Master's Thesis

Entitled


Competitive Admissions in the Imaging Science Programs at Caldwell Community

College and Technical Institute, Hudson, North Carolina


By

Jimmy L. Council


Submitted as partial fulfillment of the requirements for

The Master's Degree in Business Administration – Health Care


California College for Health Sciences

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An Abstract of

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Admission processes at community colleges typically use open door or "first-come, first-served" practices. This type of policy allows all applicants, regardless of prior experience or educational background, to have the same chance of admission into programs. As the number of applications increases, it becomes necessary to investigate predictors that may be used in competitive admissions. This study explores predictors for student success in the imaging programs at Caldwell Community College and Technical Institute, Hudson, North Carolina. Linear regressions were performed using GPA, persistence rates, and certification passage rates as dependent variables representing student success. Independent variables, or predictors, were placement test scores, history of developmental classes, science class scores, and advanced degrees. Historical data of students enrolled in imaging programs during the period of 2000 – 2004 was used in the regressions. While no correlation was found between persistence and certification rates and the predictors, there were weak associations demonstrated with GPA. Regressions also demonstrated correlations between GPA and persistence rates and GPA and

certification rates. It is suggested that selective admissions can influence program success by improving GPA. However, because of the restricted correlations and the possibility of other influences on success, a portion of admissions should always remain on a non-selective basis.

Acknowledgements

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Chapter 1: Introduction

This chapter will describe the purpose and rationale behind the research project investigating the relationship between preadmission status of students and program outcomes. In addition, basic assumptions, significance, and limitations of the project will be expressed. Definitions of key terms are also being given.

Problem Statement

The current admissions process at Caldwell Community College & Technical Institute (CCC&TI) is based on an open-door or "first-come first-served" policy. This policy allows all applicants, regardless of prior experience or educational background, to have the same chances of admission into the imaging programs. Admission requirements are based on the completion of the following tasks:  application, transcript receipt, placement tests, and information session attendance. Currently, there is no mechanism in place to identify students with low probability of program success or completion. In past years, the numbers of vacancies in the programs were sufficient to accommodate both types of students, those with high and low probabilities of success.

Over the last five years, there has been an increase in applicants interested in the imaging fields. Concerns are that admitted students with low probability of success are filling seats that could be given to those with a higher probability of program completion. Both college administration and faculty believe that because of limited resources,

competitive admissions should be used to screen students, giving priority to those applicants who are more likely to be successful.

Currently there is no mechanism defined to accomplish admission screenings. It is also unknown if competitive admission screenings will result in an increase in student success. Several parameters can be accessed for the possibility of inclusion in a competitive admissions process, such as placement test scores, history of developmental classes, previous science classes, or advanced degrees. Measurable outcomes, attrition, certification passage rates, and GPA can also be obtained. Administration should find it useful to have concrete data to base a decision on whether to adopt a competitive admissions process and which of the current parameters would be the best predictor of student success.

## Hypotheses

$H_0$ = The program outcome parameter of attrition is not influenced by preadmission status of students, such as placement test scores, history of developmental classes, previous science classes, or advanced degrees.

$H_0$ = The program outcome parameter of certification passage rates is not influenced by preadmission status of students, such as placement test scores, history of developmental classes, previous science classes, or advanced degrees.

$H_0$ = The program outcome parameter of GPA is not influenced by preadmission status of students, such as placement test scores, history of developmental classes, previous science classes, or advanced degrees.

Purpose of Study

Students enrolled in an imaging program at CCC&TI form a cohort that progresses together through a defined course of study for two years. Due to program prerequisites, if a student withdraws prior to completion of his or her program it is impossible to fill the vacant position in the cohort with another student. Without a complete cohort, valuable instructional resources are unused. If preadmission predictors of completion can be determined, it will allow the maximum number of students the opportunity to train for employment in a desired field. Similarly, if a student fails to succeed in passing the professional certification exams the student cannot practice in that profession. This adds to the technologist crisis in fields that are at record shortages. These program vacancies may be avoided if success predictors can be identified prior to admission and used to place those students more likely to pass certification exams into the programs.

Additionally, CCC&TI receives operational monies from the State of North Carolina. Much of the budget is based upon program outcomes such as retention and certification rates. If the positive program outcomes can be increased, the potential to receive additional monies for program needs and expansion is increased.

Basic Assumptions

Most of the data used in the research will be of a historic nature. Our community college maintains a student record database through a program called Datatel. It is assumed that most of the required information, specifically previous courses, placement test scores, GPA, and early withdrawal can be easily obtained from this database. This information is considered official and reliable. The database information can be obtained

from the database administrator, Sandy Duncan, in bulk form by request, or by individual

record access utilizing faculty workstations.

The credentialing passage rates will be obtained from the outside organizations

specific to the imaging fields, The American Registry of Radiologic Technology

(ARRT), The Nuclear Medicine Technology Certification Board (NMTCB), and The

American Registry of Diagnostic Medical Sonography (ARDMS). These records, with

the exception of the ARDMS, can be obtained by internet connection from the

researcher's office. Kim Watts, Medical Sonography Director, maintains records of

ARDMS passage.

Surveys from current students can be obtained easily by addressing individual

classes with little interruption of class activities. The directors of the representative

programs have previously given consent to poll their classes. These surveys can be

administered by the researcher or class instructor depending upon the preference of the

program director.

## Significance of the Study

Most of the community colleges in the North Carolina Community College

System adhere to the open-door policies that date over a hundred years. Research into

how preadmission status relates to outcomes of the diverse applicant pool of the imaging

sciences at the community college level is very limited. This project will fill part of that

void and help support administrative decisions concerning competitive admissions.

