developed by local school districts (Gerber, 1971). At that time, community colleges were regarded as a part of secondary education rather than of higher education. In 1963 legislation created by the State of Minnesota and the Junior College Board established 15 state operated junior/community colleges. This particular study was a follow-up investigation of the important factors influencing students participating in the Minnesota student acceleration program. Research conducted by Chamberlain, Pugh, and Sebellhammer, titled "Does Advanced Placement Continue Throughout the Undergraduate Years?" found that advanced placement students achieved at a higher level than did a group of equal ability students who did not receive advance placement credit. Their findings pointed to AP students completing a greater number of course hours at the junior level and above which indicates an increased probability of success for students electing to continue to the undergraduate level. The research findings also indicated that AP students completed a greater number of course hours per semester than non-AP students of equal ability.

The Syracuse University Project Advance (SUPA) is one of the largest programs of its type in the United States offering high school students the opportunity to enroll in college courses (Mercurio, 1980). During the 1980 school year the
program served 76 high schools and approximately 4,000 students in New York, Massachusetts, Michigan, and New Jersey. The Mercurio study found that 98 percent of the SUPA students responding went on to enroll in some type of college or professional school, while 91 percent of those completing degree requirements reported having achievement levels of "B" or above for course work attempted. A percentile breakdown of grade distribution is as follows: a) A - 28%, b) B - 62%, c) C - 9%. The study also concurred that eighty-four percent of students graduating with a degree did so in the normal amount of time required, i.e., four years in a senior level institution, and two years at the junior or community college level (Mercurio, 1980). Findings were concluded from a Student Attitude Questionnaire designed to gather information about four areas. Those areas were: personal characteristics; familiarity with college; one's perception about their grades, future plans; and student attitudes about the local college (IBID, Appendix E).

The specific course being investigated was college-level calculus. A grade of "C" or better was used as the cut-off for measuring success. According to the study, students have less than a 50 percent chance of succeeding in calculus based on the following criteria:

1.) if they score less than the 94th percentile on the math portion of the SAT or ACT.
2.) if they have less than a 3.0 cumulative grade point average in high school.
3.) if they have less than a "B" in any high school math class.
4.) if they have less than a "B" in any college math taken prior to calculus.
5.) if they have less than a 3.0 grade point average in college for classes taken prior to calculus. (p. 5)

According to almost 300 articles of research related to predictors of college success, Pedrini and Pedrini (1974) concluded the following:

The research concerned with prediction of college achievement has considered many single and multiple predictor variables. The literature is replete with reports studying the predictive validity of high school grades and achievement/aptitude test scores. While many factors are important, it appears that for the majority of students, the high school average (or class rank) is the best single predictor of college grades. (p. 197)

In a 1977 study on the validity of admission policy at the University of New Haven Department of Engineering, several factors were investigated for their predictive value in assessing student achievement. Those factors were: a) SAT score, verbal section, b) SAT score, mathematics section, c) grades in college mathematics, and d) GPA at graduation. A multiple correlation analysis was used to statistically accept or reject the hypotheses associated with the aforementioned criteria. The results of the study based on a 98 percent confidence level were:

a.) Mathematics scores on SAT are not related to the graduating GPA of engineering students;
b.) Verbal scores on SAT are related to the graduating GPA of engineering students;
c.) Total SAT scores are related to graduation GPA of engineering students;
d.) Grades in college mathematics are related to the graduating GPA of engineering students;
e.) The combined effect of total SAT scores and grades in college mathematics is related to the graduating GPA of engineering students;
f.) SAT mathematics scores are not related to college math grades;
g.) Total SAT scores are not related to college math grades; and
h.) Verbal SAT scores are not related to college math grades. (Costello, 1977, pp. 13-34)

Fishman and Pasenella (1960) in a study conducted over a ten year period of 263 college admission programs reported a mean correlation of 0.50 between high school grades and subsequent grades earned during the first year of college. In addition a 0.47 mean correlation was determined between standardized test scores prior to entering college and grades earned during the first year of college (p. 308).

Chase et al. (1973) concluded that SAT verbal and mathematics scores account for approximately 14 percent to 15 percent, respectively, for the variance in grades for college students enrolled the first year. He goes on to add that, as a result of multiple correlation analysis, only 18 percent of variance in grades can be contributed to the combined effect of verbal and mathematics SAT scores. Chase also investigated differences in predictability between men and women and determined that SAT scores were a more valid predictor of college achievement for women. Combining verbal and mathemat-
ics SAT scores for women accounted for 23 percent of variance in college grades (p. 11).

Research resulting from a 1975 study of high school records and admission testing, Chester Judy writes:

Hundreds of studies have shown that prediction of college achievement based on weighted combinations of test results and information from high school records (such as high school rank) are more accurate than predictions made from test scores alone, or from high school records alone. These studies have also generally shown that optimum prediction is obtained when more consideration, or weight, is given to high school record information than to test information. (p. 6)

Judy also states in the same study:

A fourth and final observation is that, historically for the purpose of academic prediction, much more attention has been given to the qualification of any equivalent amount of data obtained from the existing academic record, data extending over a longer sample of an individuals functioning than two or three hours of test behavior. (p. 9)

Judy determined that the high school record was the single best predictor of college performance, and for that reason should be given more weight than selection-test scores in a combined prediction role.

**Dual Enrollment/Dual Credit**

Today many opportunities exist for high school students to earn college credit applicable toward an associate or baccalaureate degree prior to graduating from high school, (e.g., advanced placement through credit-by-examination, concurrent high school-college enrollment, and college courses
offered as a part of the regular high school curriculum) (Mercurio, 1980). Much consideration has been given to the advantages of such opportunities for students as evidenced by the literature (Willingham, 1974a, 1974b; Carnegie Commission on Higher Education, 1973; Wilbur, 1975; Wilbur & Chapman, 1978; Menacker, 1975; NASSP, 1975). High school-college cooperative programs are designed to reduce duplication of course content between high school and college, relieve senior-year boredom by enriching the high school curriculum, and reduce the rigors of transition from high school to college. In addition, by taking college courses and receiving credit from both the high school and post-secondary institution, the time required for program completion at the college would in theory, be shortened.

Information conveyed by this review of related literature emphasizes how participation in dual enrollment (e.g., high school and college concurrently) correlates to student achievement at post-secondary institutions after high school graduation.

One of the most highly recognized programs offering opportunities for dual enrollment is the Syracuse University Project Advanced (SUPA). The program was initiated as a means of serving local high school students, and has grown to serve thousands of students throughout New York, Massachusetts, Michigan, and New Jersey. Considerable research was undertak-
en by SUPA to strengthen the credibility of its programs and academic characteristics (Baranowski & Chapman, 1976; Chapman & Slotnick, 1976; Chapman, 1976a), as well as numerous studies which indicate that SUPA students perform at least as well as, and in some cases, better than college students completing the same courses on the Syracuse University campus (Chapman & Slotnick, 1975a; Chapman & Slotnick, 1975b; Chapman, 1976b; Chapman, 1976c; Chapman, 1976d; Chapman, 1976e; Chapman, 1976f).

According to a 1980 SUPA study, 91 percent of students completing degree requirements reported having a letter grade of B or better. While 84 percent completing degrees did so in the normal amount of time (i.e. four years in a four-year institution, two years in a two-year institution), 11 percent completed their degree requirements one semester earlier than usual; 5 percent completed degree requirements one year earlier than usual. In summary, the evidence strongly suggests participation in the Syracuse University Project Advance continues to play an important and positive role in academic achievement and progress.

The Post-Secondary Enrollment Options Program (PSEOP) enacted by the Minnesota state legislature in 1985 allows students to take regular college courses, and receive both high school and college credit concurrently. Data collected after the first two groups of students finished the winter and
spring quarters in 1985 evidenced that participating students fared as well or better than did their freshmen counterparts in the same courses. According to a study conducted by the University of Minnesota, 31 percent of high school students received grades of A, while 60 percent received grades of A or B (Randall, 1988, p. 15).

Similar results were reported in a study of New York City Community College students (DeLuca, 1977). Of the 26 dual enrollment students entering college in the Fall 1976, 68 percent received an A or B as compared with the regular freshmen of which only 50 percent received an A or B. Dual enrollment students enrolled in courses registered a cumulative average of 2.98 as compared to the regular freshman of 2.66 during the fall semester, and finished the first year of the study with a cumulative average of 3.22. The regular freshmen students received a cumulative average of 2.50. The yearly mean for dual-enrollment students of 3.19 is compared to the mean for regular freshmen of 2.21 (p. 7).

In a survey of students previously enrolled in dual-enrollment courses at Parry McCluer High school in Buena Vista, Virginia, 100 percent of the respondents felt that they would recommend that college courses continue to be offered at Parry McCluer. According to the survey, the following responses were given:

- Seventy-two percent agreed that college courses
taken at Parry McCluer prepared them for full-time college work

- Seventy-eight percent of dual-enrollment students viewed courses as a bridge between high school and college level work

- Fifty percent of respondents believed that dual-enrollment courses reinforced their decision to attend college

In terms of actual achievement, a review of available college grades showed improvement for students who participated in dual-enrollment courses during high school. In addition, students having dual-enrollment experience tended to enroll in more rigorous freshmen college courses (p. 7). Results continue to suggest that dual-enrollment students benefit academically with better than average freshman grades, as well as personal benefits (i.e., self-esteem, reduced nervousness) further strengthening their likelihood for success in college (p. 10).

In a separate study, dual-enrollment students previously enrolled at Southside Virginia Community College, presently attending a four-year college or university, were asked for self-reported grades at their present school. The self-reports revealed a mean 3.22 GPA, which was higher than the (3.12) post-transfer GPA reported in November 1991 by the SCHEV-VCCS Joint Committee as transfer from Virginia Community
Colleges to four-year institutions (Barnes, 1991).

Concurrently, a study of dual-enrollment students who were high school graduates in 1989 and 1990, and who subsequently enrolled at Southside Virginia Community College were divided into two groups: those who had participated and those who had not participated in dual-enrollment courses. Dual-enrollment and non-dual-enrollment students were matched on high school GPA, class rank, and academic work completed at the college level. The mean GPA of the two groups was compared in two ways: all mean grades for all course work attempted, and a mean of all grades of "C" or above. A significant difference ($p < .05$) was found for dual-enrollment vs. non-dual-enrollment students, with dual-enrollment students showing an increase of +.33 average GPA over students with no previous experience in college work (SVCC, 1991).

**High School Curriculum**

In many instances, persons who attend a community college are not as academically prepared as those who matriculate at a four-year college or university. According to the community college mission and purpose, persons wishing to attend a community college are not denied access due to a lack of prior advanced academic preparation. In lieu of this preparation, developmental courses offer the student an opportunity to remediate academic deficiencies, however, this may require the
student to matriculate beyond two years for program comple-
tion. The open admissions policy allows persons the opportu-
nity to attend the community college, but in most cases, specific curriculum requirements include minimum satisfaction (i.e., passing) of prerequisites prior to acceptance in that curriculum.

Information conveyed by this literature review is intended to create a basic overview of academic preparation at the high school level and how that participation may correlate to college achievement. Due to the open admission policy used by community colleges and after a reasonable search of related literature, no information was identified on high school curriculum and subsequent community college achievement. The following review investigates factors associated with achievement in four-year colleges/universities based on prior participation in various high school curricula.

In a 1986 study titled "Preparation for Academic Performance and Achievement at Southeast Missouri State University," the author stated that colleges afford students the opportunity for planned and structured academic study beyond high school. In addition, the academic knowledge and competencies gained as a result of such an exposure are intended to develop strong work habits and study skills which enable persons to think critically and evaluatively about the world around them (p. 3). The Missouri study further states that learning is a
lifelong process which encourages people to develop traits such as self-reliance, initiative, integrity, compassion, resourcefulness, courage, creativity, and responsibility.

Recommendations set forth by the study were directed toward students, their parents, and educational planners in promoting an adequate understanding of levels of academic preparation and attainment necessary for high school students to succeed in college. The study ascertained that students having adequate preparation in high school with a thorough background in reading, mathematics, and the sciences were more likely to graduate from college than were those lacking academic skills. Since only mathematics prerequisites are included as a part of this study, only information concerning course recommendations in the area of mathematics are included. The following list of courses were recommended by the Missouri study for high school students aspiring to attend college. Those courses were: a) algebra I, b) algebra II, c) plane geometry, d) probability and statistics, e) trigonometry, and f) pre-calculus.

An Oklahoma study published in April 1993, investigated several major factors that either presently or in the future will affect student academic preparation for college. Research indicates that students who prepare academically in high school by completing core subjects with strong academic content tend to earn better grades in college and are more
likely to persist to graduation. In short, "the academic preparation a student receives in high school correlates with success in college" (p. 3). Included in the same study, and gathered from preliminary student assessment results, were indications that many students entering higher education are not prepared for college level work. Specifically, 31 percent of freshmen entering college in the fall of 1991 required at least one remedial course; while 47 percent of students enrolled in remedial courses met or exceeded their high school core curriculum requirement (p. 6). The study concludes by stating that currently the Oklahoma State Regents are formally studying the need to strengthen the high school core curricula requirements for college entry beyond the present requirement of 11 units of English, mathematics, history, and lab sciences. This effort is intended to better prepare high school students academically to the rigors of college level work by increasing the number of required math and science courses needed for graduation.

Galligani (1988) published a report regarding a qualitative evaluation of outcomes from 20 school/college partnership projects based on enhancing college preparatory curricula. The study was sponsored by the California Academic Partnership Program (CAPP) between 1984 and 1987, and designed to involve college faculty and junior high and high school teachers in an effort to provide students with the knowledge needed for suc-
cess in college through curriculum development leading to student skills enhancement.

The primary findings of this study followed results indicated by other related research. Those findings pointed to the increased probability of higher student achievement in college based on the amount of academic preparation at the high school level.

In a 1984 report, "Making High School Count," the Nevada Joint Council on College Preparation investigated student preparedness for college level work. The report states:

Preparing for college is a serious task which requires planning and hard work. The most systematic way to acquire the competencies needed for success in college is to take a sound course of basic academic subjects in high school. (p. 1)

Suggested mathematics courses included algebra and geometry with additional math courses suggested for persons enrolling in the math and science fields.

The report cited the College Board of New York in Academic Preparation for College, "the importance of mathematics to the college-bound student cannot be overstated" (p. 2). While mathematics is the "indispensable language of science and technology," students having a strong preparation in mathematics will have an intellectual edge in the high tech information age, including a wider range of college options. The report concluded by stating that college entrants need more than basic mathematics preparation. Students interested
in engineering and other high tech fields should be involved in high school curriculums offering four years of mathematics to develop more extensive knowledge and skills.

Aldridge and Johnston (1984) finds the United States facing a crisis of major proportions. In their study *A Response to the National Reports*, the crisis is the educational and knowledge gap between a small sector of the population and the vast majority of citizens (p. 20). Cited in the same report is the National Commission on Excellence in Education, *A Nation at Risk*, which recommends that all students be required to pass three years of math and science before receiving a high school diploma. In a report of the National Science Board’s Commission on Pre-College Education in Mathematics, Science, and Technology, all students should be involved in programs which offer improved science and mathematics exposure, not just for those who might become scientists and engineers. This report calls for three full years of math and science for grades 9-12, as well as courses in technology. In addition, the report recommends student exposure should include:

Awareness of the nature and scope of a wide variety of science and technology related careers open to students of varying aptitudes and interests . . . scientific and technical knowledge needed to fulfill civic responsibilities, improve the students’ own health and life and ability to cope with an increasingly technological world . . . new science curricula that incorporate appropriate scientific and technological knowledge and are oriented toward practical issues. (p. 45)
Dickason (1984) studied the predictive value of secondary school honors-type courses and their correlation to college achievement. A sample of 950 freshmen at Pennsylvania State University made up the sample. The study measured college performance based on prior participation in honors-type courses. Earlier research suggests that students taking honors-type courses generally are of higher ability, have done better in secondary school, and do better in college than their peers who have not participated in higher level courses (Cahow et al., 1979; Chamberlain et al., 1978; Ruch, 1968; Simms, 1982; Weitzman, 1982). Thus, demonstrating stronger secondary school credentials are needed for college success.

A summary of the Dickason study reveals that college GPA differences are greater for students with higher secondary school credentials entering college, and suggests a visible relationship with college success. Various subpopulations were also analyzed and suggest further differentiation by curriculum. Students in science and mathematics based curriculum achieved at a higher level in college than those with less exposure, suggesting the importance of overall high school curriculum leading to subsequent college achievement.

