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An Investigation of the Relationship Between High School Courses Taken and Graduation from Chadron State College Within Six Years

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Graduation from Chadron State College Within Six Years

by

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An Investigation of the Relationship Between High School Courses Taken and

Graduation from Chadron State College Within Six Years

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Chadron State College is one of three institutions in Nebraska's State College
System. Because of its mission as an open-enrollment institution, Chadron State College
has no academic course requirements for admission, and any student who has completed
high school or its equivalent is eligible for enrollment.

The purpose of the study was to find whether or not there was a relationship
between the characteristics of a Nebraska student's high school education and the
probability of that student's graduation from Chadron State College within six years of
matriculation.

A sample of 180 high school records were retrieved from the Chadron State
College data base, 90 for students who had graduated within six years and 90 for students
who had not. Six independent variables were analyzed using logistic regression.

Six specific research questions were addressed:

1. Was the ratio of academic credit units to total credit units a predictor of
   graduation within six years? No predictive relationship was found.

2. Was the ratio of mathematics and science credit units to total credit units a
   predictor of graduation within six years? No predictive relationship was
   found.

3. Was the ratio of language arts, foreign language, and social studies credit units to total credit units a predictor of graduation within six years? No predictive relationship was found.

4. Was the total number of credit hours taken a predictor of graduation within six years? A predictive relationship was found.

5. Was high school grade point average a predictor of graduation within six years? A predictive relationship was found.

6. Was the composite ACT score a predictor of graduation within six years? A predictive relationship was found.

The results of this study were contrary to national-level statistical tests conducted by Adelman (1999, 2006) and Trusty (2004), who found that the strongest predictor of bachelor's degree completion was the academic intensity of a student's high school program.

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and my mom and dad, Allan and Shirley. Thank you Dr. Uerling for being my steadfast,

true advisor.

**"I am in blood stepped in so far that should I wade no more, Returning were as
tedious as go o'er."   Macbeth, Act 3**

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Chapter 1

Introduction

Background of the Study

Chadron State College (CSC), one of three state colleges in Nebraska's State College System and the only four-year public institution in western Nebraska, serves a student body of approximately 2,500 students. The majority of the freshmen that enroll at CSC have previously graduated from a Nebraska high school. According to Nebraska's Coordinating Commission for Post-secondary Education (CCPE, 2008) 66.6% of CSC's fall 2006 freshmen originated from Nebraska, with 63.8% of the fall 2004 freshmen, and 69.8% of the fall 2002 freshmen also having originated from Nebraska. Many of CSC's enrolling freshmen have come from its rural service area of 30 sparsely populated western Nebraska counties (CSC, Office of Institutional Research, 2009). In a study conducted in 1991, Roweton and Bare noted that an average 77% of the students in two freshman cohorts were from homes located within 300 miles of the college.

Characterization of the level of high school course preparation of the student body at CSC has been elusive, and reliable information concerning what high school courses students have completed cannot be realized from the college's admission requirements, from ACT test-taker self-reports, or from high school graduation requirements. Because of its mission as an open-enrollment institution, Chadron State College has no academic course requirements for admission, and any student who has completed high school or has attained the equivalent of a high school degree has been eligible for enrollment and the pursuit of a post-secondary education. CSC's admission requirements stipulate that matriculating students have completed a standardized test, such as the American College

Test (ACT); the results of such tests have been used for student placement in remedial English or math courses (CSC, Office of Admissions, 2009). ACT, Inc. has compiled and made available the number of test takers who have taken a recommended high school curriculum; however, this list, from self-reports, is unlikely to be highly reliable. Adelman (1999) noted "significant differences" (p. 24) between courses students self-reported as having completed and what the students actually completed. Further, as the Nebraska Coordinating Commission for Postsecondary Education (CCPE) noted, the number of students who elected to self-report each year fluctuated between a high of 99% in 2010 (CCPE, 2011) and a low of 87% in 2007 (CCPE, 2008). Further, unexplained improvements were observed in ACT scores in 2006 and 2007 by Nebraska students who did not take the recommended curriculum; no ACT score gains have been accomplished since 2008 for Nebraska students who did take the recommended curriculum (CCPE, 2011). Characterization of student academic preparation based on high school graduation requirements has been further complicated because of Nebraska's educational policies. Students enrolled at CSC who also graduated from a Nebraska high school have not been required by Nebraska public education policy to have taken a uniform set of specific high school courses before graduation. Instead of a state-wide, uniform set of course requirements, the specific academic credit units that must be earned by students in order to graduate from high school are determined by the board of education of each of Nebraska's individual school districts (Nebraska Department of Education, 2009b).