## Limitations of the Study

The primary limitation will be the time factor associated with assembling the data

from the related sources into an Excel database for analysis. The information accessed

from Datatel, even if in bulk form, is not compatible electronically with Excel and must be manually transferred. Program passage rates suffer the same limitations; this data can only be accessed one record at a time. Review was of the last five years resulted in 213 records.

## Definitions of Key Terms

- ARDMS – American Registry of Diagnostic Medical Sonographers – nationally recognized credentialing agency for sonography technologists.

- ARRT – American Registry of Radiologic Technology – nationally recognized credentialing agency for radiologic, nuclear medicine, and sonography technologists.

- Attrition – reduction of class size, from student withdrawal or failure to complete program specific progression criteria.

- CCC&TI – Caldwell Community College and Technical Institute, Hudson, North Carolina.

- Competitive admissions – the process or theory of using screening criteria to limit admission into a course of study.

- Datatel – software application used to obtain, store, and access student records at CCC&TI.

- GPA – Grade point average.

- NMTCB – Nuclear Medicine Technology Certification Board – nationally recognized credentialing agency for nuclear medicine technologists.

- Open-door policy – admissions policy that allows students to enter a program after completing basic requirements, regardless of academic background.

- Preadmission status – status of potential students prior to admission into an imaging program, may include placement, previous classes, or advance degrees.

- Professional certification – certification by one of the nationally recognized agencies, ARRT, NMTCB, or ARDMS.

## Conclusion

Investigations on how preadmission factors influence program outcomes can have a large impact on decisions concerning competitive admissions in a community college. At a time when program applicants outnumber vacancies by eight to one, college administrators are considering ways to utilize resources in a manner that will maximize outcomes. This can translate into discovering ways to predict which students will have a greater probability of successfully completing a program of study and professional certification, then limiting program admission to those students.

This thesis investigated historical data and tried to uncover predictors of student success. Data for this project was easily obtainable from the official database of the college and program directors. However, a major obstacle for the project was the effort required to compile the data into a usable form.

The next chapter will review theoretical literature findings associated with admission policies and outcomes. It will also discuss how those theories may relate to the particular admission concerns at CCC&TI. A literature review in this area may include

theories of admission for two and four year institutions, student outcomes, and a comparison of competitive with open-door policies.

Chapter 2:  Literature Review

The community college system in the United States has roots reaching over 100 years (Coley, 2000). Throughout that time, it has offered educational opportunities to thousands of individuals. The community college has withstood the test of time by providing students with successful occupational training or transition into four year universities (Bailey, 2003). Community colleges are experiencing increases in enrollment, which are predicted to grow 11 to 16 percent by 2010 (Bailey, 2003). Moreover, while enrollment soars, funds are becoming increasingly difficult to obtain (Marks, 2005; McPherson, 2004). Accountability for the use of resources and student success has also become an issue (Bailey, Alfonso, Calcagno, Jenkins, Kienzl, & Leinbach, 2004; Bailey, Calcagno, Jenkins, Leinbach, & Kienzl, 2005a). Many educational analysts believe that addressing admission or entry into high demand programs can help alleviate concerns regarding optimal resource utilization (Seago & Spetz, 2003).

This chapter investigates admission processes that may be of value to community colleges. It explores the predictors of student success and the potential for applying these predictors to limit enrollment to students more likely to succeed. It concludes with an overview of a commission report on community college nursing programs from the

California State Postsecondary Education Commission and the California Policy

Research Center.

<div align="center">Admissions</div>

There have been several investigations into college admission practices. Much of

this research focuses on student performance and attrition, dealing primarily with the four

year colleges or universities. There are very few studies regarding admission into the

community college. This lack of relevant data exists because most community colleges

employ open admissions and accept all applicants, regardless of academic achievement

(Rosenbaum, 2002). However, the lessons learned regarding university admissions could

still offer valuable information on student achievement in the community college setting.

*Agricultural Students*

A study by Garton, Dyer, King and Ball (2000) probing into performance and

retention of agricultural students in a four year institution examined several predictors of

academic success. These researchers considered high school grade point average, ACT

examination scores, class rank, and learning styles as possible predictors of performance.

This study was limited to first year college performance.

Over 664 students from the College of Agriculture, Food, and Natural Resources

at the University of Missouri were investigated in 1997 and 1998. Little correlation

between learning styles and academic performance was shown in this study (Garton et

al., 2000). The best predictor of student accomplishment in 1997 proved to be a

combination of high school grade point average and ACT score. High school grade point

average was the best predictor in 1998. Even though the data was inconclusive as to the

best predictor of student success, high school grade point average accounted for about 33 percent of the variance in students' performance (Garton et al., 2000).

*Traditional Versus Non-traditional*

Julie Noble conducted a similar study using 1997 ACT data encompassing characteristics of 219,443 first-year students from 301 colleges (Noble, 2000). This study looked at traditional versus non-traditional college students. Enrolling in larger numbers in the community college, the non-traditional student is defined as older students, usually over the age of 30 (Burton & Ramist, 2001; Noble, 2000). Noble found the best predictor of college achievement was a combination of ACT test scores and high school grade point average. This combination of predictors held for both the non-traditional and traditional student. Using two variables "would allow students with lower high school averages to increase their chances of admission by having higher ACT composite scores and vice versa" (Noble, 2000, p. 21). Noble (2000) suggested that to further reduce possible discrepancies in age, other variables such as motivation and work experience should be considered in admission decisions.

*Weighted HSGPA and Modified High School Percentile*

A case study performed by Nan Hu in 2002 investigated using a weighted high school grade point average along with SAT total score as a predictor of first year academic achievement. Hu used six freshman cohorts totaling 4,871 students in his investigation. In his findings, the highest correlation for achievement, $r = 0.386$, was with high school grade point average followed by total SAT score, $r = 0.265$. Combining the two and giving the high school grade point average a weight of 600, he found a correlation of $r = 0.437$, much higher than either predictor alone (Hu, 2002).