A 1982 study, "College Participation Among Graduates of the College Core Curriculum at Phineas Banning High School," conducted by the California Postsecondary Education Commission, concluded that the greatest barrier to equal educational
opportunity continues to be poor academic preparation of students at the secondary level. It emphasized the need to strengthen high school curriculums and improve their articulation with college curricula:

The major priority in the State effort during the next five years should be to strengthen the basic college preparatory curriculum in mathematics, English, and science at California's junior and senior high schools. This effort must involve cooperation among secondary and post-secondary educators, parents, and local school boards. (p. 25)

Reported data came from students first enrolled at the University of California fall 1976 compared to students enrolled fall 1980. After revising the high school curriculum including increased requirements for mathematics and science courses, the number of students enrolled in four-year colleges increased by 20 compared with those who enrolled in 1976. Increases were also seen in community college enrollments for the same time period. Approximately 50 percent of the 1980 College Core Curriculum graduating class at Banning High School had been below grade level in reading and one-third were below grade level in mathematics prior to changes to the curriculum (p. 16).

Based on the data the following conclusions were drawn:

- Despite the variance in academic abilities and aspirations, the first graduating class of the College Core Curriculum took considerably more courses required for admissions by the University of California, particularly in mathematics and English, than their 1976 college-bound counterparts.
The mean verbal and mathematics Scholastic Aptitude Test (SAT) scores which were recorded for 1980 College Core Curriculum seniors slightly increased over those of the 1976 college-bound group.

More College Core Curriculum Students seem to be attending four-year institutions, particularly the State University, compared to the college-going members of the class of 1976.

The proportion of the entire Banning graduating class attending college has increased over the course of the years studied.

The College Core Curriculum appears to be better preparing students for college study at public four-year colleges as evidenced by less decline in the grade-point average between high school and college-level study from 1976 to 1980.

Finally, 1980 College Core Curriculum graduates performed better at the University of California during their first year than did 1976 Banning graduates and considerably better than their 1980 non-College Core Curriculum counterparts.

Research points to evidence supporting a pattern of post-secondary entrance requirements exerting a major influence on high school graduation requirements (Glendenning, 1991, p. 12). Although high school grade point averages in mathematics and science serve as a strong predictor of college achievement, this may suggest that community college open admission policies create a reason, for persons not interested in attending a four-year college or university immediately after high school, to only take the minimum required math and science courses needed for graduation.
Summary

The literature consistently pointed to the positive influence of advanced high school mathematics courses and subsequent college achievement. Basic and advanced skills learned in high school algebra create a strong foundation for the more rigorous math courses required for college degrees.

Optional program participation in articulated high school programs tend to mature the prospective college student academically to the expectations of college life. Those programs simultaneously create a more smooth transition from high school to college while lessening "senior boredom" experienced by many high schools students.

Of all predictors of college achievement based on high school participation and performance, grade point average was considered to be the most reliable. Standardized placement tests, while viewed as being helpful in assessing student progress, were not considered to be as valuable thus reaffirming that overall high school achievement was the most consistent in predicting subsequent college achievement.
CHAPTER III

METHODOLOGY

Introduction

Chapter III discusses the methods and procedures used in the study. The chapter is divided into the following sections: (a) research design; (b) a description of the study population; (c) essential data; (d) data analysis; and (e) summary. Data collected for this study consisted of information on the entire population of subjects selected from the two community colleges investigated. Findings of this study do not generalize nor can one infer results to any other population of students.

Research Design

Statement of the Problem

It is unknown whether specific academic variables contribute to timely completion of an Occupational and Technical Associate in Applied Science (AAS) Degree program at Southside Virginia or Central Virginia Community Colleges. The academic variables selected for this study were: (a) high school grade point average (HSGPA); (b) community college mathematics placement test scores; (c) successful completion of high school mathematics prerequisites (i.e., algebra I, geometry, algebra II/ trigonometry); (d) the type of high
school enrollment involvement (i.e., dual enrollment or traditional articulation); and (e) the type of high school curriculum involvement (i.e., general or academic).

It was also unknown whether these selected variables contributed to achievement in mathematics courses required for an AAS degree at the two community colleges investigated. Moreover, the relative importance of these variables toward achievement in the engineering technology, drafting and design technology, and electronics technology programs was also unknown.

Research Questions

This study focused on investigation of criteria in three areas. Those areas were: (a) mathematics achievement, based on grade point average, for college math courses required to earn an AAS degree in either drafting and design technology, electronics technology, or engineering technology; (b) overall occupational/technical program achievement based on cumulative grade point average; and (c) time, based on full-time participation, required to graduate with an AAS degree from one of the two community colleges studied.

The research questions were as follows:

1. Which of the selected academic variables are statistically significant in predicting achievement in mathematics courses required for the three
occupational/technical associate degree programs?

2. Which of the selected academic variables are statistically significant in predicting program achievement for full-time occupational/technical associate degree students?

3. Which of the selected academic variables are statistically significant in predicting length of time to program completion for full-time occupational/technical community college students?

**Description of the Study Setting and Population**

Permission to conduct the study was first obtained from the Vice Chancellor of the VCCS and later from the presidents of the two community colleges where data were obtained. Additional college and secondary school personnel were used to collect and organize the pertinent data. Anonymity of students records used in this study was strictly observed.

**Study Setting**

The population for this study was persons enrolled in an associate in applied science degree program in drafting, engineering technology, or electronics at one of two Virginia community colleges. Those colleges were: (a) Central Virginia Community College, and (b) Southside Virginia Community College. The two colleges were selected on the following
criteria: (a) Southside Virginia serves a largely rural population whereas Central Virginia is located in a more populous region serving both city and county schools, (b) approximately 36 percent of all dual enrollment courses offered in the state were offered by these two colleges (Flythe, 1993), (c) both schools offered AAS degree programs in Drafting and Design, Engineering Technology, and Electronics Technology, (d) placement tests administered at both schools were drawn from the Comparative Guidance and Placement Program (CGP) as a part of their Assessment and Placement Services, (e) both Southside Virginia and Central Virginia Community Colleges offer both traditional articulation and dual enrollment options for students seeking an occupational/technical associate in applied science degree since the fall of 1989.

According to the Virginia Community College System (VCCS), the Fall 1994 enrollment was 1,980 FTEs for Southside Virginia Community College (SVCC) while Central Virginia Community College (CVCC) had an enrollment of 1,861 FTEs. CVCC, located in Lynchburg, Virginia, consists of one campus serving the city of Lynchburg and surrounding rural secondary schools. Those schools are: (a) Heritage, (b) E. C. Glass, (c) Amherst County, (d) Appomattox County, (e) Bedford County, and (f) Campbell County.

Southside Virginia Community College (SVCC) offers
programs to students from a ten county service area by the means of a three campus structure. The campuses are John H. Daniel Campus, Keysville, Virginia; Christanna Campus, Alberta, Virginia; and the Campus Without Walls, Emporia, Virginia.

Based on square miles, SVCC maintains the largest service area in the Virginia Community College System (SVCC Student Handbook, 1994-1996). Area public and private schools served by SVCC are: (a) Buckingham County, (b) Cumberland County, (c) Prince Edward County, (d) Fuqua School, (e) Charlotte County, (f) Lunenburg County, (g) Brunswick County, (h) Halifax County, (i) Nottoway County, (j) Mecklenberg County, (k) Greensville County, and (l) portions of Prince George County.

**Study Population**

**Time of Participation**

Data were collected on students \( N = 287 \) enrolled full time (minimum 12 semester hours) starting fall semester 1988 until completion of or withdrawal from the program through summer 1995. Students enrolled prior to the fall semester 1988 were not included in the population because credit earned prior to the fall of 1988 was awarded on the quarter system rather than the present semester system. Students who with-
drew between fall 1988 and summer 1995 were not counted as a part of the population.

**Participation Requirements**

The following criteria were used to select eligible participants which then constitute the study population based on high school academic involvement prior to attending the two community colleges full time. Those criteria were:

1. Persons who were once involved in a traditional articulation program during high school prior to attending full-time (minimum 12 semester hours) at either Central Virginia (CVCC) or Southside Virginia (SVCC) Community College during the specified time period.

2. Persons who were once involved in a dual enrollment (i.e., high school and community college concurrently) program prior to attending full-time at either Central Virginia or Southside Virginia Community College during the specified time period.

3. Persons enrolled full-time during the specified time period at either CVCC or SVCC in an occupational/technical AAS degree program who did not previously participate in a traditional articulation or dual enrollment program.
Prerequisite Identification

Data were collected on students participation in high school mathematics courses prior to full time attendance at one of the two community colleges. The three courses in mathematics offered at the high school level were: (a) algebra I, (b) algebra II/trigonometry, and (c) geometry (see Appendix F). These courses were significant because they are prerequisites to the first college level mathematics course required for graduation from an occupational/technical AAS degree program at the two community colleges.

College Curriculum

Although curriculum titles used by the two colleges are different (i.e., drafting and design technology and engineering technology), degree requirements are similar enough not to justify statistical comparisons of programs between the two schools, as noted in appendices G, H, and I.

Essential Data

Data analyzed in this study focused on three areas. Those areas are: (a) college mathematics achievement, (b) overall occupational/technical program achievement, and (c) time to complete an AAS degree. Table 4 and 5 are summary tables of the variables used for analysis in this study.
Table 4

**Summary table of variables for persons in a general high school curriculum**

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<thead>
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<th>Type of Variable</th>
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<tr>
<td>Program Achievement (GPA)</td>
<td>Interval</td>
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<td>Time to Complete Program</td>
<td>Interval</td>
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</tr>
<tr>
<td>Type of H.S. Curriculum</td>
<td>Nominal</td>
</tr>
<tr>
<td><strong>Covariates:</strong></td>
<td></td>
</tr>
<tr>
<td>High School GPA</td>
<td>Interval</td>
</tr>
<tr>
<td>Placement Test Scores</td>
<td>Interval</td>
</tr>
</tbody>
</table>
Table 5

**Summary table of variables for persons in an academic high school curriculum**

<table>
<thead>
<tr>
<th>Type of Variable</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variables:</strong></td>
<td></td>
</tr>
<tr>
<td>Math Achievement (GPA)</td>
<td>Interval ---</td>
</tr>
<tr>
<td>Program Achievement (GPA)</td>
<td>Interval ---</td>
</tr>
<tr>
<td>Time to Complete Program</td>
<td>Interval ---</td>
</tr>
<tr>
<td><strong>Predictor Variables:</strong></td>
<td></td>
</tr>
<tr>
<td>Type of Enrollment</td>
<td>Nominal Traditional/Dual/Regular</td>
</tr>
<tr>
<td>Type of H.S. Curriculum</td>
<td>Nominal Academic</td>
</tr>
<tr>
<td><strong>Covariates:</strong></td>
<td></td>
</tr>
<tr>
<td>High School GPA</td>
<td>Interval ---</td>
</tr>
<tr>
<td>Placement Test Scores</td>
<td>Interval ---</td>
</tr>
<tr>
<td>Math Prerequisites</td>
<td>Interval AlgI/Geom/AlgII</td>
</tr>
</tbody>
</table>

78
College Math Achievement

Achievement in mathematics courses required for an associate in applied science degree in the three programs investigated was calculated on a 4.0 scale, with 4.0 points representing an "A", 3.0 points awarded for a "B", 2.0 points awarded for a "C", and 1.0 point awarded for a "D". All mathematics course grades were calculated on a 10 point scale with no course credit awarded for final course averages below 59 (i.e., 90-100 = A, 80-89 = B, 70-79 = C, 60-69 = D, and 59-0 = F). Data analysis was obtained using the grade point averages awarded students for participation in Math 161 and 162 (see Appendix J).

Program Achievement

Overall occupational/technical program achievement was calculated using raw scores (GPA) awarded students for participation in courses required for an AAS degree at the two colleges. Only courses required for an AAS degree were used to calculate cumulative GPA. Student GPAs including additional coursework were recalculated to reflect cumulative GPA based on program requirements. Persons (less than 10) having transfer credit from other institutions, or credits awarded on the quarter system were not used in the study population. In addition, persons who exceeded the minimum degree requirements were not included in the analysis of time
required to complete an AAS degree. Identical credit requirements, i.e. 72 credits, were required for program completion by the two colleges investigated. Program achievement was based on a 4.0 scale as defined by the guidelines stated for achievement in college mathematics.

**Time to Program Completion**

Time required for program completion was coded as the number of semesters enrolled full-time (minimum 12 semester credits) starting with the first semester enrolled full time and ending with the semester of graduation. Only students enrolled in an occupational/technical program between the fall semester of 1988 and ending the summer semester of 1995 were included in the study population.

**Variable Selection**

**Dependent Variables**

Three dependent variables; time of matriculation required for AAS degree, achievement in college mathematics courses required for an AAS degree, and overall occupational/technical program achievement while seeking an AAS degree were chosen because they serve as indicators for students seeking an associate degree from the two community colleges investigated in this study. This study investigated interactions between the selected academic predictor variables, covariates, and
dependent variables. The study population was selected on the basis of participation in the following categories. Those categories were: (a) high school curriculum (i.e., general or academic), (b) high school program option (i.e., traditional articulation or dual enrollment), and (c) high school mathematics prerequisites (i.e., algebra I, geometry, algebra II/trigonometry). Although the findings of this study should not be generalized to any other population, they suggest how useful the individual academic variables chosen for investigation in this study are in predicting achievement and time required to complete an AAS degree.

Predictor Variables

The predictor variables investigated in this study were: (a) high school cumulative grade point average (HSGPA), (b) community college mathematics placement test scores, (c) high school math prerequisites (i.e., algebra I, geometry, and algebra II/trigonometry), (d) type of high school enrollment (i.e., traditional articulation (TA), dual enrollment (DE), and regular enrollment [i.e., no prior participation in TA or DE]), and (e) type of high school curriculum participation (i.e., general or academic).

These variables were selected because, as a part of the VCCS open door policy, no level of high school achievement is required for admission to community college programs.
Although high school transcripts are maintained in the records department in the individual colleges, admission is not based on any prior scholarly achievement and does not determine placement in college level courses. This study focuses on how data obtained from analyses using these variables might serve as predictors of achievement at the two community colleges investigated, and also upon the interactions, if any, among the variables.

**Variable Coding**

**Other Predictor Variables Also Used As Covariates**

**High School Grade Point Average**

High school grade point average (HSGPA) was calculated based on a raw score using a 4.0 scale. In several instances, grade points were standardized for high school students for successful participation in honors or advanced placement courses which used a higher scale than grade points awarded for coursework completed in the general curriculum, as shown in Table 6. For the purpose of analysis, all high school grades based on a rating scale higher than 4.0 were re-calculated and adjusted to represent a 4.0 scale. Table 7 illustrates letter grades and corresponding points awarded.

**Placement Test**

Placement test raw scores on the mathematics portion of
Table 6

**Optional achievement rating scale**

<table>
<thead>
<tr>
<th>Grade</th>
<th>AP</th>
<th>Academic</th>
<th>General</th>
<th>Basic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7 points</td>
<td>6 points</td>
<td>5 points</td>
<td>4 points</td>
</tr>
<tr>
<td>B</td>
<td>6 points</td>
<td>5 points</td>
<td>4 points</td>
<td>3 points</td>
</tr>
<tr>
<td>C</td>
<td>5 points</td>
<td>4 points</td>
<td>3 points</td>
<td>2 points</td>
</tr>
<tr>
<td>D</td>
<td>4 points</td>
<td>3 points</td>
<td>2 points</td>
<td>1 point</td>
</tr>
<tr>
<td>F</td>
<td>0 points</td>
<td>0 points</td>
<td>0 points</td>
<td>0 points</td>
</tr>
</tbody>
</table>

Grade-Point Average 1994
Table 7

**Letter grades and corresponding points**

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.0</td>
</tr>
<tr>
<td>A-</td>
<td>3.7</td>
</tr>
<tr>
<td>B+</td>
<td>3.4</td>
</tr>
<tr>
<td>B</td>
<td>3.0</td>
</tr>
<tr>
<td>B-</td>
<td>2.7</td>
</tr>
<tr>
<td>C+</td>
<td>2.4</td>
</tr>
<tr>
<td>C</td>
<td>2.0</td>
</tr>
<tr>
<td>C-</td>
<td>1.7</td>
</tr>
<tr>
<td>D+</td>
<td>1.4</td>
</tr>
<tr>
<td>D</td>
<td>1.0</td>
</tr>
<tr>
<td>D-</td>
<td>.7</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
</tr>
</tbody>
</table>
the Comparative Guidance Placement (CGP) battery were used as a covariate. Southside Virginia (SVCC) maintains a cutoff raw score of 18 as minimum passing requirement for first semester college math. Central Virginia (CVCC) based their cutoff minimum at 50 so a conversion factor of 2.7778 was used to recalculate raw scores from SVCC. Due to scores earned by students at the two schools being recorded differently, all scores earned by SVCC students, on the math portion of the placement test were multiplied by 2.7778 for the purpose of analysis in this study.