National-level research has demonstrated a strong relationship between the level of high school academic course intensity and the likelihood that a student will graduate with a bachelor's degree within six years (Adelman, 1999, 2006; Trusty, 2004). In

Nebraska, an increased rate of graduation followed increased academic admission requirements at the University of Nebraska-Lincoln (UNL). As a selective-admissions institution, UNL has long stipulated the minimal academic preparation that students must meet to be eligible for enrollment. In 1997, UNL instituted a change in admission policy that increased the amount of academic course preparation a student needed to complete during high school in order to be eligible to attend UNL (Appendix A); UNL did not increase the composite ACT score requirement of 20. In the six years following that change, the six-year graduation rates of student cohorts who had enrolled at UNL as first time, full-time freshmen rose from 54.3% for the cohort that enrolled in 1996 (graduation by year 2002) to 63.4 % for the cohort that enrolled in 2001 (graduation by 2007) (UNL, Institutional Research and Planning, 2006, 2008).

The relationship between the level of high school academic preparation of student cohorts at Chadron State College and bachelor's degree completion has been less clear. Roweton and Bare (1991) studied two freshman cohorts enrolled at CSC to establish precollege predictors of attrition. Students defined as belonging to a high academic ability level were more likely to persist at the college than were students in the low academic ability level. However, such non-academic factors as population size of hometown, age, and career interest were also found to be significant to student persistence. Additionally, Roweton and Bare found that a significant number of Chadron State College students categorized as academically "at-risk" (p. 15) remained enrolled. The researchers noted that average composite ACT scores for the two cohorts ranged from 5 to 31.

A pilot study of a preliminary sample of students who graduated from CSC revealed variation in the amount of their high school academic preparation. High school transcripts were randomly selected. The transcripts represented students who graduated from a Nebraska high school, entered CSC as first-time, full-time freshmen, and completed a Bachelor's degree at Chadron State College within four, instead of six, years of matriculation. Three of the students in the sample had graduated from high school in 2001, and one student had graduated from high school in 1997. Transcript data was categorized and compared to the post-1997 admission policy standards of UNL, after its admissions policy change was instituted. Three of the four CSC graduates met or exceeded UNL's admission policy stipulations in the combined area of science, mathematics, language arts, social studies, and foreign languages (Appendix A). However, only one of the four CSC graduates met or exceeded UNL's admission requirement specifically in science and mathematics credit units (Appendix B). All four of the CSC graduates failed to meet UNL's admission requirement in the combined area of social studies, foreign language, and language arts credit units (Appendix C).

How elements of a Nebraska high school student's education relate to the completion of a bachelor's degree at an open enrollment institution such as Chadron State College needed further investigation. National studies conducted by Adelman (1999, 2006) and by Trusty (2004) found that the academic intensity of a student's high school curriculum, measured as the highest level of high school math taken by a student, was the strongest precollege indicator of the likelihood of obtaining a bachelor's degree within six years. Are there characteristics of a Nebraska high school education that can be used as indicators of whether or not a student will graduate from CSC within six years? Does

taking an increased number of high school academic credits earned in mathematics, science, social studies, foreign language, and language arts result in an increased likelihood of obtaining a bachelor's degree at CSC? Has there been a difference in the number of high school mathematics and science credits taken by students who graduate from CSC within six years of matriculation and that amount taken by students who did not graduate within six years of matriculation? Have either the high school grade point average (G.P.A.) or the average composite ACT score of CSC students been stronger predictors than high school coursework of the likelihood of degree completion? The relationship of academically-intense high school courses to the likelihood of graduating from Chadron State College with a bachelor's degree should be analyzed.