Tam and Sukhatme (2004) also looked at high school performance for use as an admission factor, focusing on high school percentile rank. They developed a modified percentile rank that could be used to predict academic achievement. Tam and Sukhatme compared slopes of least squares estimates of various input variables that were commonly used as admission factors. Findings supported modified high school percentile rank as a better predictor than SAT, ACT, non-modified high school percentile rank, or any combination of the latter. It was suggested that the modified percentile rank, along with other selection criteria, could be a useful tool in college admission criteria (Tam & Sukhatme, 2004).

Missouri Department of Higher Education requires four year colleges and universities to use an unmodified percentile rank combined with ACT or SAT percentile as an admissions criterion. A tiered system is used with the following categories and ranks:  highly selective, 140; selective, 120; moderately selective, 100; open enrollment, any rank. If students perform above certain levels on standardized tests, they are admitted regardless of combined rank (Marble & Stick, 2004).

*Assessment Issues for Teachers*

Noble and Camara (2003) supported the concept that student achievement can be predicted using standardized admission tests, high school grade point average, and high school rank. However, they recommended that other factors be considered in the admission process. Moreover, they also stated that not one measure encapsulates all of the student's attributes (Noble & Camara, 2003).

According to Noble and Camara (2003), assessment tests like the ACT and SAT provide easy, straightforward, and quantifiable measures that are readily available. When

considering single predictors, high school grade point average or ACT scores accurately forecast success in about three-fourths of students. Combining the ACT score and high school grade point average, academic success can be predicted for about 80 percent of students (Noble & Camara, 2003).

*Assessment Scores in the South*

Many colleges use achievement test scores, such as the ACT and SAT, to help determine students' readiness for higher education (Lord, 2003; Tam & Sukhatme, 2004). The Southern Regional Education Board is using these determinates to answer the question: "Are [high school] students in [Southern Regional Education Board] states being sufficiently prepared for college?" (Lord, 2003, p. 14). The answer was a resounding "no".

The Southern Regional Education Board reported agreement that achievement tests, like the ACT and SAT, are routinely used as admission criteria, but that there are no formal established benchmarks available to determine readiness. Using guidelines from the National Collegiate Athletic Association, the Southern Regional Education Board looked at achievement scores in four categories (Lord, 2003).

The basic level included students who scored 17 on the ACT and 800 on the combined SAT. This level was adequate for admission, but often required students to take remedial courses (Lord, 2003). Remedial coursework is required to elevate students' skills to the collegic level (Illich, Hagan, & McCallister, 2004); these are college classes at a high school level that usually result in no college credit.

 The minimum level for admission was an ACT score of 19 and combined SAT score of 900. These scores are the typical threshold for college admission. At these levels,

some of the students are required to take remedial coursework (Lord, 2003). The other levels; standard admission threshold, 21 ACT and 1000 SAT; and proficient, 26 ACT and 1200 SAT, either required little or no remedial work (Lord, 2003).

Only 84 percent met the basic level in North Carolina. Even worse, Southern Regional states averaged only 67 percent. No state achieved over 50 percent at the standard level for ACT, with North Carolina achieving this level on only the math portion of the SAT. The number of students achieving the proficient level ranged from one in four to less than one in 10 (Lord, 2003).

Remedial Course Work

One implication of the Southern Regional Education Board study is that students graduating high school have a high probability of being required to take remedial course work prior to enrollment in college level classes. This is especially true of colleges that follow an open admission policy without screening applicants based on academic preparedness. In fall of 2000, 28 percent of all students entering postsecondary institutions and 42 percent of those entering public two year colleges were provided with remedial course work (Wirt, Choy, Rooney, Provasnick, Sen, & Tobin, 2004).

Information concerning the effects of remedial coursework on achievement is very limited. Illich, Hagan, and McCallister (2004) reported no difference in college-level course passage rates of those students who took remedial courses compared to those who did not. However, they did report that those students who were not required to take remedial classes performed better.

Kallajo (2004) somewhat supported these findings. He reviewed the mean GPA of students not taking remedial classes, those taking only one, and those taking two or more.

Records of approximately 125 graduates were analyzed over a three-year period (2000 –

2002). Students taking only one remedial class performed as well as those not taking

remedial classes. Those taking two or more remedial classes performed at a slightly lower

level (Kallajo, 2004). Both studies reported that students taking remedial coursework

took longer for graduation completion (Illich et al., 2004; Kallajo, 2004).

A 2005 critical success factor study by the North Carolina Community College

System [NCCCS] (2005) compared success rates of those taking remedial coursework to

non-remedial takers. The results summarized: "Eighty-six percent (86%) of the students

who completed a developmental course(s) had a grade of "C" or better in subsequent

college-level courses. Eighty-seven percent (87%) of the non-developmental students

performed at the same level" (NCCCS, 2005, p. 29). This study did not differentiate

among the success rates of those taking single and multiple remedial courses.

Often the SAT or ACT scores are not available to the community college. A

common alternative to the SAT or ACT for placement into remedial coursework is the

ACCUPLACER exam, administered by the College Board, over the Internet. The

ACCUPLACER was administered over five million times in 2004 (Sanchez, 2005). The

North Carolina Community College System, in August of 2004, commissioned a validity

study to assess ACCUPLACER's success in placing students into college level courses

(Michaelides, 2005).

The validation study looked at four areas: arithmetic, elementary algebra, reading

comprehension, and sentence skills. Over 11,000 student records from 58 community

colleges were examined and compared with grades in 32 different classes (Michaelides,

2005). The study indicated: "[S]tudents with higher scores on an ACCUPLACER test

before taking a relevant course, were more likely to successfully complete the course than their counterparts with lower scores . . . [and that] the predictive validity of ACCUPLACER tests for performance in courses in which students are placed in their first semester of college [was established]" (Michalides, 2005, pp. 8-9).