**Mathematics Prerequisites**

Data on high school mathematics courses investigated in this study were based on raw scores using a 4.0 rating scale, as shown in Table 7. The three math courses were: (a) algebra I, (b) geometry, and (c) algebra II/trigonometry. For purposes of analysis, the study only included data from students having participated in all three math courses. Analysis of data for students with participation in less than the three mathematics prerequisites were determined to have insufficient cell size. Therefore, persons participating in a general high school curriculum were not included in the analysis of high school mathematics prerequisites.
**Predictor Variables**

**High School Enrollment**

Data coding based on high school enrollment was determined by student participation in one of three categories. Those categories were: (a) participation in a traditional articulation program at the high school, (b) participation in a dual enrollment option, i.e., high school and community college concurrently, and (c) no high school participation in either traditional articulation or dual enrollment prior to full attendance at one of the two community colleges.

**High School Curriculum**

Data coding according to high school curriculum was based on participation in specific high school courses. Curriculum assignment was based on whether or not a student had participated in all three high school mathematics prerequisites prior to attending one of the two community colleges full time. Those curriculum area designations were: (a) general and (b) academic. Persons not having participated in all three mathematics prerequisites were assigned to a general high school curriculum. Persons who participated in all three mathematics prerequisites were assigned to an academic curriculum (see Appendix F).
Dependent Variables

The dependent variables investigated in this study were achievement in required mathematic courses at the community college level, overall achievement in occupational/technical associate degree program, and time required to complete associate degree. Mathematics achievement was measured using individual course grades based on a 4.0 scale. Program achievement was measured using overall occupational/technical program GPA based on all courses required for an AAS degree. Length of time required for program completion was measured in consecutive full-time enrolled (12 semester hours) semesters.

Cell Description

Table 8 illustrates cell assignment according to student participation in high school curriculum and program option. The following cell descriptions are:

Cell 1--high school participation in a general curriculum with no involvement in traditional articulation or dual enrollment;

Cell 2--high school participation in an academic curriculum with no involvement in traditional articulation or dual enrollment;

Cell 3--participation in a general high school curriculum while enrolled in a traditional articulation program option;

Cell 4--participation in an academic high school curriculum while enrolled in a traditional articulation program option.
Table 8

Cell descriptions according to student participation in high school program options

<table>
<thead>
<tr>
<th>Cell</th>
<th>Program Option</th>
<th>Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regular</td>
<td>General</td>
</tr>
<tr>
<td>2</td>
<td>Regular</td>
<td>Academic</td>
</tr>
<tr>
<td>3</td>
<td>Traditional Articulation</td>
<td>General</td>
</tr>
<tr>
<td>4</td>
<td>Traditional Articulation</td>
<td>Academic</td>
</tr>
<tr>
<td>5</td>
<td>Dual Enrollment</td>
<td>General</td>
</tr>
<tr>
<td>6</td>
<td>Dual Enrollment</td>
<td>Academic</td>
</tr>
</tbody>
</table>

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Cell 5--participation in a general high school curriculum while enrolled in a dual enrollment program option; and

Cell 6--participation in an academic high school curriculum while enrolled in a dual enrollment program option.

Data Analysis

The information gathered by this study on the data analysis procedure is described in two stages. Stage one is the initial analysis which is designed to test for possible statistical significance using a 2X3 MANCOVA and a One-Way MANCOVA. Tests of research assumptions will be conducted on data in stage one. Stage two will be the development of a regression model using any statistically significant predictors found from the analysis of stage one. For the purpose of determining statistical significance, the alpha level of $p < .05$ was used in this study.

Initial Analysis

The initial phase of data analysis was intended to identify significant interactions of the predictor variables on the three dependent variables simultaneously. The three dependent variables were: (a) college math achievement, (b) overall occupational/technical program achievement, and (c) time to complete an AAS degree. The predictor variables were high school curriculum and high school program option. The covariates also used as predictor variables were: (a) high
school GPA, (b) placement test scores, and (c) mathematics prerequisites for persons in an academic curriculum. Data collected on high school math prerequisites was based on grade point average for each of the three math prerequisites, to identify possible significant interactions between high school math courses and college achievement, at the $p < .05$ level.

Tests of Assumptions

1) The observations on the three dependent variables follow a multivariate normal distribution in each of the six groups.

   - A graphical test incorporating Mahalanobis distance was used to determine multivariate normality in each of the six groups. If non-normality is evident, then skewness and kurtosis coefficients on each of the three variables within each group will be calculated and, if necessary, transformations to normalize data were conducted.

2) The population covariance matrices for the three dependent variables in each group are equal.

   - Box’s test was conducted to assess the homogeneity of the covariance assumption. According to test assumption #1, violations of the homogeneity of covariance should be avoided.
3) Multicollinearity does not exist between the dependent variables.
   - The inherent purpose of this study necessitates incorporating both Math GPA and total Program GPA into the multivariate analysis. Because Math GPA is incorporated into the calculation of Program GPA, a relationship between these two variables must exist. A correlation matrix will be constructed to determine the degree to which Math GPA and total Program GPA were correlated.

4) There is a linear relationship between the dependent variables and the covariates.
   - A correlation matrix will be calculated to determine the relationship between the dependent variables and the covariates. In addition a series of scatter plots will be constructed to evaluate the linearity of relationships.

5) There is homogeneity of the regression planes for each group.
   - This assumption is met when there is no evidence of an interaction between a covariate and a categorical variable. Command lines to test for significant interactions will be incorporated into the SPSS MANCOVA procedure.
MANCOVA

A test to identify the relationship between college math achievement and overall occupational/technical program achievement identified a moderately strong correlation between the variables. A procedure to test for the relationship among the dependent variables was recommended in the NCSS 5.3 Advanced Statistical Reference Manual.

As a result of the strong correlation between variables a 2x3 MANCOVA was conducted to identify significance of row effects (curriculum), column effects (high school enrollment), and interactions of these on the three dependent variables; simultaneously, using high school GPA and scores on standardized mathematics placement tests as covariates. The analysis was selected as a means of securing the most powerful analytical tool suitable for analyzing the data collected in this study. The principal advantage of the multivariate procedure used over a traditional test of separate univariate F tests is that it permits a test of possible interactions among the multiple criteria that can not be evaluated as well if the criterion variable is tested on its own (Bounds, Cormier & Huck, 1974, p. 192). By using a multivariate analysis, the statistical test insures maximum sensitivity to differences among variables being compared. Although the groups may not be significantly different on individual variables, jointly the set of variables may combine to produce
overall difference (Stevens, 1992, pp. 152-153).

**Post-Hoc Analysis**

Post-hoc procedures were used to identify significant differences between dependent variable(s) means and the predictor variable(s) that contributed to those differences. The procedures were implemented after initial multivariate analysis determined a significant interaction between main effects. Therefore, further analysis was needed to identify contributors to that interaction.

To test which enrollment group’s adjusted means differ, a post-hoc procedure utilizing the Bryant-Paulson test was conducted. The Bryant-Paulson test uses the following formula:

\[
BP = \frac{\bar{Y}_i^* - \bar{Y}_j^*}{\sqrt{MS_{a^*}[1 + \frac{1}{(J - 1) \ TR(B_e W_e^{-1})]/n}}}
\]

**One-way MANCOVA**

A One-way MANCOVA was conducted to identify the significance of the main effect (enrollment) on the three dependent variables, simultaneously, using high school GPA, scores on standardized placement tests, algebra I GPA, geometry GPA, and algebra II GPA as covariates. Post-hoc procedures were conducted to identify significant differences
between means, if any, and the dependent variable(s) that may have contributed to those differences.

**One-Way MANCOVA Cell Description**

Table 9 illustrates cell assignment according to high school mathematics achievement (i.e., algebra I, geometry, and algebra II/trigonometry) and high school enrollment option. The following cell descriptions are:

- **Cell 1**—high school mathematics achievement (HSGPA) and no participation in traditional articulation or dual enrollment,
- **Cell 2**—high school mathematics achievement and participation in a traditional articulation program, and
- **Cell 3**—high school mathematics achievement and participation in a dual enrollment program.

**Regression Analysis**

Stage two of this study used multiple regression analysis to analyze the data gathered from students. The level of significance was established at the $p < .05$ level. The variables used to predict community college achievement and time required to finish an occupational/technical AAS degree program were:

(a) prior completion of high school mathematics, i.e., algebra I, geometry, and algebra II/trigonometry, prerequisites measured by individual course GPA;

(b) prior participation in a dual-enrollment program
Table 9

**Cell assignment according to high school mathematics achievement**

<table>
<thead>
<tr>
<th>Cell</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regular</td>
</tr>
<tr>
<td>2</td>
<td>Traditional Articulation</td>
</tr>
<tr>
<td>3</td>
<td>Dual Enrollment</td>
</tr>
</tbody>
</table>
designed to offer high school students the opportunity to enroll in occupational/technical community college courses, i.e., drafting and design, engineering technology, and electricity/electronics, concurrently during their junior and senior years;

(c) participation in a traditional articulation program, prior to attending a community college, designed to award students advanced placement (AP) or specific course work waiver for technical courses taken in high school. Course credit is generally awarded for first semester community college courses, however, may also include second semester courses depending on the agreement signed between the secondary and post-secondary institutions.

(d) cumulative grade point average (GPA) on all high school coursework attempted prior to high school graduation. Credit awarded to student for dual-enrollment courses is included in the calculations of high school and community college GPA.

(e) achievement, i.e., raw score, on the math portion of a comparative guidance placement pre-test taken prior to enrolling in community college courses.

(f) type of high school curriculum completed, i.e., general or academic, prior to attending community college full time.
Variables

Table 10 is a list of variables used in the second part of this analysis. The purpose of the second stage was to determine a means of predicting college math achievement, overall program achievement, and time required to complete program.

Tests of Regression Assumptions

Tests of regression assumptions were conducted, which were identical to the tests of assumptions conducted for the 2x3 MANCOVA; therefore, they were not duplicated in this section.

Theoretical Regression Model

The theoretical regression model used for this portion of the study prior to a determination of statistical significance is as follows:

Dependent Variables:

\[ Y_1 = \text{achievement in college level mathematics courses} \]
\[ Y_2 = \text{overall occupational/technical program achievement} \]
\[ Y_3 = \text{time required to complete occupational/technical AAS degree} \]

Predictor Variables:

\[ X_1 = \text{participation in dual enrollment} \]
Table 10

**Summary Table of Regression Variables**

<table>
<thead>
<tr>
<th>Type of Variable</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Achievement (GPA)</td>
<td>Interval</td>
</tr>
<tr>
<td>Program Achievement (GPA)</td>
<td>Interval</td>
</tr>
<tr>
<td>Time to Complete Program</td>
<td>Interval</td>
</tr>
</tbody>
</table>

**Dependent Variables:**

**Predictor Variables:**

<table>
<thead>
<tr>
<th>Type of Enrollment</th>
<th>Nominal</th>
<th>Traditional/Dual/Regular</th>
</tr>
</thead>
</table>

**Covariates:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type of</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School GPA</td>
<td>Interval</td>
<td>---</td>
</tr>
<tr>
<td>Placement Test Scores</td>
<td>Interval</td>
<td>---</td>
</tr>
<tr>
<td>Math Prereq.-Algebra I</td>
<td>Interval</td>
<td>---</td>
</tr>
<tr>
<td>Math Prereq.-Geometry</td>
<td>Interval</td>
<td>---</td>
</tr>
<tr>
<td>Math Prereq.-Algebra II</td>
<td>Interval</td>
<td>---</td>
</tr>
</tbody>
</table>
\[ X_2 = \text{participation in traditional articulation} \]
\[ X_3 = \text{no participation in dual enrollment or traditional articulation} \]
\[ X_4 = \text{participation in academic curriculum} \]
\[ X_5 = \text{GPA in algebra I} \]
\[ X_6 = \text{GPA in geometry} \]
\[ X_7 = \text{GPA in algebra II/trigonometry} \]
\[ X_8 = \text{HSGPA} \]
\[ X_9 = \text{placement test scores} \]

Therefore the theoretical statistical model is as follows:

\[ Y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + C \]

\[ Y_2 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + C \]

\[ Y_3 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + C \]

**Summary**

The methodology proposed in this chapter was designed to identify which of the selected academic variables were statistically significant in predicting college mathematics achievement, overall occupational/technical program achievement, and time required to complete an AAS degree. The design was developed in two stages. First, tests of assumptions were conducted to assess normality and homogeneity of data. A 2X3 MANCOVA was conducted to identify the effect of predictor variables and their interactions on the three dependent
variables. Next, a one-way MANCOVA was conducted to identify possible statistical significance of main effects on the three dependent variables and covariates. Post-hoc procedures were used, if necessary, to identify differences between means and the dependent variables possibly contributing to any differences found. Upon identification of statistical significance, between variables, a regression model was developed to create a means of prediction for the three dependent variables.
CHAPTER IV

DATA PRESENTATION AND FINDINGS

Introduction

The purpose of this study was to determine the relative importance of selected academic variables in predicting mathematics performance of students enrolled full-time at either Central Virginia Community College in Lynchburg, Virginia, or Southside Virginia Community College located in Keysville and Alberta, Virginia. Secondly, the study was to ascertain the extent those variables may relate to overall program performance, and thirdly, what relationship those variables may have to length of time required to complete an occupational/technical degree program.

This chapter is divided into three topical sections. Those sections are: (a) introduction, (b) data presentation and findings, and (c) summary.

Data for this study were supplied by the Virginia Community College System, and collected with assistance from the Department of Planning and Research (VCCS), and from individual high school transcripts located at the respective colleges.

Tests of Assumptions

Assumption 1. The observations on the three dependent
variables follow a multivariate normal distribution in each of the six groups.

Results: Due to insufficient cell sizes necessary to conduct a graphical test incorporating Mahalanobis distances, a univariate assessment of normality within each group was conducted. Specifically, Kolmogorov-Smirnov tests of univariate normality within each of the six groups was conducted along with the calculation of skewness and kurtosis coefficients, using an alpha level of .05 (see Appendix K). The results revealed significant nonnormality in five of the six groups on the dependent variable "Time". To detect the influence of possible outliers on the normality of the data within these five groups, a normal probability plot was generated for "Time". The plots identified an outlier which potentially contributed to nonnormality in four of the five groups. These outliers were removed and the analysis of univariate normality was repeated. This created normality within the groups on each dependent variable and covariate. The nonnormality in the fifth group (cell 2) was caused by a significant leptokurtosis coefficient. However, because this coefficient was significant on only one dependent variable within
one cell, the power of the test was not compromised. Therefore, no transformation to normalize data was conducted.

Assumption 2. The population covariance matrices for the three dependent variables in each group were not significantly different.

Results: Both a univariate test (Bartlett-Box Test) and a multivariate test (Box's M) was conducted to test the homogeneity of covariance assumption. The results of the tests were nonsignificant (see Appendix K). Therefore, the covariance matrices were not significantly different on the three dependent variables, and the assumption of homogeneity of covariance was satisfied.

Assumption 3. There is a significant relationship between the dependent variables and the covariates.

Results: The results of the correlation matrix indicated moderate relationships between "HSGPA" and "MATHGPA" (.50), "PRGMPGA" (.49) and a slightly weaker relationship between "PLMTSCRS" and "MATHGPA" (.44), "PRGMPGA" (.27). Weak relationships were found between the two covariates and "TIME". However, jointly the covariates had a significant effect on the dependent variables.
Thus, the assumption was tentatively satisfied since a weak relationship existed between each of the covariates and "TIME".

Assumption 4. There is homogeneity of the regression planes for each group.

Results: The results indicated that there was no significant interaction of regression planes. According to the Test of Homogeneity the following results were determined:

\[ F = 1.16482, \text{df} \ 6/107, \ p = .331 \]
\[ F = 1.34543, \text{df} \ 6/107, \ p = .244 \]
\[ F = .64947, \text{df} \ 6/107, \ p = .690 \]

Thus, the assumption was satisfied.

2X3 MANCOVA

Findings according to the 2X3 MANCOVA are recorded in Table 11. Descriptive statistics presented include means (M), standard deviations (SD), and standard error of means (SE). The alpha level for all statistical tests was set at .05.