Purpose of the Study

The purpose of the study was to find whether or not there was a relationship between the characteristics of a Nebraska student's high school education and the probability of that student's graduation from Chadron State College within six years of matriculation.

Research Questions

Six specific research questions were addressed:

1. Is there a difference between the ratio of academic credit units to total credit units for students who graduate and the ratio of academic credit units to total credit units for students who did not graduate?

2. Is there a difference between the ratio of mathematics and science credit units to total credit units for students who graduate and the ratio of mathematics and science credit units to total credit units for students who did not graduate?

3. Is there a difference between the ratio of language arts, foreign language and social studies credit units achieved by students who graduate and the ratio of language arts, foreign language, and social studies credit units achieved for students who did not graduate?

4. Is there a difference in the number of total of credit hours taken by students who graduate and the total number of credit hours taken by students who did not graduate?

5. Is there a difference between the high school GPA of students who graduate and the level of mathematics achieved for students who did not graduate?

6. Is there a difference in the average (mean) composite ACT scores of students who graduate and the average (mean) composite ACT scores of students who did not graduate?

Variables

The dependent variable was whether or not a student at Chadron State College graduated with a Bachelor's degree within six years of matriculation.

The independent variables for questions 1, 2, 3 and 4 were high school credit units.

The independent variable for question 5 was high school GPA.

The independent variable for question 6 was the student's average (mean) composite ACT score.

Definition of Terms

Academic intensity (or curriculum intensity)—high school courses such as mathematics or science (Adelman 1999, 2006)

American College Test (ACT)—a standardized test taken by high school students preparing for the admission process to college.

ACT score, average (mean) composite—the ACT consists of five academic tests: mathematics, science, social studies, language arts, and a written component. The raw score of each test is given a scale score; the added average score of each area gives the average composite score of the exam. Scores range from 1 (low) – 36 (high)

Attrition—a reduction in the numbers of a student cohort enrolled at a post-secondary institution

Carnegie unit—a defined amount of time a high school student should spend on a topic; 120 hours in one subject earns one Carnegie unit of high school credit. (A course that meets 50 minutes per day, five days per week, 30 weeks.)

Class rank (high school)—a ranking of high school students from highest to lowest, usually based on grade point average at the time of high school graduation.

Cohort—a group of individuals that matriculate in the same semester

Core curriculum—according to the Nebraska Education Department, Rule 10, the core curriculum for high schools includes Language Arts, Social Science, Mathematics, Science, Foreign Language, Career and Technical Education, Personal Health and Physical Fitness, and Visual and Performing Arts (Nebraska Department of Education, 2007). The graduation requirements (see below) for high school students are based on the core curriculum.

Credit hours (or credit units)—the amount of credit awarded to a student for completing a course. The Nebraska Department of Education (2009b) states that the number of credit hours that are awarded by the district for a course may be equal to, be

less than, or may exceed, by up to 25%, the number of instructional (clock) hours allotted to complete the course. For example, a course that took one instructional hour to complete could be recorded as one credit hour, less than one credit hour, or could be worth up to 1.25 credit hours.

First-time, full-time freshmen—students who enroll as full time students in post-secondary education and who have not enrolled in college before, therefore do not have credits to transfer.

Graduation rate for colleges—The U.S. Department of Education uses a period of six years (150% of normal time) when calculating the rate at which a college graduates student cohorts. The period starts when a student matriculates as a full-time first-time freshman.

Graduation requirements for a Nebraska high school student (Nebraska Department of Education, 2007)—According to the Nebraska Education Department, Rule 10, a high school student must earn at least 200 credit hours to graduate from a Nebraska high school; at least 80% (or 160 hours) of which must come from the core curriculum (defined above).