<div align="center">Retention</div>

Along with academic achievement, a measure of student success is program completion or retention. The North Carolina Community College System identifies retention and graduation as one of the core components of college accountability (NCCCS, 2005). North Carolina community colleges reported an overall retention and return rate, those students completing or continuing their studies, of 67 percent for 2004. Of the 161,351 students included in the report, only 14 percent graduated (NCCCS, 2005). This can be compared to a nation wide study reported by the Community College Research Center having 22.3 percent graduating (Bailey, Calcagno, Jenkins, Leinbach, & Kienzl, 2005b).

When reviewing graduation numbers it is important to remember that graduation may not be the goal of a significant number of community college students (Bailey et al., 2005a). Many of the students who may have originally stated that degree or graduation completion was their primary goal, later realized that their goals have changed to completing some college courses or transferring to another institution (Bailey et al., 2005b; Bailey, Jenkins, & Leinbach, 2005).

Several factors have been attributed to increased retention among community colleges. Institutional expenditures for instruction have a statistically significant impact on retention. It is estimated that for every $ 1,000 spent on instruction per full time

equivalent, graduation rates will improve by 1.3 percent (Bailey et al., 2005b). Accurate

placement into classes, remedial or college level, has also been linked to student retention

rates. Placement programs, such as those using ACCUPLACER, can be successfully used

to increase student success and retention (Overstreet, 2004). Other studies have also

linked non-academic factors, such as "academic self-confidence, achievement

motivation, institutional commitment and social support" to student retention (Lotkowski,

Robbins, & Noeth, 2004, p. 13)

<div align="center">Community College Nursing Program</div>

The study that best describes and offers solutions to the problems facing the

health science areas in community college systems was undertaken by the California

Postsecondary Education Commission and the California Policy Research Center in

2003. Not unlike other health science programs, the nursing programs in California are

experiencing more student applications than admission slots. This study investigated,

among other things, selective and non-selective admissions, attrition, national board

passage rates, and best practices of community college programs (Seago & Spetz, 2003).

*Non-selective Admissions*

Most of the colleges use some form of non-selective admission policy. Lottery

programs using random number lists or drawings, first-come on registration day, or first-

come waiting lists are techniques used in student selection. In some programs students

who have not been accepted in 2 to 3 years are given preference (Seago & Spegtz, 2003).

*Selective Admissions*

Selective admission strategies are employed by eight of the 67 California

community colleges. Using a point system, these colleges give priority to students who

receive higher grades in prerequisite courses, have previous health care experience, or performed community service. Over half of these colleges reserve some enrollment slots, using open admissions, for students not making priority status (Seago & Spegtz, 2003).

*Retention*

Retention of students focuses not only on graduation rates and early leavers but also on those students who do not succeed in passing the licensing examination goal. The main reason given by students for leaving a nursing program was the necessity to work and support themselves and family (Seago & Spegtz, 2003). Other studies have supported the relationship between work, attrition, and completion of student goals (Bailey et al., 2004). Academic preparation before admission was the second most common reason for not successfully completing a program or failing the licensing examination (Seago & Spegtz, 2003; Bailey et al., 2004).

*Best Practices*

Three of California's community colleges, with demographics not conducive to high completion rates, have success rates of at least 90 percent. These colleges all "require at least four biology, four anatomy and four physiology prerequisite units" and offer support services for students (Seago & Spegtz, 2003, p. 31). In addition, a variety of other attributes such as additional math and chemistry prerequisites, skills lab and remedial education support, and planning services and financial aid geared toward diverse students are present at various colleges. All have average faculty ratios between 6.9 and 10.3 students per faculty. The two programs with the highest license passage rates both require at least a GPA of 2.5 for admission and use selective admission strategies (Seago & Spegtz, 2003).

*Recommendations and Findings*

Several of the recommendations and findings of the California study are as follows (Seago & Spegtz, 2003):

- Predictors of students' success in nursing programs consisted of overall college GPA, English GPA, core biology GPA, and the number of times a student repeated any core biology course.

- The number of support services offered to students was associated with higher completion rates.

- Although it is suggested that selective admissions increases program success, a portion of admissions should be on a non-selective bases.

- Student performance is negatively impacted by full-time employment.

Conclusion

This chapter explored several factors that influence student academic achievement and retention. Admission criteria such as high school grade point average, achievement test scores, and high school rank have been used as predictors of college accomplishment, all with varying levels of success. Student remediation for use when skill levels were judged not adequate for completion of college level coursework was investigated. Retention strategies, such as academic placement and instructional financing, were also examined. Finally, a look at the practices and best efforts of the nursing programs of California community colleges was undertaken.

The topics discussed still leave much undecided concerning the best means to predict student success prior to admission into community college programs. It is also unclear if any of the practices would be successful at Caldwell Community College and

Technical Institute. The next chapter will describe the proposed methodology that will be used to study several of the factors previously discussed. Academic achievement in the form of attrition, examination passage rates, and GPA will be examined to see if they are influenced by placement strategies or previous advanced classes or degrees.

Chapter 3: Methods

There has been little research involving the prediction of student success in community colleges. Possible predictors include placement strategies, completion of related science classes, and developmental course work. This chapter describes the methods employed to investigate these factors and how they relate to student outcomes.

Study Design and Sample Selection

The study was based on historical or retrospective data. The majority of data was gathered from the Caldwell Community College and Technical Institute (CCCTI) database, Datatel, and from online sources. Student educational level, SAT (Scholastic Aptitude Test), ACT (American College Testing), and ACCUPLACER CPT (computer placement test) scores were provided by the information technology department from the college's database using an Excel spreadsheet.