Correlation Results

Correlation procedures were used to examine relationships among selected academic variables and the three dependent variables identified in this study. The academic variables
Table 11

Descriptive analysis data for 2X3 MANCOVA

<table>
<thead>
<tr>
<th>Variables</th>
<th>General Curriculum</th>
<th>Academic Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>TIME¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>6.93</td>
<td>2.13</td>
</tr>
<tr>
<td>Traditional Articulation</td>
<td>6.75</td>
<td>1.28</td>
</tr>
<tr>
<td>Dual Enrollment</td>
<td>6.00</td>
<td>2.30</td>
</tr>
<tr>
<td>MATHGPA²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>2.06</td>
<td>1.07</td>
</tr>
<tr>
<td>Traditional Articulation</td>
<td>2.33</td>
<td>.92</td>
</tr>
<tr>
<td>Dual Enrollment</td>
<td>2.21</td>
<td>1.09</td>
</tr>
<tr>
<td>PRGMGPA²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>2.86</td>
<td>.58</td>
</tr>
<tr>
<td>Traditional Articulation</td>
<td>2.56</td>
<td>.64</td>
</tr>
<tr>
<td>Dual Enrollment</td>
<td>2.99</td>
<td>.68</td>
</tr>
<tr>
<td>HSGPA²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>2.27</td>
<td>.50</td>
</tr>
<tr>
<td>Traditional Articulation</td>
<td>2.44</td>
<td>.51</td>
</tr>
<tr>
<td>Dual Enrollment</td>
<td>2.36</td>
<td>.52</td>
</tr>
<tr>
<td>PLMTSCRS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>51.72</td>
<td>9.22</td>
</tr>
<tr>
<td>Traditional Articulation</td>
<td>52.67</td>
<td>11.82</td>
</tr>
<tr>
<td>Dual Enrollment</td>
<td>47.24</td>
<td>12.52</td>
</tr>
</tbody>
</table>

¹ TIME was measured in semesters
² GPA was expressed using a 4.0 scale
are: (a) high school grade point average (HSGPA), and (b) placement test scores. The three dependent variables are: (a) college math GPA, (b) overall occupational/technical program GPA, and (c) time required to complete an AAS degree. The correlation coefficients for these variables are presented in Table 12 and 13.

The correlation matrix indicated a weak negative correlation between time and college math achievement (GPA), time and overall program achievement (GPA), and time and high school GPA. Invariably, the lower the math GPA, program GPA, and high school GPA, the more time required to complete requirements for an associate degree. Additionally, a weak positive correlation was found between the mathematics portion of the college placement test and time required to complete program.

A moderate correlation existed between college math achievement and high school achievement. Analysis also determined a moderately strong relationship between college math achievement and placement test scores.

Program achievement (GPA) and high school GPA were determined to have a moderate positive correlation. However, a weaker correlation between placement test scores and program GPA was observed.
Table 12

Pearson correlation coefficients showing relationships among time, mathgpa, prmgpa, hsgpa, and plmtscrs variables (n = 119)

<table>
<thead>
<tr>
<th></th>
<th>TIME</th>
<th>MATHGPA</th>
<th>PRGMGPA</th>
<th>HSGPA</th>
<th>PLMTSCRS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( r )</td>
<td>( r^2 )</td>
<td>( r )</td>
<td>( r^2 )</td>
<td>( r )</td>
</tr>
<tr>
<td>TIME</td>
<td>1.0000</td>
<td>-0.0923</td>
<td>-0.2530</td>
<td>-0.1538</td>
<td>0.0778</td>
</tr>
<tr>
<td>MATHGPA</td>
<td>1.0000</td>
<td>0.6487</td>
<td>0.4208</td>
<td>0.5011</td>
<td>0.4500</td>
</tr>
<tr>
<td>PRGMGPA</td>
<td>1.0000</td>
<td>0.4974</td>
<td>0.2474</td>
<td>0.2729</td>
<td>0.0745</td>
</tr>
</tbody>
</table>

Dependent Variables

Covariates

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HSGPA</td>
<td>1.0000</td>
<td>0.4269</td>
<td>0.1822</td>
</tr>
<tr>
<td>PLMTSCRS</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
</tbody>
</table>
Table 13
Pearson correlation coefficients showing relationships among time, mathgpa, prgmgpa, hsgpa, plmtscrs, alg1, geom, and alg2 variables
(n = 88)

<table>
<thead>
<tr>
<th></th>
<th>TIME</th>
<th>MATHGPA</th>
<th>PRGMGPA</th>
<th>HSGPA</th>
<th>PLMTSCRS</th>
<th>ALG1</th>
<th>GEOM</th>
<th>ALG2</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME</td>
<td>1.0000</td>
<td>-0.0746</td>
<td>-0.2453</td>
<td>-0.1325</td>
<td>0.0583</td>
<td>-0.2164</td>
<td>0.0468</td>
<td>-0.1724</td>
</tr>
<tr>
<td>MATHGPA</td>
<td>1.0000</td>
<td>0.5869</td>
<td>0.3445</td>
<td>0.3982</td>
<td>0.3450</td>
<td>0.4762</td>
<td>0.2268</td>
<td>0.4187</td>
</tr>
<tr>
<td>PRGMGPA</td>
<td>1.0000</td>
<td>0.3937</td>
<td>0.1550</td>
<td>0.1522</td>
<td>0.0232</td>
<td>0.4098</td>
<td>0.1679</td>
<td>0.2775</td>
</tr>
</tbody>
</table>

Dependent Variables

<table>
<thead>
<tr>
<th></th>
<th>TIME</th>
<th>MATHGPA</th>
<th>PRGMGPA</th>
<th>HSGPA</th>
<th>PLMTSCRS</th>
<th>ALG1</th>
<th>GEOM</th>
<th>ALG2</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME</td>
<td>1.0000</td>
<td>0.4045</td>
<td>0.1636</td>
<td>0.5511</td>
<td>0.3037</td>
<td>0.6626</td>
<td>0.4390</td>
<td>0.6341</td>
</tr>
<tr>
<td>MATHGPA</td>
<td>1.0000</td>
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<td>0.1444</td>
<td>0.4215</td>
<td>0.1777</td>
<td>0.4503</td>
<td>0.2028</td>
<td></td>
</tr>
<tr>
<td>PRGMGPA</td>
<td>1.0000</td>
<td>0.5764</td>
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<td>0.5626</td>
<td>0.3165</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HSGPA</td>
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<td>0.6475</td>
<td>0.4193</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLMTSCRS</td>
<td>1.0000</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
High school achievement (GPA) was found to correlate moderately high with the mathematics portion of the college placement test (CGP).

In summary, the results of the correlation matrix indicated a moderate relationship between high school GPA and math GPA (.50), program GPA (.49), and a slightly weaker relationship between placement test scores and math GPA (.44), and program GPA (.27). Weaker relationships were found between the two covariates and time required to complete program. However, jointly the covariates had a significant relationship to the dependent variables.

Descriptive Overview of 2X3 MANCOVA Data

The dependent variables were: (a) college math achievement, (b) overall occupational/technical program achievement, and (c) time required to finish an AAS degree. Predictor variables investigated were: (a) type of high school enrollment (i.e., traditional articulation [TA], dual enrollment [DE], no participation with either TA or DE), and (b) type of high school curriculum (i.e., general or academic). Covariates used for analysis were: (a) high school GPA, and (b) placement test scores.

For purpose of explanation, data was compared according to high school participation in a general high school curriculum (n = 119) and participation in an academic high
school curriculum (n = 88), while simultaneously participating in either a traditional articulation or dual enrollment program option or none. Data organization according to this particular format is found in Table 14 and 15.

**College Mathematics Achievement Descriptive Findings**

This study found that regular community college students having participated in a general high school curriculum had the lowest college mathematics achievement of any group with a mean GPA of 2.06 (SD = 1.07). In contrast, traditional articulation persons were reported to have the highest mathematics achievement maintaining a mean GPA of 2.33 (SD = .91). Dual enrollment students fell at the midrange with a mean GPA of 2.21 (SD = 1.08).

Persons enrolled in an academic high school curriculum were consistently higher in all three program options, however, followed the same scenario as persons in a general high school curriculum. Regular college students reported the lowest mathematics achievement with a mean GPA of 2.68 (SD = .99), while dual enrollment students again were recorded at the midrange with a mean GPA of 2.73 (SD = 1.13). Similarly, traditional articulation students maintained the highest level of college math achievement with a mean GPA of 3.22 (SD = .73). The study concluded that participation in an academic high school curriculum created higher mathematics achievement.
<table>
<thead>
<tr>
<th>Enrollment Option</th>
<th>Variables</th>
<th>General</th>
<th>Academic</th>
<th>Overall</th>
<th>Group M</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Adjusted</td>
<td>Observed</td>
<td>Adjusted</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>MATHGPA</td>
<td>2.0643</td>
<td>2.3530</td>
<td>2.6780</td>
<td>2.4830</td>
<td>2.427</td>
</tr>
<tr>
<td></td>
<td>PRGMGPA</td>
<td>2.8606</td>
<td>3.0810</td>
<td>2.9973</td>
<td>2.8620</td>
<td>2.943</td>
</tr>
<tr>
<td></td>
<td>MATHGPA</td>
<td>2.3334</td>
<td>2.4930</td>
<td>3.2241</td>
<td>2.7000</td>
<td>2.914</td>
</tr>
<tr>
<td></td>
<td>PRGMGPA</td>
<td>2.5551</td>
<td>2.6750</td>
<td>3.1923</td>
<td>2.8390</td>
<td>2.971</td>
</tr>
<tr>
<td>Dual Enrollment</td>
<td>TIME</td>
<td>6.0000</td>
<td>5.8570</td>
<td>6.5000</td>
<td>6.5180</td>
<td>6.200</td>
</tr>
<tr>
<td></td>
<td>MATHGPA</td>
<td>2.2083</td>
<td>2.5590</td>
<td>2.7292</td>
<td>2.6490</td>
<td>2.417</td>
</tr>
<tr>
<td></td>
<td>PRGMGPA</td>
<td>2.9921</td>
<td>3.1185</td>
<td>3.2038</td>
<td>3.1640</td>
<td>3.078</td>
</tr>
</tbody>
</table>

111
Table 15

**Observed and adjusted means by curriculum option participation**

<table>
<thead>
<tr>
<th>Variables</th>
<th>General</th>
<th>Academic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Adjusted</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>MATHGPA</td>
<td>2.154</td>
<td>2.431</td>
</tr>
<tr>
<td>PRGMGPA</td>
<td>2.860</td>
<td>3.029</td>
</tr>
</tbody>
</table>
as compared to those participating in a general high school curriculum. The lowest mathematics achievement for persons in an academic curriculum (regular college students) scored higher than any of the three groups investigated having participated in only a general high school curriculum.

**Program Achievement Findings**

Overall occupational/technical program achievement (GPA) for persons involved in a general high school curriculum was found to be somewhat different among the three program options, as compared to math achievement. Traditional articulation students reported the lowest program achievement with a mean GPA of 2.56 (SD = .64), with regular college students having a mean GPA of 2.86 (SD = .58). Dual enrollment students reported the highest in overall program achievement with a mean GPA of 2.99 (SD = .68).

Program achievement for persons involved in an academic high school curriculum rated consistently higher than those in a general curriculum. Regular college students had the lowest program achievement with a mean GPA of 3.00 (SD = .58) which were still higher than all three groups for those participating in a general curriculum. The traditional articulation students reported a mean GPA of 3.19 (SD = .51), while dual enrollment program achievement rated highest of all groups with a mean GPA of 3.20 (SD = .47).
Time To Complete

Time required to complete a program was stated in terms of semesters. Persons participating in a general curriculum with no involvement (i.e., regular), in a traditional articulation or dual enrollment program required the most time to finish an AAS degree, recording a mean time of 6.93 (SD = 2.12) semesters for program completion as compared to a slightly lower mean of 6.75 (SD = 1.28) semesters for persons having participated in a traditional articulation option. Dual enrollment students required the least amount of time to complete a program with a mean of 6.00 (SD = 2.30) semesters.

Similar results were reported for students having participated in an academic high school curriculum. Regular college students required the greatest amount of time to finish an AAS degree of all persons in an academic curriculum with a mean of 6.90 (SD = 2.12). However, this was still less than those participating in a general curriculum. Traditional articulation students required somewhat less time with a mean of 6.73 (SD = 1.66) semesters. The least amount of time for persons in an academic curriculum was understandably the dual enrollment population with a mean of 6.50 (SD = 3.03) semesters required to complete an occupational/technical program while seeking an AAS degree.
High School Achievement (GPA)

Descriptive statistics generated by this study based on high school cumulative grade point averages reported that regular college students (i.e., persons without articulation experience) in a general curriculum had the lowest overall high school GPA of all groups investigated with a mean of 2.27 (SD = .49). Dual enrollment students were next highest with a high school GPA mean of 2.36 (SD = .51). The general curriculum group with the highest high school GPA were traditional articulation students with a mean of 2.44 (SD = .50). High school GPAs for all persons participating in a general high school curriculum were lower than those participating in an academic curriculum.

High school students participating in an academic curriculum were again the highest achievers. Dual enrollment participants had the lowest reported high school GPA with a mean of 2.70 (SD = .49), while regular college students had a midrange mean high school GPA of 2.87 (SD = .50). Traditional articulation students were reported to have the highest cumulative high school GPA of all groups with a mean of 3.22 (SD = .46).

Placement Test Scores

Placement test scores on the mathematics portion of the CGP also found that persons involved in a general curriculum
during high school consistently scored lower than those participating in an academic curriculum. Dual enrollment students scored lowest on the math placement tests with a mean score of 47.24 (SD = 12.51), while regular college students scored the next highest with a mean score of 51.72 (SD = 9.22). Students in a general curriculum while participating in a traditional articulation program option were reported to have scored the highest with a mean of 52.67 (SD = 11.82).

As previously reported, persons involved in an academic curriculum while in high school, performed at a higher level than those persons participating in a general curriculum. Dual enrollment students recorded the lowest scores on the math placement test with a mean of 55.81 (SD = 12.94), while regular college students scored a mean of 56.26 (SD = 12.21). Once again, traditional articulation persons scored highest with a mean of 60.70 (SD = 9.01).

Results of 2X3 MANCOVA

According to Wilks Lambda criterion (W.L.(6,218) = .96870, p = .744), the results indicate that, after adjusting for the effects of the covariates, the multivariate and univariate interaction between the "ENROLLMT" and "HSCURR" was found to be not significant. Further, the main effect for "HSCURR" is not significant in either the multivariate or univariate analysis (W.L.(3,109) = .97964, p = .522). How-
ever, a significant multivariate main effect for "ENROLLMT" was found (W.L.(6,218) = .88923, p = .044). The univariate analysis indicates that only "PRGMGPA" is responsible for the differences between the groups based on "ENROLLMT" (W.L.(2,111) = 3.96197, p = .022).

A post-hoc procedure utilizing the Bryant-Paulson test was conducted to determine which enrollment group’s adjusted means significantly differ. The results of the test finds that only the difference between the traditional group’s adjusted mean and the dual enrollment group’s adjusted mean is statistically significant at an alpha level of .05. Specifically, the dual enrolled group’s adjusted mean (3.196) is significantly higher than the traditional group’s adjusted mean (2.819).

Tests of Assumptions for One-Way MANCOVA

Identical tests of assumptions were conducted prior to analysis using the one-way MANCOVA. All assumptions were satisfied as reported in Appendix K.

Results of One-Way MANCOVA

The results indicate that, after adjusting for the effects of the covariates, the multivariate and univariate main effect for enrollment was found not to be significant (W.L.(6,156) = .92130, p = .372). Thus, the adjusted popula-
tion means for the three dependent variables were also not found to be statistically different between regular, dual enrollment, and traditional articulation enrollment groups.

Results of Regression Analysis

After having conducted the multivariate analyses on both sets of data (i.e., for persons in a general or academic high school curriculum), regression models incorporating the variables found to be statistically significant were developed. The following statistical model shows a means of predicting MATHGPA, PRGMGPA, and TIME required to complete an AAS degree program for persons in a general high school curriculum according to results of analysis to determine statistical significance.

\[
Y_2 = \beta + \beta_1X_1 + \beta_2X_2 \\
MATHGPA' = .6769885 + .6784832(HSGPA) + .02575(PLMTSCRS)
\]

\[
Y_3 = \beta + \beta_1X_1 - \beta_2X_2 + \beta_3X_3 \\
PRGMGPA' = 1.491243 + .552559(HSGPA) - .1515477(TA) + .20717(DE) \\
Y_4 = \beta - \beta_3X_3 \\
TIME' = 8.18443 - .5600783(HSGPA)
\]

High school GPA and scores on mathematics placement tests were found to be the only statistically significant factors in predicting college math achievement. This study found that high school GPA, participation in a traditional articulation
and dual enrollment program option proved to be the only statistically significant factors when predicting overall program achievement. The only statistically significant predictor of time required to complete an AAS degree for those persons in a general high school curriculum was found to be high school GPA.