Grade Point Average (GPA)—a numeric method for comparing student grades. Generated by dividing the total number of grade points achieved by the total number of points attempted

Instructional unit—one instructional unit represents 900 minutes of instructional time. A class that that meets five times a week for 50 minutes per meeting and for 180 days creates 9000 instructional minutes, or 10 instructional units (Nebraska Department

of Education, 2009b). The number of credits per course may equal the instructional units, may be less, or may be up to 25% more (Nebraska Department of Education, 2007).

Open admission (or open enrollment)—a post-secondary institution that is defined by mission as accepting all high school graduates

Persistence—the continued enrollment of a student in a college

Retention—students of a particular cohort that remain enrolled in, and taking courses at, a college

Scholastic Aptitude Test (SAT)—a standardized test taken by high school students preparing for the admission process to a college. The choice to take either the ACT or the SAT (or both) typically depends on college admission requirements. Scores on the SAT are converted to a scale that ranges from 200 – 800; the scores can be compared with ACT scores.

Secondary curriculum academic areas based on Nebraska Administrative Code Title 92, Chapter 10 (Nebraska Department of Education, 2007)—

- Mathematics—communicating, reasoning, problem solving, numeration, computation, estimation, measurement, geometry, data analysis, probability and statistical concepts, and algebraic concepts
- Language arts—includes written composition, critical reading, interpretation of fiction and non-fiction, oral presentation, and application of listening skills
- Social science—American and world history, geography, economics, civics, government and citizenship and may also include content from other social science areas such as sociology, psychology, and anthropology. This includes instruction in the U.S. and Nebraska Constitutions, the benefits and

advantages of our government, the dangers of Nazism, Communism, and
similar ideologies, the duties of citizenship and the appropriate patriotic
exercises to include Lincoln's birthday, Washington's birthday, Flag Day,
Memorial Day and Veterans Day as provided in 79-724 R.R.S. All history
courses stress contributions of all ethnic groups in the development and
growth of America.

- Science—science concepts and processes, science as inquiry, physical
  science, life science, earth and space science, science and technology, and
  history and nature of science.

- Foreign language—reading, writing, speaking, and listening skills for
  communicating in one or more languages other than English, knowledge and
  understanding of other cultures, and developing insight into the nature of
  language and culture.

Socio-economic status (SES)—a composite of parent income, educational
attainment, and occupational prestige (Trusty, 2004)

Significance of the Study

National-level studies (Adelman, 1999, 2006; Trusty, 2004) have indicated that a
student's academic high school coursework can be a stronger predictor than such pre-
college variables as the ACT or high school GPA of the likelihood of completing a
bachelor's degree. The University of Nebraska-Lincoln (UNL), a selective-admissions
university, realized gains in student bachelor's degree completion after it adopted
admissions requirements in 1997 that stipulated greater numbers of high school credits
earned in the academic areas of math, science, social studies, language arts, and foreign

language. The effect of high school academic preparation on the likelihood of obtaining a bachelor's degree at Chadron State College has not been studied and may vary from UNL or from such national-level studies as those conducted by Adelman (1999, 2006) and Trusty (2004).

Because the levels of high school academic preparation of matriculating students at CSC have not been clear, the relationship between high school academic preparation and the likelihood of bachelor's-degree completion at CSC has not been readily apparent. Open admissions institutions have a defined educational mission to accept, educate, and graduate students of all academic capabilities and cannot specify a level of academic preparation level for students to matriculate. Open-admissions institutions in Nebraska cannot assume uniform levels of high school student academic preparation because neither the high schools nor the State College System require it. The exact high school graduation requirements in Nebraska have largely been determined by local school boards. While state-wide minimal requirements in math, science, social studies, language arts, and foreign language have been determined, the state of Nebraska has no uniform academic requirements regarding high school graduation and preparation for post-secondary education. Further, the Nebraska State College System has no uniform academic course preparation requirements or recommendations to matriculate at CSC. To further understand the relationship between the academic high school preparation of the CSC student body and how these characteristics contributed to bachelor's degree completion, a logistic regression of Nebraska high school transcript data was used to predict the likelihood of bachelor's degree completion within six years of matriculation.