According to the College Board, "The SAT Reasoning Test™ is a . . . test that measures critical reading, mathematical reasoning, and writing skills that students have developed over time and that they need to be successful in college" (collegeboard.com, 2005a). Like the SAT, the ACT is a college entrance exam assessing high school students' abilities to be successful in college (ACT, 2005). The SAT and ACT are generally taken while a student is still in high school. If an applicant either has not taken the SAT or ACT, the ACCUPLACER exam is available for colleges to gauge a student's

preparedness. The ACCUPLACER exam is nationally normed and is available over the internet from the College Board (collegeboard.com, 2005b).

Other information including GPA (grade point average), science course grades, program completion, birth date, and gender was obtained from individual student transcripts and added to the spreadsheet. National board passage information, with the exception of sonography, was gathered from the respective credentialing agencies at the following web sites: American Registry of Radiologic Technologist, http://www.arrt.org; The Nuclear Medicine Technology Certification Board, http://www.nmtcb.org. The sonography program director provided records of sonography certification passage rates. The decision not to include surveys from currently enrolled students was made because the subjective data gained would add little to the intent of the study.

Information consisted of records of students who started imaging programs during the period of 2000 – 2004. Data over this five-year period adequately represented the types of students who are currently enrolling into imaging programs at CCCTI. The sample size is represented as follows: radiology, $n = 98$; nuclear medicine, $n = 73$; medical sonography, $n = 42$; total, $n = 213$. All students accepted into the three imaging programs were included in the study. The sample is described in Tables 1 and 2. However, incomplete records, based on analysis parameters, excluded some student records from portions of the analysis.

Table 1

Sample Description – Sex, Age, GPA.

|  | Male | Female | Mean Age | Mean GPA |
|---|---|---|---|---|
| Radiology | 27.6 % | 72.4 % | 31 | 3.045 |
| Nuclear Medicine | 41.1 % | 58.9 % | 30 | 3.296 |
| Medical Sonography | 0 % | 100 % | 27 | 3.709 |
| Total Sample | 26.3 % | 73.7 % | 32 | 3.205 |

Note. N=213.

Table 2

Sample Description – Educational Level.

|  | High School or Equivalency | Vocational Diploma | Associate Degree | Bachelor's Degree | Master's Degree |
|---|---|---|---|---|---|
| Radiology | 73.4 % | 4.1 % | 14.3 % | 8.2 % | 0.0 % |
| Nuclear Medicine | 68.5 % | 5.5 % | 12.3 % | 12.3 % | 1.0 % |
| Medical Sonography | 73.8 % | 2.4 % | 16.7 % | 7.1 % | 0.0% |
| Total Sample | 71.8 % | 4.2 % | 14.1 % | 9.4 % | 0.5 % |

Note. N=213.

There are several rules of thumb regarding the appropriate number of samples for use with regression techniques. These rules range from no more than one independent

variable per ten cases or samples to one variable per 40. At most, there were four independent variables used in a multiple regression analysis. Since all of the records were used, and inclusion of student records prior to 2000 was not representative of current applicants, current sample size was deemed adequate for this study.

The size of our sample is supported by a power analysis for size determination. The probability that the test will correctly reject the null hypothesis when it is false is indicated by the power of the test. Using a .80 power and a $p = .05$ with four groups, to achieve a medium effect size of .75 would require a minimum of 40 in each group. Sonography, the smallest group, contains 42, which is within this limit.

The data was readily available, with no direct associated costs involved with the data collection and analysis. The persons involved in data collection, analysis, and review were bound by employment contracts in regards to student record confidentiality. There was no reporting of information that compromised the identity of any student. Appropriate precautions, for electronic data base security and written information, included passwords and physical data protection procedures.

<div align="center">Methods of Analysis</div>

Microsoft Excel spreadsheet with the Analyse-it plug-in was used for data analysis. The dependent variables of persistence rates, certification passage rates, and GPA were compared to the independent variables of placement scores, number of developmental classes, previous science class scores, and level of education using individual regression analysis. The regressions were performed for individual programs and a composite of all programs.

Regression analysis is the best method to make correlations based on dependent and independent variables. Using this technique, degrees of correlations can be determined, allowing for discussion as to cause and effect. The principle factor in the results was the adjusted $R^2$. Analyse-it uses a least-squares estimation method and provides a regression ANOVA (Analysis of Variation) table, adjusted $R^2$ statistic, regression line plot, and plots of residuals.

*Assumptions*

Several assumptions for data were included in the testing. Students enrolling into the programs for the 2004 class were only included in the persistence and GPA analysis. BIO 163, Basic Anatomy and Physiology, was considered equivalent to BIO 168, Anatomy and Physiology I. Medical sonography and nuclear medicine have two credentialing exams. Passage of either exam was considered as passage of a certification exam.

CCCTI uses SAT, ACT, or ACCUPLACER computerized placement test individually or in combination for placement purposes. SAT and ACT scores are normally reported as two individual scores, verbal or English and math; an additive score was used for comparison purposes. ACCUPLACER consists of four academic tests – sentence skills, arithmetic, algebra, and reading. Regression using all of the ACCUPLACER scores was performed with each dependent variable. In addition, a regression with an average of all ACCUPLACER scores was also performed. Table 3 defines the grouping that was used for SAT, ACT, and ACCUPLACER regressions.

Table 3

Placement Score Grouping

| ACT | SAT | ACCUPLACER |
|---|---|---|
| 0 – 34 | 0 – 700 | 0 – 50 |
| 35 – 39 | 701 – 800 | 51 – 70 |
| 40 – 44 | 801 – 900 | 71 – 90 |
| 45 + | 901 – 1000 | 91 – 110 |
| | 1001 – 1100 | 111 + |
| | 1100 + | |

GPA is reported on a four-point scale. Grades for science courses are reported in Datatel using the convention of A, B, C, D, and F. For analysis, the nominal grade data was converted to numbers using the following rule:  A = four, B = three, C = two, D = one, and F = zero. Likewise, the nominal data for highest grade level prior to admission into a program was reported as numbers as follows:  high school or equivalency = 12, one-year vocational diploma = 13, associate degree = 14, bachelor's degree = 15, and master's degree or higher = 16.