Based on findings of the one-way MANCOVA, statistically significant variables were included in the prediction regression equation for each dependent variable. The statistical model for persons participating in an academic high school curriculum is as follows:

\[ Y_2 = \beta + \beta_3 X_3 \]

\[ \text{MATHGPA}' = 1.477312 + .5202233(\text{ALG1 GPA}) \]

\[ Y_3 = \beta + \beta_3 X_3 + \beta_5 X_5 \]

\[ \text{PRGMGPA}' = 1.878357 + .1835056(\text{ALG1 GPA}) + \]

\[ .2617162(\text{HSGPA}) \]

\[ Y_4 = \text{No significant variables found} \]

\[ \text{TIME}' = \text{no significant variables found} \]

The only statistically significant predictor of college math GPA for persons participating in an academic high school curriculum was found to be algebra I GPA. Statistically significant factors in predicting overall program achievement were found to be high school GPA and algebra I GPA. No statistically significant predictors were found for time to complete an AAS degree for persons in an academic curriculum.
Summary

This chapter reports findings based on analysis of data to determine which selected academic variables were found to be statistically significant in predicting college math achievement, overall occupational/technical program achievement, and time to complete an AAS degree. Tests of assumptions were conducted and as a result all were satisfied. Having conducted multivariate analysis on data from persons in both a general and academic high school curriculum, the statistically significant predictors were identified. For persons participating in a general curriculum, high school GPA was the best predictor of time required to complete an AAS degree, while college math achievement was best predicted by high school GPA and college mathematics placement test scores. Overall program achievement was best predicted by high school GPA and participation in a traditional articulation or dual enrollment program.

For persons participating in an academic high school curriculum, no statistically significant predictors were found on time required to complete an AAS degree. College math achievement was best predicted by achievement in algebra I. Significant predictors for overall college achievement were high school GPA and algebra I.
CHAPTER V

SUMMARY, INTERPRETATION OF RESULTS, IMPLICATIONS AND SUGGESTIONS FOR FURTHER STUDY

Introduction

This chapter reviews the study, discusses the findings and implications, and delineates conclusions and suggestions for further research. Chapter five is organized into the following sections: (a) significance of the study, (b) purpose of the study, (c) review of the methodology, (d) summary of the findings, (e) discussion of the theoretical and practical implications, and (f) suggestions for further research.

Since this study investigated persons involved in an engineering technology curriculum, while pursuing an AAS degree at one of the two community colleges, one may conclude that high school mathematics and high school grade point average would be found as significant contributors to college math achievement, as well as overall college program achievement. Therefore, it does not infer similar results to persons enrolled in other curricula.

Only persons participating in an academic high school curriculum (i.e., having completed all three math prerequisites) were analyzed according to how that participation may have influenced college math and overall program achievement. Thus one cannot make any generalizations as to the effects of those math prerequisites, taken either singly or in
combination, upon college achievement for persons in other curricula. Moreover the effects of having participated in less than all three high school math courses was likewise not studied.

This study does not take into account what effect participating in specialized technical or vocational courses while in high school may have on overall college program achievement. Nor can one make inferences regarding participation in any other high school program as a result of conclusions drawn by this study.

Significance of the Study

The Virginia Community College System (VCCS) states, as a part of its overall mission, "to assure that all individuals in the diverse regions of the Commonwealth of Virginia are given a continuing opportunity for the development and extension of their skills and knowledge through quality programs and services..." (Virginia Community College System, 1981). The "Purpose of the VCCS" also states, "programs shall be designed to serve the educational needs of qualified post-high school age youth and adults to prepare them for employment or advanced collegiate education, (VCCS Policy, 1992).

The basis of the community college mission, to serve anyone who can benefit from any of its programs, has created a situation wherein persons having diverse educational
backgrounds seek to gain knowledge and learn employable skills from a community college experience (State Board of Community Colleges, 1981). Many of these persons, however, are lacking the prior educational experiences which would prepare one for the rigors of college.

In an effort to prepare those persons who need additional background knowledge in the areas of English and mathematics, the community colleges offer, as a part of their developmental program, courses to strengthen skills required in college level courses. As a result, the student is involved in satisfying coursework considered prerequisite to courses required for an associate degree. This tends to lengthen the time required to complete an occupational/technical program beyond two years.

One option secondary schools routinely employ, in an effort to head off potential delays in community college program completion, is offering students an opportunity to earn college credit while enrolled full-time in high school.

The program options are student participation in a traditional articulation, or dual enrollment program. Those programs extend to high school students the opportunity to earn both high school and college credit concurrently, thus potentially shortening the time required to complete a community college degree program.

Students also have the means to reduce the likelihood of
needing to enroll in developmental courses at the community college. Completion of high school mathematics courses, which serve as prerequisites to college level math courses, may enhance math skills adequately to allow the beginning college student to move directly into college level math without the need for developmental courses.

According to the "Plan for Dual Enrollment", created in 1988, the VCCS is constantly searching for ways to evaluate its programs, as well as a means by which it can better serve the citizens of Virginia. The research conducted in this study examined the relationships between selected academic variables and student achievement at two Virginia community colleges. Those potential relationships might provide a basis for predicting student achievement. This study offers a means of predicting college achievement as well as assessing how participation in high school curricula and optional program affiliation may contribute to that achievement. This study also focuses on how high school achievement and participation in optional programs may relate to time required to complete a community college degree.

Purpose of the Study

The purpose of this study was to determine the ability of selected variables to predict the academic performance of students enrolled full-time in one of two Virginia community
colleges and the length of time required for completion of an occupational/technical associate in applied science degree program. Prior to this study, it was unknown to what extent selected academic factors relating to these variables would contribute to academic performance for community college students or what relationship those variables have to the length of time required to finish an occupational/technical degree program. However, by determining the relationships of these selected variables to academic performance in community college curricula, one might better predict both college achievement in an occupational/technical program and the time required to complete such a program.

**Review of Methodology**

Data used in this study were collected with VCCS permission from three sources. Those sources were: (a) the VCCS mainframe computer system located at J. Sargent Reynolds Community College in Richmond, Virginia, (b) the offices of institutional research and student records at Central Virginia Community College (CVCC) in Lynchburg, Virginia, and (c) student records at Southside Virginia Community College (SVCC) in Alberta and Keysville, Virginia.

Data were gathered only for those students meeting the following criteria: (a) enrolled full-time (minimum twelve semester hours at CVCC or SVCC, (b) persons participating in
an engineering technology, electronics technology, or drafting and design technology program at either of the two colleges, and (c) enrolled during the period from the fall semester of 1988 through the summer semester of 1995.

Variable assignment was classified according to the following: (a) dependent variables, (b) predictor variables, and (c) covariates. Dependent variables used for this study were: (a) college mathematics achievement (GPA), (b) overall occupational/technical program achievement (GPA), and (c) time required to complete an AAS degree program (semesters). Predictor variables investigated were, high school curriculum participation (i.e., general or academic) and high school program option participation (i.e., traditional articulation or dual enrollment). The covariates used in this study were high school GPA (HSGPA), scores on math portion of community college placement test (CGP), and achievement in high school math prerequisites. Since the study focused on achievement in all three high school math courses, analysis using high school math GPA was only conducted on persons in an academic curriculum.

The analysis procedures of this study included two stages. A 2X3 MANCOVA was conducted to identify significance of row effects (curriculum), column effects (enrollment), and interactions on the three dependent variables, simultaneously, using high school GPA and raw scores on math portion of place-
ment tests as covariates. In addition, post-hoc procedures were conducted to identify significant differences among means and the predictor variable(s) that contributed to those differences.

Tests of assumptions were conducted on the data used in both stage one and two of the analysis. The second stage of analysis was conducted using a One-Way MANCOVA. The purpose was to identify the significance of the main effect (enrollment) on the three dependent variables, simultaneously, using high school GPA, scores on math placement tests, Algebra I GPA, Geometry GPA, and Algebra II/Trigonometry GPA as covariates. Also, post-hoc procedures were conducted to identify significant differences between means and the predictor variable(s) that may have contributed to any differences found.

Based on the results of stage one of the analysis and the One-Way MANCOVA, regression models incorporating only those predictor variables found to have a significant relationship to the dependent variables were developed. Multivariate and bivariate regressions were conducted for the purpose of creating a means of prediction as associated with the three dependent variables.

Summary of Findings

This portion of chapter five is organized chronologically
according to analysis procedures discussed in chapter three, "Methodology", and in the previous portion of this chapter, "Review of Methodology". Those procedures are: (a) tests of assumptions, (b) 2X3 MANCOVA, (c) One-Way MANCOVA, (d) regression models, and (e) research questions and associated findings.

**Tests of Assumptions**

The tests of assumptions for stage one (2X3 MANCOVA) and stage two (One-Way MANCOVA) were conducted and all assumptions were satisfied. A summary of findings for tests of assumptions, as related to the analysis using a 2X3 MANCOVA are as follows: (a) the observations on the three dependent variables followed a multivariate normal distribution in each of the six cell groups, (b) the population covariance matrices for the three dependent variables in each group were not found to be significantly different, (c) it was determined that significant relationships did exist between the dependent variables and the co-variates, and (d) analysis indicated there was no significant interaction of regression planes between groups as indicated by the "Test of Homogeneity" results.

Tests of assumptions for the analysis using a One-Way MANCOVA were also satisfied. In summary, the following results were determined: (a) due to insufficient cell sizes
necessary to conduct a graphical test incorporating Mahalanobis distances, a univariate assessment of normality within each group was conducted using a Kolmogorov-Smirnov Test with an alpha level of $\alpha = .05$, (b) the covariance matrices were determined to not be significantly different for the three dependent variables, thus satisfying the assumption of homogeneity of covariance, (c) findings determined a moderately strong correlation between college math GPA and overall program GPA (for persons in a general high school curriculum, $r = .65$, academic curriculum, $r = .59$); however, was less than the .99 required, thus eliminating the possibility of multicollinearity, (d) significant linear relationships were found between the dependent variables and the covariates, and (e) results of the SPSS MANCOVA procedure indicated no significant interaction between regression planes.

**Summary of Findings for 2X3 MANCOVA**

The results of the 2X3 MANCOVA analysis indicated that, after adjusting for the effects of the covariates, the multivariate and univariate interaction between high school enrollment options (i.e., dual enrollment [DE], traditional articulation [TA], regular student [no participation in either DE or TA], and high school curriculum participation [i.e., general or academic]) was found to be not statistically
significant, $W.L.(6,218) = .96870, p = .744$. A further test for main effect for high school curriculum was determined to be not statistically significant at $p < .05$ using both the multivariate and univariate analyses, $W.L.(3,109) = .97964, p = .522$. However, a statistically significant multivariate main effect for high school enrollment was found, $W.L.(6,218) = .88923, p = .044$, which indicated that only overall program GPA was responsible for differences found between groups based on high school enrollment option, $W.L.(2,111) = 3.96197, p = .022$.

A test to determine statistical significance between main effects for high school enrollment option groups was conducted. Specifically, the dual enrollment group had an adjusted mean GPA of 3.196, while the traditional articulation group had an adjusted mean GPA of 2.819. Analysis determined only the difference between the dual enrollment and traditional articulation groups to be statistically significant at the alpha level of .05.

**Summary of Findings for One-Way MANCOVA**

After adjusting for the effects of the covariates, the multivariate and univariate tests of main effect for high school enrollment option was found to be not statistically significant, $W.L.(6,156) = .92130, p = .372$. Thus, the analysis determined the adjusted population means for the
three dependent variables were not found to be statistically
different between the regular college, dual enrollment, and
traditional articulation groups.

Regression Model--General Curriculum

Summary of Results of Regression Analysis

Analysis for this portion of the study was conducted on
two data sets. Those sets were: (a) persons not having com-
pleted all three high school mathematics prerequisites \(n =
119\), and (b) persons having completed all three high school
math courses \(n = 88\). After multivariate analyses were
conducted on both sets of data, regression models were deve-
loped incorporating only those variables found to be signi-
ficant in the prior analyses.

The following regression model was developed for persons
not completing all three high school math courses:

\[
MATHGPA = 0.6769885 + 0.6784832 (HSGPA) \\
+ 0.02575 (PLMTSCRS)
\]

\[
PRGMGPA = 1.491243 + 0.552559 (HSGPA) \\
- 0.1515477 (TA) + 0.20717 (DE)
\]

\[
TIME = 8.18443 - 0.5600783 (HSGPA)
\]

A second regression model was developed for persons
having all three high school math courses. The model is as
follows:

\[
MATHGPA = 1.477312 + 0.5202233 (ALGI GPA)
\]
PRGM GPA = 1.878357 + .1835056 (ALGI GPA) 
    + .2617162 (HSGPA)
TIME = no significant predictors found

Research Questions and Associated Findings

Specific research questions were addressed by the data
analysis conducted in the study. This portion of chapter five
is devoted to a summary of findings associated with the in-
dividual research questions as stated throughout the study.

Regression models were developed according to statistical
significance determined by analysis of two groups based on
high school curriculum participation (i.e., general or aca-
demic). Basis for the distinction between general and aca-
demic high school curriculum is that only students enrolled in
the academic curriculum completed all three math prerequi-
sites. As a result, data from students enrolled in a general
curriculum were not analyzed according to participation in
high school math courses. Secondly, regression models were
only developed for persons completing an occupational/tech-
nical AAS degree program, therefore an adjusted population N
was used for analysis. The following population N’s were: (a)
overall study population, N = 287, (b) general high school
curriculum participation, n = 119, and (c) academic high
school curriculum participation, n = 88.
The study research questions and analysis information pertaining to each question are as follows.

Research Question 1.
Which of the selected academic variables are statistically significant in predicting achievement in mathematics courses required for occupational/technical associate degree programs?

Regression model for general curriculum high school participation (n = 119):

\[
\text{MATHGPA} = -0.6769885 + 0.6784832 \times (\text{HSGPA}) \\
+ 0.02575 \times (\text{PLMTSCRS})
\]

Regression model for academic curriculum high school participation (n = 88):

\[
\text{MATHGPA} = 1.477312 + 0.5202233 \times (\text{ALGI GPA})
\]

Research Question 2.
Which of the selected academic variables are statistically significant in predicting achievement for full-time occupational/technical associate degree students?

Regression model for general curriculum participation:

\[
\text{PRGMGPA} = 1.491243 + 0.552559 \times (\text{HSGPA}) \\
- 0.1515477 \times (\text{TA}) + 0.20717 \times (\text{DE})
\]

Regression model for academic curriculum participation:

\[
\text{PRGMGPA} = 1.878357 + 0.1835056 \times (\text{ALGI GPA}) \\
+ 0.2617162 \times (\text{HSGPA})
\]

Research Question 3.
Which of the selected academic variables are statistically significant in predicting length of time to program completion for full-time occupational/technical community college students?

Regression model for general curriculum participation:

\[
\text{TIME} = 8.18443 - 0.5600783 \times (\text{HSGPA})
\]
Regression model for academic curriculum participation: 
TIME = no significant predictors were determined

Theoretical and Practical Implications

This portion of the study is devoted to conclusions drawn from information gained as a result of this study. The conclusions and subsequent implications are: (a) theoretical, and (b) practical. Theoretical conclusions are based on information gathered in chapter two, "Review of Related Literature". Implications of this study are stated in terms of comparisons as they parallel previous research or related topics. The following section is divided into: (a) mathematics prerequisites, (b) placement tests and high school grade point average, (c) high school program option in either traditional articulation, or dual enrollment, and (d) high school curriculum.

Mathematics Prerequisites—Theoretical Implications

A survey of literature surrounding the importance of high school mathematics courses and college achievement, soundly acknowledges the positive influence of a strong background in mathematics prior to entering/beginning post-secondary education. Findlen (1994) proposes that technical schools and community colleges should demand the same high school preparation that traditional college-bound students are required to
have in preparation for the more advanced college courses. Findlen also adds that community colleges should require program and course prerequisites for students seeking to succeed in today's educational environment.

In a 1989 study conducted by the California Community Colleges, California State University, and the University of California, minimum math competencies were assessed for entering college freshmen. The study emphasized and encouraged students to experience mathematics throughout high school. It was ascertained that the ability to discern mathematical relationships, reason logically, and use mathematical techniques to solve problems were enumerated as characteristics of mathematically mature students. The study further concluded, sufficient mathematical maturity was desired for students to be able to achieve success in first-year college math courses. Specifically, the courses detailed as required for promoting those positive student characteristics were algebra and geometry.

Other studies such as House, 1993; Craney & Armstrong, 1985; Noble & Sawyer, 1987; Ozsogomonyan & Loftus, 1979; Pederson, 1975; Reiner, 1971; and Ferrari & Parker, 1992, concluded that high school mathematics achievement was significantly related to first-year college achievement. The literature is very much in agreement with Rotman, 1991, that "a definite consistency of higher achievement is apparent in
community college mathematics courses when students complete algebra in high school" (p. 5).