Chapter 2

Review of the Literature

Introduction

According to three separate longitudinal studies by Adelman (1999, 2006) and Trusty (2004), intensive high school math and science courses were stronger predictors of the likelihood of bachelor's degree completion than student ACT score or student high school grade point average. All three studies followed high school students for eight years after high school graduation; data used were collected by the National Center for Education Statistics [NCES] from nation-wide age-cohort longitudinal studies such as the National Education Longitudinal Study of 1988 [NELS:88] and the High School and Beyond [HS&B] study. The studies focused on bachelor's degree completion and evaluated the predictive strength of numerous variables. Adelman tested high school academic as well as socio-economic [SES] variables, and post-matriculation variables (1999, 2006). Trusty (2004) evaluated student variables from 8th grade up to college entry, and included behavior-related variables, SES, and academic variables. Both researchers consistently found that higher levels of high school mathematics and science courses were firm and reliable predictors of the likelihood of bachelor's degree completion.

The link between Nebraska high school academic courses and the likelihood of bachelor's degree completion at Chadron State College (CSC) has not been readily apparent; this is largely because students are not required to have met uniform academic requirements to attend CSC. Because CSC has no specified amount of high school academic preparation for acceptance, it cannot be assumed that the level of academic

preparation of CSC's student body has been uniform. Nor have Nebraska public high school students been required to meet a standardized and state-wide set of academic preparations beyond minimal academic requirements. For example, the arc of high school mathematics can include algebra 1, algebra 2, trigonometry, pre-calculus, and calculus. While the Nebraska Department of Education has required that high school students must satisfy requirements in mathematics consistent with an algebra 1 level capability, it has not specified levels of mathematical preparation beyond this level, such as education that includes algebra 2, or calculus. The public school educational policy of Nebraska has granted this authority to local school boards, who specify high school graduation course requirements for their districts (Nebraska Department of Education, 2009a). These considerations meant that the clearest and most direct path for studying the predictive strength of high school variables on bachelor's degree completion at CSC was to study high school transcript data of Nebraska students who either attained a bachelor's degree, or did not, within six years of matriculation.

The effect that the level of Nebraska high school academic preparation has on the likelihood of bachelor's degree completion at CSC cannot be assumed to mirror the results of the national-level studies of Adelman (1999, 2006) or Trusty (2004). A previous study by Roweton and Bare (1991) of two cohorts of first-time, full-time freshmen at Chadron State College found a relationship between student persistence (students remaining enrolled through sophomore year) and two academic pre-college variables but also five non-academic pre-college variables. The study did not examine student high school academic coursework. A preliminary study of selected CSC four-year graduates compared their level of academic preparation to the requirements for entry to

the University of Nebraska-Lincoln (UNL), a selective-admissions institution; the CSC graduates had a lower level of high school academic preparation (Appendix A). And, finally, CSC graduation rates did not appear to be directly influenced by increased (or decreased) cohort ACT scores (Appendix D). The six-year graduation rate at CSC decreased by 2.1% between 1996 and 2000 although the average composite ACT scores of matriculating freshmen cohorts for that period increased by 0.7 points. Decreased cohort ACT scores did not necessarily relate to decreased graduation rates. The cohort that enrolled at CSC as full-time freshmen in 2000 had an average composite ACT score of 22.3 and achieved a six-year graduation rate of 45.2%. Conversely, the cohort that enrolled in 2002 had an average composite ACT score of 21.7 but achieved a six-year graduation rate of 49.3% (Appendix D).