Threats to Validity

Regression analysis is not without problems and threats to study validity. Basic regression relies on several assumptions, linearity, normality, and non-multicollinearity.

- Linearity – it is assumed that there is a linear relationship between variables. This can be evaluated somewhat by visual analysis of a scatter

plot of the dependent versus the independent variable. If the non-linearity is severe, the results of the regression may be unusable.

- Normality – the assumption that the residuals of the observations are distributed normally. Analyse-it produces a plot of the residuals with normal curve fit for review.

- Non-multicollinearity – deals with the interrelatedness of the independent variables. Multicollinearity is also considered redundant predictors, which may make analysis unreliable. Excel provides a correlation matrix that can be used to test for multicollinearity.

- Lack of data – deals with incomplete or volume of data. The data being utilized for this study is a good representation of the current mix of students enrolling in CCCTI. Inclusion of students prior to 2000, because of local economic trends, would not be suitable. Information that is more complete may be provided if data is collected for several more years.

## Conclusion

Evaluation of predictors of student success can be accomplished using statistical regression techniques. Regression analysis of historical data containing persistence rates, certification passage rates, and GPA can be correlated with predictors in an attempt to forecast future students' chances of success in an imaging program. Microsoft excel, in conjunction with Analyse-it, was used to provide descriptive information of students enrolled in imaging programs from 2000 - 2004. This technique is not without the potential for error. Assumptions of linearity, normality, and multicollinearity were considered. Findings will be presented in the next chapter.

Chapter 4:  Results

As described in the methods section, regression analysis is the technique chosen to assess the correlation between predictors and outcomes. Dependent variables, attrition rates expressed as persistence, certification passage rates, and GPA were compared with the independent variables; placement test scores, number of developmental classes, science class grades, and educational level of students prior to beginning a program. The regression was performed to help identify trends that may be used in the development of a competitive admissions policy. The hypotheses that are to be answered are as follows:

$H1_0$ = The  program outcome parameter of attrition is not influenced by preadmission status of students, such as placement test scores,  history of developmental classes, previous science classes, or advanced degrees.

$H2_0$ = The  program outcome parameter of certification passage rates is not influenced by preadmission status of students, such as placement test scores,  history of developmental classes, previous science classes, or advanced degrees.

$H3_0$ = The  program outcome parameter of GPA is not influenced by preadmission status of students, such as placement test scores,  history of developmental classes, previous science classes, or advanced degrees.

Results of Analysis

The regression result summaries are presented in Tables 1 – 4. Each regression was assessed for a significance of $p = .05$. Nuclear medicine and sonography demonstrated correlations between the independent variables and GPA, ranging from .06 (p<.05) to .73 (p<.0001) for adjusted $R^2$. Sonography also demonstrated correlation between persistence and the ACCUPLACER reading test, adjusted $R^2 = .89$ ($p = .0390$). Radiography demonstrated correlations in only three areas:  GPA and number of developmental courses, adjusted $R^2 = 0.70$ ($p = .0056$); GPA and science class grade, adjusted $R^2 = .41$ ($p = < .0001$); and certification passage rate and science class grade, adjusted $R^2 = .88$ ($p = .0416$)

Regression of the combined dataset revealed only correlations with GPA and all of the independent variables, with the exception of ACT scores. Adjusted $R^2$ ranged from .04 (p<.05), for SAT score, to .43 (p<.001) for science class grade. There were no other associations discovered between the dependent and independent variables.

A regression between the dependent variable GPA and the dependent variables, persistence and certification passage was also performed. Combined dataset GPA and persistence rates resulted in adjusted $R^2 = .59$ ($p = < .0001$). Combined dataset GPA and certification rates resulted in adjusted $R^2 = .49$ (p = .0008).

Table 4

Regression Summaries for Nuclear Medicine

| | GPA | | Persistence | | Certification | |
|---|---|---|---|---|---|---|
| | Adjusted $R^2$ | $n$ | Adjusted $R^2$ | $n$ | Adjusted $R^2$ | $n$ |
| Developmental Classes | .23 *** | 71 | .17 | 62 | .11 | 44 |
| Educational Level | .06 * | 73 | .20 | 62 | .40 | 44 |
| Science Class Grade | | | | | | |
| Anatomy & Physiology I | .40 *** | 71 | .65 | 62 | - .40 | 44 |
| Anatomy & Physiology II | .54 *** | 46 | .34 | 39 | - .50 | 33 |
| General Chemistry | .57 *** | 39 | .25 | 40 | - .40 | 30 |
| Placement Tests | | | | | | |
| Sentence Skills | .41 *** | 46 | .39 | 37 | .00 | 27 |
| Reading | .30 *** | 58 | .54 | 50 | 60 | 35 |
| Arithmetic | .33 *** | 60 | - .33 | 52 | .16 | 37 |
| Algebra | .23 *** | 61 | - .26 | 53 | .33 | 37 |
| Average CPT | .36 *** | 60 | .49 | 52 | .37 | 37 |
| SAT | .20 * | 20 | - .33 | 20 | - ∞ | 18 |
| ACT | - .13 | 6 | __ | | __ | |
| GPA | | | .27 | 62 | .27 * | 44 |