**Mathematics Prerequisites—Practical Implications**

This particular study suggests conclusions very similar to those found in the literature. A moderately strong statistical relationship, $r = 0.47$, was found to exist between participation in algebra I and college math achievement. Similarly, a moderately strong relationship, $r = 0.40$, was found between algebra I and overall college program achievement. However, a negative correlation of $r = -0.21$ between algebra I and time required to complete an associate degree was found. In the overall analysis algebra I was determined to be a significant predictor, at the $p < .05$ level, of both college math achievement as well as overall program achievement for those persons investigated.

Participation in high school math prerequisites was directly related to time required to finish an associate degree, as well as college math achievement and overall program achievement. Persons who had completed all three high school math courses, whether involved in an articulated or dual enrollment program, required less time to finish an AAS degree than those who had not completed the prerequisites. The only exception was for persons in a dual enrollment program option who were also in a general curriculum. This situation may be
explained because persons in a dual enrollment program have the option to enroll in college courses during both their junior and senior year in high school. Persons enrolled in higher level math courses may choose to enroll in college technical courses only their senior year thus earning only half the total college credits possible from such an involvement. Secondly, the study found a statistically significant positive relationship between high school GPA and time required to complete an AAS degree for those in a general curriculum which may indicate the importance of overall high school achievement rather than achievement in certain courses.

College math and overall program achievement was higher for persons having had all three high school math courses. Persons in an academic curriculum, while involved in an articulated program, had a slightly higher college math GPA than those in the dual enrollment program option. However, dual enrollment students from an academic high school background had the greatest overall college program achievement, followed by persons in the same academic track with involvement in a traditional articulation program.

**Placement Tests and High School GPA—Theoretical Implications**

Numerous studies have examined the relationship between admission and placement test scores and subsequent college level achievement. Birnham and Hewitt (1971), and Howlett
(1969) reported correlations ranging from $r = -0.21$ to $r = 0.53$ for relationships between math placement tests and college level algebra achievement. Fishman and Pasenella (1960) in a study conducted on college admissions programs reported a mean correlation of 0.47 between standardized test scores earned prior to entering college and achievement during the first year of college. Judy (1975) concludes studies have generally shown that optimum prediction is obtained when more consideration is given to high school GPA than to information regarding standardized or placement tests. Judy further concluded, college achievement was more accurately predicted by overall high school performance than results of a two or three hour test.

According to almost 300 articles of research related to predictors of college success, Pedrini and Pedrini (1974) concluded the following:

> it appears that for the majority of students, the high school average is the best single predictor of college grades. (p. 197)

**Placement Tests and High School GPA--Practical Implications**

In this study, correlations between placement test results and college math GPA ranged from $r = 0.34$ for academic high school curriculum persons to $r = 0.45$ for persons in a general curriculum. Overall college program achievement was slightly higher, reporting correlations of $r = 0.15$ for the
academic population and $r = 0.27$ for the general group. Placement test results and time to complete a program were found to have even lower correlations, $r = 0.05$ for the academic group and $r = 0.07$ for the general group.

Correlations between high school GPA and subsequent college achievement were moderately higher than those for placement tests as reported by supporting literature. For persons enrolled in an academic high school curriculum a correlation of $r = 0.39$ between high school GPA and college math GPA was found. Likewise a correlation coefficient of $r = 0.39$ between high school GPA and college program GPA was calculated for that group. Correlations were slightly higher for persons in a general high school curriculum with a $r = 0.50$ correlation between math GPA and high school GPA and a $r = 0.49$ between high school GPA and program GPA. Correlations regarding time to completion and high school curriculum participation ranged from a $r = -0.13$ for academic persons to a $r = -0.15$ for general curriculum participation. These results reflect the importance of high school achievement and serve to emphasis predictive value of high school excellence in post secondary situations. Even with open door admission policies in place, persons who are more adequately prepared academically tend to achieve at a higher level when exposed to college requirements. Students who had increased exposure to higher level courses while in high school achieved at a higher level
in both college math courses and in their college program overall.

**Enrollment Options—Theoretical Implications**

The literature review was based on a consensus of opinion that both traditional articulation and dual enrollment program options were to provide means of maintaining excellence in education. Boyer, 1987, reported approximately 50 percent of the 2,650,000 graduating students of that year entered some type of post-secondary institution (p. 61). Greenberg (1989) and Tyler, et al. (1987) determined that moderate achievers in articulated programs generally did quite well in college level courses.

In a recent study of university parallel students at Southside Virginia Community College, it was discovered that students with prior participation in a dual enrollment program had a .33 higher GPA at senior institutions than those persons without dual enrollment experience (Barnes, 1991). Similar results were reported by a study of New York City Community College students (DeLuca, 1977). Students with dual enrollment experience had a yearly cumulative mean GPA of 3.19 while regular college freshmen with no prior dual enrollment exposure had a mean GPA of 2.21 (p. 7).
Enrollment Options--Practical Implications

Findings of this study indicate very similar results as noted throughout the related literature. Math achievement for college students with prior articulation or dual enrollment experience was higher for both general and academic groups than was the math GPA for regular students. With only one exception, participation in an articulation or dual enrollment program enhances college performance as measured by GPA or time to program completion. That exception is in the overall program GPA for traditional articulation general high school curriculum persons which were found to have a slightly lower GPA than their counterparts in the regular category.

This may be partly due to the early exposure to a college environment, which as the literature suggests, reduces the problems associated with transition from one educational institution to another. In addition, it is noted that a reduction in "senioritis" or "senior boredom" and a reassurance of one’s ability to successfully handle college level work may carry over the confidence needed for successful completion in other courses required for an associate degree.

According to the findings reported in this study, involvement in a traditional articulation or dual enrollment program enhances both college math and overall occupational/technical program achievement, while helping to shorten the time required to finish an AAS degree. In general, dual
enrollment program options appear to offer students interested in acquiring an AAS degree in a technical area the best opportunity for success.

High School Curriculum—Theoretical Implications

In a 1986 study conducted by Southeast Missouri State University on "Preparation for Academic Performance and Achievement," researchers ascertained that students having adequate preparation in high school with a thorough background in reading, mathematics, and the sciences were more likely to graduate from college than those lacking academic skills. Additionally, an Oklahoma study published in 1993 investigated several major factors that affect student academic preparation for college. The research indicated that students who were prepared academically in high school by completing core subjects with strong academic content tend to earn better grades in college and are more likely to persist to graduation.

A 1984 report, "Making High School Count," issued by the Nevada Joint Council on College Preparation, states:

Preparing for college is a serious task which requires planning and hard work. The most systematic way to acquire competencies needed for success in college is to take a sound course of basic academic subjects in high school. (p. 1)

Dickason (1984) studied the predictive value of secondary school honors courses and their correlation to college achievement. The study concluded that students taking higher
level courses in high school did better in college than their peers who did not engage in honors courses.

The literature is in agreement that a thorough exposure to strong academic preparation while in high school offers one the best opportunity for success in college. In addition, a review of related literature indicates a strong correlation between a rigorous high school program and the likelihood of graduation from college.

**High School Curriculum--Practical Implications**

Persons participating in an academic high school curriculum were found to have higher achievement in both college mathematics and overall occupational/technical programs. Findings indicate the positive influence of participation in high school math courses while enrolled in an articulated or dual enrollment program more so than for persons enrolled in an academic curriculum with no exposure to articulation. This research suggests the importance of high school achievement combined with participation in a traditional articulation or dual enrollment program for persons seeking an associate degree from the two community colleges investigated.

**Suggestions for Further Research**

During an investigation of topics covered by this study, several areas of concern for further research were determined.
This section is devoted to possible areas for further research based on concerns with student achievement and preparation for the application of knowledge.

First, there seems to be a need for an assessment of attitudes of guidance personnel dealing with student advisement and career planning. The age old stereotyping of vocational students as second-class citizens has forced many potentially mentally qualified persons to accept less than adequate academic training due to a lack of awareness of current technological advances by high school guidance counselors.

Secondly, an evaluation of math competencies and skill enhancement strategies may be needed to qualify present efforts in the classroom. Changes in technology require today's student to have a thorough understanding of mathematics principles which may need to become more current and relevant in meeting the needs of today's students and workforce.

Community colleges must constantly evaluate programs and their relevance to situations found in the workplace. An evaluation of present course content and curriculum requirements based on skills needed by today's workers should remain a central focus of community college educators.
Summary Conclusions

The findings of this study indicate a moderately strong relationship between participation in algebra I for both college mathematics achievement and overall occupational/technical program achievement. In addition, participation in algebra I proved a slightly weaker negative correlation to time required to complete an AAS degree. These findings serve to suggest the importance of participation in algebra I as it relates to college achievement, and may point to the value of basic skills learned in such a course. Accordingly, for persons having participated in all three prerequisites, algebra I shows a positive correlation to student achievement as well as helping to shorten time required to complete an associate degree. Participation in articulated programs while in a general high school curriculum further enhances ones college achievement, and suggests the best combination for prospective community college students having participated in that group.

As concluded in the related literature, high school performance is consistently one of the best predictors of college achievement as pointed out by this study. For persons seeking to earn an associate degree in drafting and design technology, electronics technology, or engineering technology, a rigorous high school program including advanced level math courses while participating in a dual enrollment or tradi-
tional articulation program option was found to be the best avenue to greater community college achievement.
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APPENDIX A

LETTERS REGARDING PERMISSION TO USE VCCS DATA
February 21, 1995

Dr. Elmo D. Roesler
Assistant Chancellor For Policy Studies
Virginia Community College System
James Monroe Building
101 North Fourteenth Street
Richmond, VA 23219

Dear Dr. Roesler:

Thank you for granting me permission to use Virginia Community College System student data. This information will serve as an integral component of my dissertation "The Relationship Between Mathematics Prerequisites And Other Selected Factors On Student Achievement In Two Virginia Community Colleges."

Your help and consideration with this project is sincerely appreciated. If I can ever be of assistance to you, please contact me at your convenience.

Sincerely,

Edward N. Chernault
Associate Professor
February 21, 1995

Dr. Belle J. Wheelan, President
Central Virginia Community College
3506 Wards Road
Lynchburg, VA 24502

Dear Dr. Wheelan:

As a doctoral candidate at Virginia Polytechnic Institute and State University, I am currently planning a research project which will provide data for my dissertation, "The Relationship Between Mathematics Prerequisites And Other Selected Factors On Student Achievement In Two Virginia Community Colleges." Enclosed please find a copy of the correspondence from Dr. Elmo D. Roesler, Assistance Chancellor For Policy Studies, granting permission to use VCCS student data.

I am kindly requesting with your permission, the use of data on students from your institution to be used as an integral component of my research.

The results of this study will be shared with the Virginia Community College System, as well as copies being sent to the participating colleges. It is my hope that information gained from this study will provide guidance and direction in offering the students of the Virginia Community College System the best possible opportunity for success.

I would sincerely appreciate your cooperation with this request and look forward to your reply.

Sincerely,

Edward W. Chernault
Doctoral Candidate

Enclosure
March 9, 1995

Mr. Jesse Worsham  
Institutional Research  
Central Virginia Community College  
3506 Warde Road  
Lynchburg, VA 24502

Dear Mr. Worsham:

As per our conversation on Wednesday March 8, 1995, please find enclosed the information concerning my research study "The Relationships Between Mathematics Prerequisites and Other Selected Factors on Student Achievement at Two Virginia Community Colleges".

Attached are copies of Virginia Community College System's approval for the study, as well as a copy of the letter from Dr. Wheelen approving the use of your institutional data.

It was my impression at the time of our conversation that data could be accessed from one location. However, I later determined that to be incorrect. This request is only for data from your institution.

Should you have any questions concerning this matter, please call me at your earliest convenience.

Thank you for your help and consideration.

Sincerely,

Edward M. Chernault  
Doctoral Candidate
February 21, 1995

Dr. John J. Cavan, President
Southside Virginia Community College
John H. Daniel Campus
Route 1, Box 15
Keysville, VA 23947

Dear Dr. Cavan:

As a doctoral candidate at Virginia Polytechnic Institute and State University, I am currently planning a research project which will provide data for my dissertation, "The Relationship Between Mathematics Prerequisites And Other Selected Factors On Student Achievement In Two Virginia Community Colleges." Enclosed please find a copy of the correspondence from Dr. Elmo D. Ressler, Assistant Chancellor For Policy Studies, granting permission to use VCCS student data.

I am kindly requesting with your permission, the use of data on students from your institution to be used as an integral component of my research.

The results of this study will be shared with the Virginia Community College System, as well as copies being sent to the participating colleges. It is my hope that information gained from this study will provide guidance and direction in offering the students of the Virginia Community College System the best possible opportunity for success.

I would sincerely appreciate your cooperation with this request and look forward to your reply.

Sincerely,

Edward M. Chernault
Doctoral Candidate

Enclosure
February 17, 1995

Mr. Edward N. Chernault  
Assistant Professor  
Route 1, Box 15  
Keysville, Virginia 23947

Dear Mr. Chernault:

I have received a copy of your dissertation proposal on The Relationship between Mathematics Prerequisites and Other Selected Factors on Student Achievement in Two Virginia Community Colleges. It is my understanding that you will be collecting data on full-time students enrolled in the Associate in Applied Science Degree programs in Electronics/Electricity and Engineering Technology/Drafting and Design Technology. The study's institutional population will include Central Virginia Community College and Southside Virginia Community College.

The study methods raise questions about whether or not the completion of prerequisites in mathematics and the passing of math placement tests prior to enrollment in A.A.S degree programs, increase the likelihood of students completing programs, and contribute to student achievement in required college mathematics courses and/or to achievement in occupational and technical programs. A study of this type can have meaningful results, applicable to student assessment activities, the evaluation of course subject matter and sequencing, and the review and modification of instructional methods.

Your study should produce evaluative information on the efficacy of students completing math prerequisites and passing math placement tests prior to their taking regular college mathematics courses. Once the faculty at the two colleges have such information, they should be able to determine whether or not current course entry requirements are essential to student learning of mathematics concepts and skills in regular coursework.
Mr. Edward N. Chernault
February 17, 1995
Page 2

Because the study should yield the kinds of information cited above, I am
authorizing you to proceed with your data collection and analysis activities. I understand
that you have received the cooperation of the two college presidents, and that you will
soon contact Dr. Earl McHewitt concerning your needs for student data.

Please keep Dr. Anne-Marie McCartan and me informed about the progress of
your study. When it is completed, please send to Dr. McCartan two copies of the
dissertation and any abstracts or special writings which you might want to share with all
the Virginia community colleges.

Sincerely yours,

Elmo D. Roesler
Assistant Chancellor for Policy Studies

EDR/cj

c: Dr. Arnold R. Oliver, Chancellor
Dr. Anne-Marie McCartan, Vice Chancellor
for Academic Services and Research
Dr. Earl McHewitt, Director of Research
February 24, 1995

Edward N. Chernault, Assistant Professor
Southside Virginia Community College
Route 1, Box 15
Keysville, Virginia 23947

Dear Mr. Chernault:

It is indeed my pleasure to offer the assistance, data, etc. of Central Virginia Community College to you as you conduct research for your dissertation. I do not envy you in this arduous task but will be here to offer encouragement as you work your way through the process (Smiles).

Please work through Jesse Worsham our Data Processing guru, and Barbara Thrasher our Records whiz for any information you need. Best of luck as you wrap up your work.

Sincerely,

Belle S. Wheelan
President

cc: Dr. Roesler
Dr. Bashore
Ms. Thrasher
Mr. Worsham
February 21, 1995

Dr. John J. Cavan, President
Southside Virginia Community College
John H. Daniel Campus
Route 1, Box 15
Keysville, VA 23947

Dear Dr. Cavan:

As a doctoral candidate at Virginia Polytechnic Institute and State University, I am currently planning a research project which will provide data for my dissertation, "The Relationship Between Mathematics Prerequisites And Other Selected Factors On Student Achievement In Two Virginia Community Colleges." Enclosed please find a copy of the correspondence from Dr. Elmo D. Roesler, Assistant Chancellor For Policy Studies, granting permission to use VCCS student data.

I am kindly requesting with your permission, the use of data on students from your institution to be used as an integral component of my research.

The results of this study will be shared with the Virginia Community College System, as well as copies being sent to the participating colleges. It is my hope that information gained from this study will provide guidance and direction in offering the students of the Virginia Community College System the best possible opportunity for success.

I would sincerely appreciate your cooperation with this request and look forward to your reply.