Academic Intensity and Bachelor's Degree Completion

Adelman (1999) found strong links between academic intensity of a student's high school curriculum and the likelihood of attaining a bachelor's degree within six years of matriculation. Adelman created a curriculum variable to compare the effect of high school curriculum intensity and other academic indicators on the likelihood of bachelor's degree completion. Student transcripts were assigned one of 40 gradations to indicate the intensity and the quality of completed high school coursework. To construct the intensity ranking, Adelman created a standard framework of six core areas based on coursework data from the transcripts. The six core areas were English, mathematics, science (including laboratory science), history, social studies, and foreign languages. An intensity value was assigned (beginning from a low of 2.0, 2.5, 3.0, 3.5, to a high of 3.75) to reflect the number of credits a student had taken in each core area. The intensity value

was then modified to account for the level (for example algebra, or pre-calculus) of the coursework achieved within the area; Adelman (1999) termed this modification "quality" (p. 31). The resulting scale ranged from the highest attained levels of academic preparation (a mark of 100) down to the lowest attained level (a mark of 2.5) and was used as a curriculum indicator or variable. Adelman next created quintiles of performance of each of three academic variables: the curriculum variable; student performance on a general learning-abilities assessment given in the 12th grade (an ACT-like exam); and student academic performance (a combination of class rank and GPA at time of high-school graduation). Of those students in the highest performance quintile of the curriculum variable, 70% attained a bachelor's degree. For those students achieving the highest performance quintile of the general learning-abilities assessment variable, 64% achieved a bachelor's degree, and 59% of the students in the highest performance quintile of academic performance variable (class rank/GPA) attained a bachelor's degree. In the second performance quintile, the percentages for each variable fell to 44%, 37%, and 36%, respectively. Overall, Adelman's curriculum variable consistently correlated with higher numbers of students who completed a bachelor's degree than did either the ACT-like variable or the high school GPA variable.

One of Adelman's key findings was the effect of taking high school mathematics beyond algebra 2. When he controlled for student socio-economic status (SES), Adelman found that 79.8% of the students completing high school mathematics through calculus also completed a bachelor's degree. This compared to a 74.3% Bachelor's completion rate for the students who completed high school mathematics through pre-calculus, a 62.2% degree completion rate for those who completed mathematics through

trigonometry, and a 39.5% completion rate for those who completed high school

mathematics no further than algebra 2 (Adelman, 1999). Correlation analysis (Adelman,

1999, Table 7) showed that the highest level of high school mathemathics completed

demonstrated a stronger relationship to bachelor's degree completion (r = .510) than even

entry to postsecondary education (r = .395). Adelman conceptualized the link between

higher levels of mathematics and likelihood of bachelor's degree completion as a

mathematics ladder, with the rungs beginning with less-than-algebra 2, algebra 2,

trigonometry, pre-calculus, and ending with high school calculus. Logistic regression

estimated that finishing levels of high school mathematics beyond algebra 2 more than

doubled the odds (odds ratio of 2.59) of completing a bachelor's degree; Adelman noted

that mathematics exerted the strongest and the most lasting influence of all pre-college

curricula on the likelihood of bachelor's degree completion.

During the course of his 1999 study, Adelman assessed 29 diverse independent

variables, which included financial aid, demographic variables, first-year college

performance variables and high school performance variables and arrived at 11

statistically significant variables, which were used in the final logistic model. Adelman's

curriculum-based variable was the only secondary school-performance measure that

remained significant to the prediction of bachelor's degree completion. When compared

to high school course variables (Adelman, 1999, Table 7), the ACT-like test variable and

the class rank/GPA variables demonstrated lower correlations with bachelor's degree

completion (r = .484, and r = .441, respectively). Logistic regression of the three

measures (Adelman, 1999, Table 9) estimated the curriculum variable to be the stronger

predictor of bachelor's degree completion, with an odds ratio of 2.15, compared with the

ACT-like test score variable odds ratio of 1.60 and the class rank/GPA test score odds ratio of 1.51.