Note. * $p < .05$; ** $p < .01$; *** $p < .0001$

Table 5

Regression Summaries for Sonography

| | GPA | | Persistence | | Certification | |
|---|---|---|---|---|---|---|
| | Adjusted | | Adjusted | | Adjusted | |
| | $R^2$ | $n$ | $R^2$ | $n$ | $R^2$ | $n$ |
| Developmental Classes | .32 *** | 40 | .02 | 33 | - .16 | 18 |
| Educational Level | .06 | 40 | .56 | 35 | .48 | 12 |
| Science Class Grade | | | | | | |
| Anatomy & Physiology I | .73 *** | 28 | .75 | 24 | - .02 | 24 |
| Anatomy & Physiology II | .62 *** | 24 | - ∞ | 20 | - 1.00 | 20 |
| Placement Tests | | | | | | |
| Sentence Skills | .15 * | 32 | .31 | 26 | - .85 | 12 |
| Reading | .17 | 37 | .89 * | 31 | - .47 | 16 |
| Arithmetic | .37 *** | 37 | - .31 | 31 | - .40 | 17 |
| Algebra | .31 ** | 37 | - .31 | 31 | - .49 | 17 |
| Average CPT | .34 ** | 32 | - .32 | 26 | - 0.42 | 12 |
| SAT | .00 | 19 | - .06 | 18 | - .06 | 11 |
| ACT | — | | — | | — | |
| GPA | | | .61 ** | 35 | .64 | 23 |

Note. * $p < .05$; ** $p < .01$; *** $p < .0001$

Table 6

Regression Summaries for Radiography

|  | GPA | | Persistence | | Certification | |
|---|---|---|---|---|---|---|
|  | Adjusted | | Adjusted | | Adjusted | |
|  | $R^2$ | $n$ | $R^2$ | $n$ | $R^2$ | $n$ |
| Developmental Classes | .70 | 93 | .22 | 88 | - .09 | 53 |
| Educational Level | .01 | 93 | - .23 | 88 | .11 | 53 |
| Science Class Grade | | | | | | |
| Anatomy & | | | | | | |
| Physiology I | .41 *** | 69 | .40 | 60 | .88 * | 37 |
| Placement Tests | | | | | | |
| Sentence Skills | .02 | 65 | - .13 | 63 | .48 | 40 |
| Reading | .01 | 87 | .49 | 83 | .27 | 51 |
| Arithmetic | .01 | 82 | .05 | 78 | .25 | 46 |
| Algebra | - .28 | 87 | - .32 | 83 | - .26 | 48 |
| Average CPT | - .48 | 76 | .04 | 73 | - .48 | 46 |
| SAT | - .01 | 40 | .34 | 37 | - .10 | 26 |
| ACT | - .25 | 6 | - 1.00 | 5 | - ∞ | 4 |
| GPA | | | .58 *** | 83 | .11 | 52 |

Note. * $p < .05$; ** $p < .01$; *** $p < .0001$

Table 7

Combined Nuclear Medicine, Sonography, and Radiography Dataset Regression

Summaries

| | GPA | | Persistence | | Certification | |
|---|---|---|---|---|---|---|
| | Adjusted $R^2$ | $n$ | Adjusted $R^2$ | $n$ | Adjusted $R^2$ | $n$ |
| Developmental Classes | .12 *** | 205 | - .03 | 177 | - .15 | 119 |
| Educational Level | .05 * | 205 | .14 | 180 | - .39 | 121 |
| Science Class Grade | | | | | | |
|    Anatomy & Physiology I | .43 *** | 144 | .29 | 127 | .26 | 84 |
| Placement Tests | | | | | | |
|    Sentence Skills | .06 ** | 144 | - .33 | 122 | .22 | 83 |
|    Reading | .07 ** | 183 | - .15 | 160 | - .31 | 141 |
|    Arithmetic | .12 *** | 180 | - .07 | 157 | .16 | 105 |
|    Algebra | .10 *** | 186 | - .32 | 163 | .37 | 108 |
|    Average CPT | .13 *** | 195 | .00 | 172 | .05 | 114 |
|    SAT | .04 * | 79 | .19 | 72 | - .25 | 50 |
|    ACT | - .04 | 14 | - 1.00 | 12 | .50 | 10 |
| GPA | | | .59 *** | 185 | .49 ** | 123 |

Note.  * $p < .05$; ** $p < .01$; *** $p < .0001$

Conclusion

Regression analysis of variables reported significant correlations between GPA and the independent variables for nuclear medicine, sonography, and the combined dataset.  Radiography only reported significant correlations in three areas. Regression also demonstrated correlations between GPA – persistence rates and GPA – certification rates.  The next chapter, discussion, will compare these outcomes with those found in the literature review.

Chapter 5:  Discussion

This chapter restates the problem for the reader and reviews the methods used in its investigation. Additionally, a summary of the results is given along with a discussion. Finally, a recommendation on how the results can be used is presented.

Problem Statement

The admissions process at Caldwell Community College & Technical Institute (CCC&TI) is based on an open-door or "first-come first-served" policy. This policy allows all applicants, regardless of prior experience or educational background, to have the same chances of admission into the imaging programs. Admission requirements are based on the completion of the following tasks:  application, transcript receipt, placement tests, and information session attendance. Currently, there is no mechanism in place to identify students with low probability of program success or completion. In past years, the numbers of vacancies in the programs were sufficient to accommodate both types of students, those with high and low probabilities of success.

Over the last five years, there has been an increase in applicants interested in the imaging fields. Concerns are that admitted students with low probability of success are filling seats that could be given to those with a higher probability of program completion. Both college administration and faculty believe that because of limited resources,

competitive admissions should be used to screen students, giving priority to those applicants who are more likely to be successful.

At present there is no mechanism defined to accomplish admission screenings. It is also unknown if competitive admission screenings will result in an increase in student success. Several parameters can be accessed for the possibility of inclusion in a competitive admissions process, such as placement test scores, history of developmental classes, previous science classes, or advanced degrees. Measurable outcomes such as attrition, certification passage rates, and GPA can also be obtained. Administration should find it useful to have concrete data to base a decision on whether to adopt a competitive admissions process and to determine which of the current parameters would be the best predictor of student success.