Sincerely,

Edward N. Chernault
Doctoral Candidate

Enclosure
APPENDIX B

ELECTRONICS TECHNOLOGY CURRICULUM
Electronics Technology Curriculum
Associate in Applied Science Degree

**First Year Course Credits**

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<td>DC and AC Fundamentals I</td>
</tr>
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<td>HLT 106</td>
<td>First Aid and Safety</td>
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<td>IND 195</td>
<td>Technical Computer Literacy</td>
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<td>ELE 195</td>
<td>Amateur Radio</td>
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<td>MTH 113</td>
<td>Engineering Tech Math I</td>
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<td>STD 100</td>
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<td>BASIC Prog Applied to Electrical/Electronics Calculations</td>
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<td>MTH 114</td>
<td>Engineering Tech Math II</td>
</tr>
<tr>
<td>ETR 141</td>
<td>Electronics I</td>
</tr>
<tr>
<td>ETR 142</td>
<td>Electronics II</td>
</tr>
<tr>
<td>ETR 121</td>
<td>Electronic Devices I</td>
</tr>
<tr>
<td>ETR 295</td>
<td>Topics in Electronics</td>
</tr>
<tr>
<td>ETR 195</td>
<td>Shop II</td>
</tr>
</tbody>
</table>

**Second Year Course Credits**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>ETR 223</td>
<td>Communications I</td>
</tr>
<tr>
<td>ETR 263</td>
<td>Microprocessor Application I</td>
</tr>
<tr>
<td>ETR 279</td>
<td>Digital Prin, Term, and Appl</td>
</tr>
<tr>
<td>ETR 195</td>
<td>Shop III</td>
</tr>
<tr>
<td>PSY 120</td>
<td>Human Relations</td>
</tr>
<tr>
<td>ECO 120</td>
<td>Survey of Economics</td>
</tr>
<tr>
<td>ETR 224</td>
<td>Communications II</td>
</tr>
<tr>
<td>ETR 265</td>
<td>Adv Microprocessors</td>
</tr>
<tr>
<td>ETR 195</td>
<td>Shop IV</td>
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</tbody>
</table>

Elective
APPENDIX C

ENGINEERING TECHNOLOGY CURRICULUM
### First Year Scheduling Option 1

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGR 195</td>
<td>Introduction to Engineering Technology</td>
</tr>
<tr>
<td>ENG 111</td>
<td>College Composition I</td>
</tr>
<tr>
<td>MTH 113-114&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>Engineering Technical Math I &amp; II</td>
</tr>
<tr>
<td>DRF 142</td>
<td>Industrial Drafting Techniques II</td>
</tr>
<tr>
<td>STD 100</td>
<td>Orientation</td>
</tr>
<tr>
<td>EGR 130</td>
<td>Statics &amp; Strength of Materials</td>
</tr>
<tr>
<td>ECO 120</td>
<td>Survey of Economics</td>
</tr>
<tr>
<td>IND 100</td>
<td>Basic Programming for Industrial Technicians</td>
</tr>
<tr>
<td>PSY 120</td>
<td>Human Relations</td>
</tr>
<tr>
<td>HLT 106</td>
<td>First Aid and Safety</td>
</tr>
<tr>
<td>IND 113&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>Material &amp; Processes of Manufacturing</td>
</tr>
</tbody>
</table>

OR

| CIV 171<sup>(3)</sup> | Surveying I |

### First Year Scheduling Option 2

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>EGR 195</td>
<td>Introduction to Engineering Technology</td>
</tr>
<tr>
<td>ENG 111</td>
<td>College Composition I</td>
</tr>
<tr>
<td>MTH 113-114&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>Engineering Technical Mathematics I &amp; II</td>
</tr>
<tr>
<td>DRF 141-142</td>
<td>Industrial Drafting Techniques I &amp; II</td>
</tr>
<tr>
<td>STD 100</td>
<td>Orientation</td>
</tr>
<tr>
<td>EGR 130</td>
<td>Statics &amp; Strength of Materials</td>
</tr>
<tr>
<td>ECO 120</td>
<td>Survey of Economics</td>
</tr>
<tr>
<td>IND 100</td>
<td>Basic Programming for Industrial Technicians</td>
</tr>
<tr>
<td>HLT 106</td>
<td>First Aid and Safety</td>
</tr>
<tr>
<td>IND 113&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>Materials and Processes in Manufacturing</td>
</tr>
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OR

185
<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV 171(3)</td>
<td>Surveying I</td>
</tr>
<tr>
<td>PSY 120</td>
<td>Human Relations</td>
</tr>
<tr>
<td>ARC 121</td>
<td>Architectural Drafting I</td>
</tr>
</tbody>
</table>

(1) Prerequisite: Completion of 2 units of Algebra and one of Geometry.
(2) Mechanical/Manufacturing Option
(3) Architectural/Civil Option

**Second Year Architectural/Civil Option**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG 131</td>
<td>Technical Report Writing I</td>
</tr>
<tr>
<td>CIV 240</td>
<td>Fluid Mechanics and Hydraulics</td>
</tr>
<tr>
<td>ARC 122</td>
<td>Architectural Drafting II</td>
</tr>
<tr>
<td>AIR 150</td>
<td>Air Distribution and Design</td>
</tr>
<tr>
<td>ELE 115</td>
<td>Electricity</td>
</tr>
<tr>
<td>CIV 227</td>
<td>Concrete and Soil Technology</td>
</tr>
<tr>
<td>CIV 172</td>
<td>Surveying II</td>
</tr>
<tr>
<td>CIV 246</td>
<td>Water Resource Technology</td>
</tr>
<tr>
<td>CIV 220</td>
<td>Structural Analysis</td>
</tr>
<tr>
<td>CIV 210</td>
<td>Structural Systems</td>
</tr>
</tbody>
</table>

**Second Year Mechanical/Manufacturing Option**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRF 211</td>
<td>Advanced Technical Drafting I</td>
</tr>
<tr>
<td>DRF 212</td>
<td>Advanced Technical Drafting II</td>
</tr>
<tr>
<td>AIR 150</td>
<td>Air Distribution and Design</td>
</tr>
<tr>
<td>ELE 115</td>
<td>Electricity</td>
</tr>
<tr>
<td>ENG 131</td>
<td>Technical Writing</td>
</tr>
<tr>
<td>MEC 155</td>
<td>Mechanisms</td>
</tr>
<tr>
<td>MEC 161</td>
<td>Hydraulics/Pneumatics</td>
</tr>
<tr>
<td>MEC 118</td>
<td>Automated Manufacturing Technology</td>
</tr>
<tr>
<td>MAC 126</td>
<td>Introductory CNC Programming</td>
</tr>
<tr>
<td>IND 140</td>
<td>Quality Control</td>
</tr>
<tr>
<td>CIV 240</td>
<td>Fluid Mechanics</td>
</tr>
</tbody>
</table>

In addition to the admission requirements established for the College, entry into the Associate in Applied Science degree program in Engineering Technology requires students to satisfactorily complete two units of high school algebra and one unit of geometry or equivalent...

APPENDIX D

DRAFTING AND DESIGN TECHNOLOGY CURRICULUM
Drafting and Design Technology Curriculum
Associate in Applied Science Degree

First Semester

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>DRF 141</td>
<td>Industrial Drafting</td>
</tr>
<tr>
<td></td>
<td>Techniques I</td>
</tr>
<tr>
<td>DRF 231</td>
<td>Computer Aided Drafting I</td>
</tr>
<tr>
<td>ENG 111</td>
<td>College Composition I</td>
</tr>
<tr>
<td>MTH 163</td>
<td>Precalculus I</td>
</tr>
<tr>
<td>HLT/PED</td>
<td>Health or Physical Education</td>
</tr>
<tr>
<td>SSC 101</td>
<td>Contemporary Social</td>
</tr>
<tr>
<td></td>
<td>Problems I</td>
</tr>
<tr>
<td>STD 100</td>
<td>Orientation</td>
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</table>

Second Semester

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>ARC 121</td>
<td>Architectural Drafting I</td>
</tr>
<tr>
<td>DRF 142</td>
<td>Industrial Drafting</td>
</tr>
<tr>
<td></td>
<td>Techniques II</td>
</tr>
<tr>
<td>DRF 232</td>
<td>Computer Aided Drafting II</td>
</tr>
<tr>
<td>ENG 112</td>
<td>College Composition II</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td>SPD 100</td>
<td>Principles of Public Speaking</td>
</tr>
<tr>
<td>MTH 164</td>
<td>Precalculus II</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
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<td>Approved Technical Elective</td>
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</table>

Third Semester

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>ARC 122</td>
<td>Architectural Drafting II</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>Technical Elective</td>
</tr>
<tr>
<td>DRF 198</td>
<td>Seminar and Project</td>
</tr>
<tr>
<td>DRF 211</td>
<td>Advanced Technical Drafting I</td>
</tr>
<tr>
<td>IND 115</td>
<td>Materials &amp; Processes of Industry</td>
</tr>
<tr>
<td>MEC 215</td>
<td>Advanced Jig &amp; Fixture Design</td>
</tr>
<tr>
<td>PHY 101</td>
<td>Introduction to Physics I</td>
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</table>
Fourth Semester

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEE</td>
<td>Approved Elective</td>
</tr>
<tr>
<td>DRF 298</td>
<td>Seminar and Project</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
</tr>
<tr>
<td>DRF 212</td>
<td>Advanced Technical Drafting II</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td>DRF EEE</td>
<td>Drafting Elective</td>
</tr>
<tr>
<td>MAC 161</td>
<td>Machine Shop Practices I</td>
</tr>
<tr>
<td>SSC 102</td>
<td>Contemporary Social Problems II</td>
</tr>
</tbody>
</table>
APPENDIX E

VIRGINIA PLAN FOR DUAL ENROLLMENT BETWEEN VIRGINIA PUBLIC SCHOOLS AND COMMUNITY COLLEGES
VIRGINIA PLAN FOR DUAL ENROLLMENT
BETWEEN
VIRGINIA PUBLIC SCHOOLS AND COMMUNITY COLLEGES

Broadly speaking, dual enrollment allows high school students to meet the requirements for high school graduation while simultaneously earning college credit. The Virginia Plan for Dual Enrollment arrangements give a state-wide framework for dual colleges. These arrangements may be made at the local level, i.e., between the representatives of boards of the participating public school and the participating community college authorized to contract such agreements. These arrangements may be formed in three distinct ways. First, high school students may be enrolled in the regularly scheduled college credit courses with the other college students taught at the community college. Second, high school students may be enrolled in specially scheduled college credit courses exclusively for high school students taught at the high school. Third, high school students may be enrolled in specially scheduled college credit courses exclusively for high school students taught at the community college. In the latter two cases where the college credit courses are specially scheduled for the high school students, these courses shall have the same academic rigor as, and meet all of the college accreditation standards of, the regularly scheduled college credit courses. In all cases, the particular courses to be offered shall be determined through the mutual agreement of the participating public school and community college.

Purpose

The purpose of the Virginia Plan for Dual Enrollment is both to provide a wider range of course options for high school students and to avoid the unnecessary duplication of programs, in the academic, fine arts, and vocational subject areas where appropriate. As such, the plan promotes rigorous educational pursuits and encourages learning as a lifelong process; it recognizes that high school students who accrue college credit are more likely to continue with their education beyond high school than those who do not. The plan also offers a direct cost benefit to the Commonwealth of Virginia, especially as it avoids the unnecessary duplication of facilities and equipment, and to the individual families of the high school students.

Student Eligibility

All high school juniors and seniors who are sixteen years of age or older are eligible to participate in the dual
enrollment arrangement between the public school and community college. However, appropriate public school and community college officials should take the necessary steps to assure that every student who is registered under the dual enrollment arrangement is "qualified," i.e., is amply prepared for the demands of a college level course and can benefit from the enrichment opportunity. (Exceptions to this policy for student eligibility may be made on a case by case basis, with the approval of the public school superintendent and appropriate community college official.)

Admissions Requirements

Section 7a. and 7b. of Standard C of the 1988-89 "Standards for Accrediting Public Schools in Virginia" govern the admissions requirements in dual enrollment arrangements. First, the public school principal must approve the cross-registration of the high school student to the community college. Second, the community college must accept the high school student for admission to the college level course. In other words, the high school student must be recommended by the public school and must meet the admissions requirements established by the community college.

Course Eligibility

Courses may be drawn from the academic, fine arts, and vocational subject areas. The courses must be offered for college credit and may be part of a degree, certificate, or diploma program at the community college. Regardless of the subject area, no developmental or health and physical education courses shall be eligible for a dual enrollment arrangement.

Credit Awarded

College credit shall be awarded by the community college to the participating high school students upon successful completion of the course. The award shall be in compliance with state and regional accrediting standards.

High school credit shall also be awarded to the participating high school students upon successful completion of the course. The award shall be based on the college credit hour, with one high school unit equivalent to six semester hours of college credit.
Selection of Faculty

The faculty shall be selected and employed by the participating community college. They shall meet the minimum requirements set by Form VCCS-29. If a particular part-time faculty member of the community college is employed simultaneously full time by the public school, the college may reimburse the public school board for the services of its faculty member in lieu of direct compensation to the faculty member; alternate faculty compensation plans may be negotiated by the participating community college and public school.

Tuition and Fees

According to Section 7 of Standard C of the 1988-89 "Standards for Accrediting Public Schools in Virginia," schools and colleges are encouraged to provide high school students the opportunity for dual enrollment at not tuition cost to them or their families. In addition, neither the public school nor the community college shall be penalized in their respective state appropriations for developing and implementing the dual enrollment arrangement. The public school shall receive average daily membership credit for its students who participate in the dual enrollment arrangement, and the community college shall receive FTES (full-time equivalent student) credit for the participating high school students.

Compliance with Accreditation Standards

The Virginia Plan for Dual Enrollment complies with the criteria of the Southern Association of College and Schools and with the 1988-89 "Standards for Accrediting Public Schools in Virginia."

Assessment

Assessment has long been recognized in Virginia as an important aspect of an effective instructional program. In this spirit, all dual enrollment arrangements developed and implemented under the auspices of the Virginia Plan for Dual Enrollment shall include a formal mechanism for evaluation.
APPENDIX F

COURSE IDENTIFICATION FOR HIGH SCHOOL CURRICULUM
## Course Identification for High School Curriculum

<table>
<thead>
<tr>
<th>General</th>
<th>Academic</th>
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<tr>
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<tr>
<td>English 9</td>
<td>Advanced English 9</td>
</tr>
<tr>
<td>English 10</td>
<td>Advanced English 10</td>
</tr>
<tr>
<td>English 11</td>
<td>Advanced Language Studies</td>
</tr>
<tr>
<td>English 12</td>
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</tr>
<tr>
<td><strong>Social Studies</strong></td>
<td></td>
</tr>
<tr>
<td>World Geography</td>
<td>Advanced World Geography</td>
</tr>
<tr>
<td>World History</td>
<td>College Sociology</td>
</tr>
<tr>
<td>VA/US History</td>
<td>College Psychology</td>
</tr>
<tr>
<td>VA/US Government</td>
<td>College US Government</td>
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<tr>
<td><strong>Science</strong></td>
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</tr>
<tr>
<td>Earth Science</td>
<td>Earth/Space Science</td>
</tr>
<tr>
<td>Biology</td>
<td>Advanced Biology</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Advanced Chemistry</td>
</tr>
<tr>
<td></td>
<td>College Physics</td>
</tr>
<tr>
<td></td>
<td>Intro to Anatomy</td>
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<tr>
<td><strong>Mathematics</strong></td>
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<tr>
<td>Math 9</td>
<td>Algebra I</td>
</tr>
<tr>
<td>Algebra I Part I</td>
<td>Algebra II</td>
</tr>
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<td>Algebra I Part II</td>
<td>Advanced Calculus</td>
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<td>Consumer Math</td>
<td>Formal Geometry</td>
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<td>Math Analysis</td>
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<tr>
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<td>Trigonometry</td>
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</tbody>
</table>
APPENDIX G

ELECTRONICS TECHNOLOGY PROGRAM DESCRIPTION (SVCC)
Electronics Technology Program Description (SVCC)

Purpose: The growth of the electronics and manufacturing industries and the steady demand for qualified electronics technicians have created a need for trained personnel to meet these requirements. The associate in applied science degree curriculum in electronics technology is designed to prepare the student for full-time employment immediately upon completion of the community college program.

Program Description: The electronics technology curriculum is a two-year program combining instruction required for competence as technician associate engineer, engineer in training, etc. in business and industry. The first year of the electronics technology curriculum is designed to establish a general basis in mathematics and electronics circuits. The second year develops this basis in a number of important areas of electronics such as computers, control circuits, measurements and communications. Instruction includes both the theoretical concepts and practical applications needed for future success in electronics technology. Students are advised to consult with their faculty advisor or a counselor for assistance in planning their program. (SVCC Student Handbook, p. 66)

Electronics Technology Curriculum

First Semester

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS 150</td>
<td>Introduction to Microcomputer Software</td>
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</tr>
<tr>
<td>ETR 113</td>
<td>D.C. &amp; A.C. Fundamentals I</td>
</tr>
<tr>
<td>ETR 106</td>
<td>BASIC Programming Applied to \</td>
</tr>
<tr>
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<td>Electrical/Electronic Calculation</td>
</tr>
<tr>
<td>ENG 111</td>
<td>College Composition I</td>
</tr>
<tr>
<td>MTH 163</td>
<td>Pre-calculus I</td>
</tr>
<tr>
<td>STD 100</td>
<td>Orientation</td>
</tr>
<tr>
<td>HLT/PED</td>
<td>Electives</td>
</tr>
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197
### Second Semester

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
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<tr>
<td>ETR 114</td>
<td>D.C. &amp; A.C. Fundamentals II</td>
</tr>
<tr>
<td>ETR 143</td>
<td>Devices and Applications I</td>
</tr>
<tr>
<td>EEE</td>
<td>Approved Technical Elective</td>
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<tr>
<td>ENG 112*</td>
<td>College Composition II</td>
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<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>Speech or English Elective</td>
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<tr>
<td>MTH 164</td>
<td>Pre-calculus II</td>
</tr>
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<td></td>
<td>OR</td>
</tr>
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<td></td>
<td>Applied Calculus II</td>
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<td></td>
<td>OR</td>
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<tr>
<td></td>
<td>Approved Technical Elective</td>
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<tr>
<td>HLT/PED</td>
<td>Health, Physical Education</td>
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### Third Semester

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<tbody>
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<td>Devices and Applications II</td>
</tr>
<tr>
<td>ETR 241</td>
<td>Electronics Communications I</td>
</tr>
<tr>
<td>ETR 279</td>
<td>Digital Principles, Terminology and Applications</td>
</tr>
<tr>
<td>PHY 101*</td>
<td>Introduction to Physics</td>
</tr>
<tr>
<td>SSC 101**</td>
<td>Contemporary Social Problems I</td>
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### Fourth Semester

<table>
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<th>Course No.</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>ETR 242</td>
<td>Electronic Communications II</td>
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<tr>
<td>ETR 266</td>
<td>Microprocessor Applications</td>
</tr>
<tr>
<td>EEE</td>
<td>Approved Technical Electives</td>
</tr>
<tr>
<td>SSC 102**</td>
<td>Contemporary Social Problems II</td>
</tr>
</tbody>
</table>

* Recommended for Transfer

** Students planning to transfer need to discuss General Education courses with advisor.
Engineering Technology Program Description (CVCC)

**Purpose:** The purpose of the Associate in Applied Science degree program in Engineering Technology is to prepare persons for full-time employment as engineering specialists immediately upon completion of the program. The Engineering Technology degree is also transferable to colleges or universities that offer a baccalaureate degree in Engineering Technology.

**Program Description:** The curriculum includes courses in engineering, drafting, computer aided drafting (CAD), computer programming, mathematics, and general education requirements. Instruction will include both the theoretical concepts and practical applications necessary for future success in the field of engineering technology. Each student is advised to consult with his faculty advisor while planning his program. Upon satisfactory completion of the curriculum, the graduate will be awarded the Associate in Applied Science degree in Engineering Technology with the appropriate specialization. (CVCC Student Handbook, p. 66)

**Engineering Technology Curriculum**

**First Year Scheduling Option I**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGR 195</td>
<td>Introduction to Engineering Technology</td>
</tr>
<tr>
<td>ENG 111</td>
<td>College Composition I</td>
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<tr>
<td>MTH 113-114(^1)</td>
<td>Engineering Technical Math I &amp; II</td>
</tr>
<tr>
<td>DFR 142</td>
<td>Industrial Drafting Techniques II</td>
</tr>
<tr>
<td>STD 100</td>
<td>Orientation</td>
</tr>
<tr>
<td>EGR 130</td>
<td>Statics &amp; Strength of Materials</td>
</tr>
<tr>
<td>ECO 120</td>
<td>Survey of Economics</td>
</tr>
<tr>
<td>IND 100</td>
<td>Basic Programming for Industrial Techniques</td>
</tr>
<tr>
<td>PSY 120</td>
<td>Human Relations</td>
</tr>
<tr>
<td>HLT 106</td>
<td>First Aid and Safety</td>
</tr>
<tr>
<td>IND 113(^2)</td>
<td>Material &amp; Processes of Manufacturing</td>
</tr>
<tr>
<td>CIV 171(^3)</td>
<td>Surveying I</td>
</tr>
</tbody>
</table>

\(^1\) MTH 114 is required for transfer.

\(^2\) IND 113 is required for transfer.

\(^3\) CIV 171 is required for transfer.
**First Year Scheduling Option 2**

(For Students Not Meeting The Drafting/Drawing Prerequisites.)

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>EGR 195</td>
<td>Introduction to Engineering Technology</td>
</tr>
<tr>
<td>ENG 111</td>
<td>College Composition I</td>
</tr>
<tr>
<td>MTH 113-114(^{(1)})</td>
<td>Engineering Technical Mathematics I &amp; II</td>
</tr>
<tr>
<td>DRF 141-142</td>
<td>Industrial Drafting Techniques I &amp; II</td>
</tr>
<tr>
<td>STD 100</td>
<td>Orientation</td>
</tr>
<tr>
<td>EGR 130</td>
<td>Statics &amp; Strength of Materials</td>
</tr>
<tr>
<td>ECO 120</td>
<td>Survey of Economics</td>
</tr>
<tr>
<td>IND 100</td>
<td>Basic Programming for Industrial Technicians</td>
</tr>
<tr>
<td>HLT 106</td>
<td>First Aid and Safety</td>
</tr>
<tr>
<td>IND 113(^{(2)})</td>
<td>Materials and Processes in Manufacturing</td>
</tr>
<tr>
<td>CIV 171(^{(3)})</td>
<td>Surveying I</td>
</tr>
<tr>
<td>PSY 120</td>
<td>Human Relations</td>
</tr>
<tr>
<td>ARC 121</td>
<td>Architectural Drafting I</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Prerequisite: Completion of 2 units if Algebra and one of Geometry.

\(^{(2)}\) Mechanical/Manufacturing Option

\(^{(3)}\) Architectural/Civil Option
APPENDIX I

ELECTRONICS TECHNOLOGY PROGRAM DESCRIPTION (CVCC)
Electronics Technology Program Description (CVCC)

Purpose: The rapidly expanding electronics industries have created a great demand for qualified engineering technicians, especially those with computer and computer-related skills.

In order to provide the flexibility required by the large variety of jobs available in the electronics industries, the curriculum offers a solid foundation in mathematics, science, general electronics, computers, and communications. The Electronics Technology curriculum is designed primarily for persons seeking employment in fields of computer, digital, and communications electronics immediately upon completion of the program. The Electronics Technology program is also transferable to four-year baccalaureate degrees in Engineering Technology.

Program Description: Approximately two-thirds of the curriculum will include courses in electronics technology of different areas with the remaining courses in related subjects, general education, and electives. Instruction will include both the theoretical concepts and practical applications needed for future success in electronics engineering technology. Students are advised to consult with the Electronics Department in planning their program and selecting electives. Upon satisfactory completion of the program the graduate will be awarded the Associate in Applied Science Degree with a major in Electronics Technology. (CVCC Student Handbook, p. 64)

Electronics Technology Curriculum
Associate in Applied Science Degree

**First Year**

<table>
<thead>
<tr>
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<tr>
<td>ETR 113</td>
<td>DC and AC Fundamentals I</td>
</tr>
<tr>
<td>HLT 106</td>
<td>First Aid and Safety</td>
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<td>IND 195</td>
<td>Technical Computer Literacy</td>
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<tr>
<td>ELE 195</td>
<td>Amateur Radio</td>
</tr>
<tr>
<td>MTH 113</td>
<td>Engineering Tech Math I</td>
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<td>STD 100</td>
<td>Orientation</td>
</tr>
<tr>
<td>ENG 131</td>
<td>Technical Report Writing</td>
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</table>
ETR 106  BASIC Progr Applied to
        Electrical/ElectronicsCalculations
ETR 114  DC and AC Fundamentals II
ETR 195  Shop I
MTH 114  Engineering Tech Math II
ETR 141  Electronics I
ETR 142  Electronics II
ETR 121  Electronic Devices I
ETR 295  Topics in Electronics
ETR 195  Shop II

Second Year

<table>
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<td>Communications I</td>
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<tr>
<td>ETR 263</td>
<td>Microprocessor Application I</td>
</tr>
<tr>
<td>ETR 279</td>
<td>Digital Prin, Term, and Appl</td>
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<tr>
<td>ETR 195</td>
<td>Shop III</td>
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<td>PSY 120</td>
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<td>ECO 120</td>
<td>Survey of Economics</td>
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<td>ETR 224</td>
<td>Communications II</td>
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<tr>
<td>ETR 265</td>
<td>Adv Microprocessors</td>
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<tr>
<td>ETR 195</td>
<td>Shop IV</td>
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<td>EEE</td>
<td>Elective</td>
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</tbody>
</table>

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APPENDIX J

MATHEMATICS PREREQUISITE COURSE DESCRIPTIONS
Mathematics Prerequisite Course Descriptions

High School Course Descriptions:

(1) Algebra I

Course Description: Emphasis will be placed on real numbers, algebraic expressions and equations, fractional expressions, and polynomials. Some reasonable proficiency in arithmetic skills is strongly needed as prerequisite.

Course Objectives:
   I. Operations and Variables
   II. Linear Equations and Inequalities
   III. Linear Equations and Graphs
   IV. Exponents and Polynomials
   V. Factoring

(2) Algebra II/Trigonometry

Course Description: The course will develop an understanding of algebra and strengthen computational skills. Emphasis will be placed on fractional expressions, polynomials, rational expressions, exponents, radicals, graphing, and solving linear equations and inequalities. Logarithmic functions and complex numbers will also be introduced during the last quarter of the semester. Algebra I is a prerequisite for this course.

Course Content:
   I. Operations with Rational Expressions
   II. Systems of Linear Equations and Linear Inequalities
   III. Exponents and Radicals
   IV. Logarithmic Functions and Complex Numbers

(3) Geometry

Course Description: Develops the mathematical proficiency in geometry. It is assumed that the student has a working knowledge of algebra preferably the completion of algebra I and II.

Course Objectives: To give the student the practice and training necessary to think in a logical, and ordered sequence. The student will be able to
differentiate between axioms and postulate and theorems and define line segment, compass, mid-
point, ray, angle, vertex, right angle active and obtuse angle and the angle measure. The students
will demonstrate their mastery of the theorems by writing them, by applying them for solutions of the
selected problems, or using them as reasons in a proof. The student will explore the right triangle
congruence theorems, some properties of right triangles. Review of radicals and quadratic equa-
tions, the Pythagorean theorem and applications. Basic trigonometry will be introduced. The student
will compute the area of a rectangle, square, parallelogram, triangle, trapezoid and circle. The
student should be able to demonstrate the follow-
ing:
(a) Cartesian coordinate system, origin, ordinate,
abscissa, quadrant, x-axis, y-axis, linear equa-
tion, slope, x-intercept, and y-intercept.
(b) Slope, midpoint, slope intercept form, point
slope form, standard form of straight line and
distance formula.
(c) Surface area of sphere, cylinder, prism, cube,
rectangular solid, pyramid, cone and volume of
solid bodies.

**College Mathematics Course Descriptions:**

(4) Math 161

**Course Requirement:** Student should have strong Algebra I and background. Also required basic
Trigonometry.

**Course Description:** A modern unified course in algebra, trigonometry, and analytic geometry, and
calculus.

**General Course Objectives:**
a. Understand the role of logic in deductive sys-
tems of mathematics.
b. Develop an understanding of mathematics as a
deductive science.
c. Recognize that the manipulative techniques in a
mathematical system are a reflection of the mathem-
atical structure of that system.
d. Appreciate the breadth and depth of application
of mathematics.
e. Prepare themself for modern courses in the calculus, abstract algebra, and probability.
f. Acquire facility in applying mathematical techniques.
g. Use the language and symbolism of abstract mathematics.

Topic-wise objectives:
a. The Number System
The students will reinforce their knowledge of the real numbers and be able to establish properties in a systematic way.
c. Inequalities
The student will develop a knowledge of theorems on inequalities and learn to apply the theorems on exercise which are needed later in discussion of limits in a calculus course.
d. Functions and Relations
The student will understand the idea of "function" as a special case of the general concept of "relation". An enlarged vocabulary will be used by the student--image, one-to-one function, "into", "onto", mapping.
e. Algebraic Functions
The student will be able to apply the rational operations to polynomial and rational functions.
f. Exponential and Logarithmic Functions
The student will be able to refresh the fundamentals learned before, able to graph these functions and solve the equations involving the exponential and logarithms.
g. Trigonometric Functions
The student will be able to understand better and practice more on basic functions and its values. They will be exposed more on identities, applications, and graphing of these functions.

(5) Math 162

Topic-wise objectives:
a. Analytic Trigonometry
b. The Fundamental Theorem of Algebra
c. Conic Sections
d. Systems of Equations and Inequalities
e. Sequences and Series
f. Calculus, and introduction
APPENDIX K

TESTS OF ASSUMPTIONS TABLES
Kolmogorov-Smirnov test of univariate normality results

<table>
<thead>
<tr>
<th>Cell</th>
<th>Variable</th>
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<th>p &lt; .05</th>
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<th>Kurtosis Coefficient &amp; Probability</th>
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Kolmogorov-Smirnov test of univariate normality results (cont'd)

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<th>Kurtosis Coefficient &amp; Probability</th>
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Note: Critical values greater than D are significant at the .05 alpha level.
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<td>( p &lt; .05 )</td>
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Note: Critical values greater than \( \bar{D} \) are significant at the .05 alpha level.
Univariate F-tests with (5,80) degrees of freedom

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<tr>
<th>Variable</th>
<th>R Value</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME</td>
<td>1.64029</td>
<td>.159</td>
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<tr>
<td>MATHGPA</td>
<td>6.22446</td>
<td>.000</td>
</tr>
<tr>
<td>PRGMGPA</td>
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<td>.001</td>
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Box's M Test Results

<table>
<thead>
<tr>
<th>Group Pooled (Combined)</th>
<th>Log of Covariance Determinant</th>
<th>Correlation Determinant</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENROLLMT=0</td>
<td>-0.54732698</td>
<td>0.6010690296</td>
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<tr>
<td>ENROLLMT=1</td>
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<td>0.7331441580</td>
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<tr>
<td>ENROLLMT=2</td>
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<td>0.3153585645</td>
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<tr>
<td>Box's M:</td>
<td>9.904859</td>
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Approximate Test

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df1</th>
<th>df2</th>
<th>p</th>
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<tbody>
<tr>
<td>F</td>
<td>0.77104</td>
<td>12</td>
<td>11986</td>
<td>0.679592</td>
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<tr>
<td>Chi-square</td>
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<td>12</td>
<td></td>
<td>0.680373</td>
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Within-cell correlations analysis for identifying possible multicollinearity between variables

<table>
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<tr>
<th>Variable</th>
<th>$R^2$-Other Y's</th>
<th>Variate</th>
<th>Eigenvalue</th>
<th>Percent</th>
<th>Total</th>
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</thead>
<tbody>
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<td>1.675530</td>
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<tr>
<td>PRGMGPA</td>
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<td>3</td>
<td>0.379708</td>
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<td>100.00</td>
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<tr>
<td>Variable</td>
<td>Bartlett Value</td>
<td>df1</td>
<td>df2</td>
<td>F Approx</td>
<td>p</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>-----</td>
<td>-----</td>
<td>----------</td>
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</tr>
<tr>
<td>TIME</td>
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<td>Total</td>
<td>9.048586</td>
<td>12</td>
<td>11986</td>
<td>0.771</td>
<td>0.6796</td>
</tr>
</tbody>
</table>
VITA

Edward N. Chernault was born on September 16, 1949. After graduating from Prince Edward Academy, in Farmville, Virginia, in 1967, he attended Southside Virginia Community College and received an Associate in Applied Science Degree in Drafting and Design Technology. After several years of industrial experience, he attended Virginia State University and graduated with a Bachelor of Science Degree in Industrial Engineering Technology in 1985. In 1988 he received a Master of Science in Education from Virginia Polytechnic Institute and State University. His professional experience includes teaching Drafting in the Charlotte County, Amherst County, and Appomattox County Public School Systems in Virginia. He also taught at Central Virginia Community College and Southside Virginia Community College.

Mr. Chernault is a member of Who’s Who in American Junior Colleges, Who’s Who Among American Teachers, and a member of Omicron Tau Theta Professional Society. He also earned the rank of Eagle Scout.

Edward N. Chernault

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