<div align="center">Review of Methods</div>

Placement test scores and educational levels were taken from the Caldwell Community College & Technical Institute database. Additional information including age, GPA, science course grades, number of developmental classes, and program completion were obtained from student transcripts. Certification passage rates were acquired from either the certifying agency's website or the program director for that modality. The information was limited to the students entering the imaging programs from 2000 – 2004. The sample size was represented as follows: radiography, $n = 98$; nuclear medicine, $n = 73$; medical sonography, $n = 42$; total, $n = 213$.

Linear regression utilizing least-squares estimation was used as the statistical tool for this study. The data were compiled into a Microsoft Excel spreadsheet with the Analyse-it plug-in. Regressions were performed with GPA, persistence rates, and

certification passage rates as dependent variables. Independent variables included placement test scores, number of developmental classes, previous science class scores, and educational level. Regression using persistence rates and certification passage rates as dependent variables and GPA as the independent variable was also performed. Only regressions with $p = < .05$ were considered significant.

## Discussion

Of the three hypotheses that were considered only $H3_0$, regarding GPA, was rejected for the complete dataset. GPA did show correlations with all of the independent variables, with the exception of ACT scores. These correlations were minor for most of the regressions, ranging from an adjusted $R^2 = .04$ ($p = < .05$) to .13 ($p = < .0001$). A higher correlation was demonstrated between GPA and the science class grade, adjusted $R^2 = .43$ ($p = <.0001$). This minor association implies that placement scores and science course grades can be used to forecast ending program GPA with limited ability.

Persistence and certification passage rates revealed no correlations with any of the predictors. With college success defined as completion of the program of study and passage of a certification exam, the study concludes that college success cannot be predicted by the parameters investigated. This may imply that other factors play a vital role in college success. Noble (2000) suggested other variables such as age, motivations and work experience may play a role in student success, while Noble and Camara (2003) stated that not one measure encapsulates all of the student's attributes.

Linear regression was performed using GPA as the independent variable and persistence and certification rates as dependent variables. Correlations of adjusted $R^2 =$ .59 ($p = < .0001$) for persistence and adjusted $R^2 = .49$ ($p = .0008$) for certification rates

were demonstrated. This suggests, as in the California Postsecondary Education Commission and the California Policy Research Center study, that GPA has been linked to college success (Seago & Spegtz, 2003).

Logically, we can assume that if college GPA can be maximized then the probability of college success can also be increased. However, given the weak association with the GPA predictors, admission policy should only consider using the number of developmental classes, educational level, science class grades, and placement test scores on a limited scale.

Based on the findings the following assumptions can be made concerning competitive admissions processes in the imaging programs at Caldwell Community College & Technical Institute:

- Predictors of student GPA include number of developmental courses taken prior to entering the programs, prior educational level of students, science class grades, and placement test scores.

- Program success, completion of prescribed course of study and passage of certification exam, cannot be predicted by number of developmental courses taken prior to entering the programs, prior educational level of students, science class grades, and placement test scores.

- Program success, completion of prescribed course of study and passage of certification exam, is influenced by GPA.

- It is suggested that selective admissions can influence program success by improving GPA. However, because of the restricted correlations and the

possibility of other influences on success, a portion of admissions should always remain on a non-selective basis.

## Study Limitations

The results presented by this study are limited to the imaging modalities at one community college. Even though most community colleges utilize similar open admissions policies, a wider selection of students, by academic area and geographical region, may present dissimilar results. The extent that these results may be applicable for other programs or community colleges is unknown. In addition, the study investigated only academically quantifiable parameters. Other student influences may show correlations with student success and outcomes.

## Future Research

Other investigators have indicated academic predictors may not be the only factors influencing student success (Armstrong, 2001). Future research is needed to identify, and if possible, quantify other predictors of student success. Suggestions for research may include how age, motivation, work experience, financial status, and family factors influence GPA, persistence, and certification passage rates. Once identified, research regarding application and incorporation of the predictors into the admission process is needed. Such research may allow community colleges to modify the admission process in order to better utilize valuable resources.

## Conclusion

The task of forecasting student success based on historical data for possible development into admissions criteria is problematic at best. The open access philosophy of the community college provides little information for the development of selective

admission strategies. The present study suggests there is little correlation between a limited number of predictors and student success. However, demonstration of an intermediate relationship between GPA and student achievement is possible. Reliance on preadmissions criteria to increase student GPA and thereby improve persistence and certification rates is not sufficient to base a complete admission practice. The findings of this study suggest that student outcomes are influenced by much more than number of developmental courses taken prior to entering programs, prior educational level of students, science class grades, and placement test scores. Additional research is needed to identify other factors involved in student success and to incorporate these factors into policy.

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Appendix

Figure 1

Example of Regression Analysis Output

| | n | 7 | | | |
|---|---|---|---|---|---|
| $R^2$ | | 0.08 | | | |
| Adjusted $R^2$ | | -0.10 | | | |
| SE | | 0.5583 | | | |

| Term | Coefficient | SE | p | 95% CI of Coefficient | |
|---|---|---|---|---|---|
| Intercept | 2.1992 | 1.6960 | 0.2513 | -2.1604 | to 6.5589 |
| Slope | 0.0853 | 0.1267 | 0.5307 | -0.2403 | to 0.4109 |

| Source of variation | SSq | DF | MSq | F | p |
|---|---|---|---|---|---|
| Due to regression | 0.1413 | 1 | 0.1413 | 0.45 | 0.5307 |
| About regression | 1.5585 | 5 | 0.3117 | | |
| Total | 1.6998 | 6 | | | |