Trusty (2004) also found that the strongest positive predictor of the likelihood that a student would complete a bachelor's degree within six years of matriculation was the intensity of the student's high school curriculum. Bachelor's degree completion was used as the dependent variable in logistic regression. Trusty selected independent variables that represented two categories, student background and student high school data. Background variables were taken from 8th-grade student data, and included student SES, gender, race-ethnicity, and 8th grade cognitive ability (based on the student's reading and mathematics scores on a standardized test conducted by the National Center for Education Statistics). High school data used as independent variables included high school behavior, parenting variables, student self perception, and the intensity of the high school science and mathematics courses finished by the student. High school behavior was assessed through a student survey of the amount of time spent in extra-curricular activities, transcript data of attendance, and transcript data of positive school behavior, which was based on the number of the student's in-school suspensions and school suspensions. The parenting variables included a survey that indicated the student's perception of parental involvement, as well as a survey of parents to indicate their educational expectation of the child. The student self-perception variable was based on a questionnaire that assessed student locus of control. The variable that measured the intensity of the student's high school science and mathematics courses relied on transcript data and calculated the number of credits of biology, chemistry, and physics, as well as the number of credits of algebra 2, trigonometry, pre-calculus, and calculus. Trusty

(2004) found that the intensity of high school mathematics was the strongest predictor of the likelihood of bachelor's degree completion. The likelihood of degree completion increased by 73% (log odds of 1.73) if a student finished one additional unit of intensive high school mathematics. Student SES was the second strongest influence on likelihood of degree completion. The likelihood of degree completion increased by 62% (log odds of 1.62) following a one-standard-deviation increase in student SES. The likelihood of degree completion increased by 45% (log odds of 1.45) if a student finished one additional unit of intensive science; this represented the third strongest positive predictor. The fourth strongest positive predictor of degree completion was the high school attendance variable; a one standard deviation increase in good attendance increased the likelihood of bachelor's degree completion by 25% (log odds of 1.25). The positive effects of the high-school level mathematics-intensity and science-intensity variables were independent of the effects of all other variables. The strong and positive effect of taking an intensive high school curriculum on the likelihood of bachelor's degree completion was positive for both genders, for all racial-ethnic groups tested, and across SES levels.

Adelman's longitudinal study of 2006 again found that the academic intensity and quality of a student's high school curriculum was a strong predictor of the likelihood of bachelor's degree completion. In this study, Adelman sequentially analyzed 39 independent "major" (p. 28) variables (including demographic, financial aid, and other student-centered characteristics) to establish the importance of not only the occurrence of a variable, but also the timing of the variable's occurrence. Adelman's intention was to more accurately reflect the longitudinal nature of the educational process than did his

1999 study (DesJardins, McCall, Ahlburg, & Moye, 2002). In all, the academic histories

of a weighted sample representing approximately 1.19 million students were analyzed

(Adelman, 2006). High school transcript data were used to create a curriculum intensity

variable, which consisted of 31 levels of academic intensity and quality. The distribution

was divided into quintiles. Adelman determined that 81.7% of those completing the

highest quintile of student high school academic curriculum intensity also completed a

bachelor's degree, compared to 78.8% from the highest class rank/GPA category and

74.9% from the highest category of standardized ("senior," p. 49) test. Adelman then

selected variables to analyze through correlation with bachelor's degree completion, and

also multivariate analysis. The variables included the amount of advanced placement

courses, the highest level of mathematics achieved, a science momentum variable, and

the amount of foreign language taken by the student. The correlation analysis showed that

the highest level of high school mathematics taken had the strongest positive correlation

(Pearson's $r = 0.538$) to bachelor's degree completion (Adelman, 2006). The variable

with the second strongest positive correlation ($r = 0.530$) to bachelor's completion was

the science momentum variable. Adelman noted that these two variables were collinear (r

$= 0.869$) and later used the science momentum variable as a proxy for the high

mathematics variable. The variable with the third strongest, positive correlation with

bachelor's degree completion was quintile of curriculum intensity, with $r = 0.524$.

Variables representing student class rank/GPA quintile and senior test performance

quintile produced correlations of $r = 0.493$ and $r = 0.469$, respectively.

Variables representing academically intensive high school curriculum showed

consistently stronger predictive strength in logistic regressions on bachelor's degree

attainment. Adelman regressed independent variables representing quintile of curriculum intensity, class rank/GPA, and senior test score, along with variables representing other student background factors, such as socioeconomic status, gender, advanced placement classes, foreign language classes, and science momentum. Various combinations of the variables were tested in three separate logistic regressions (Adelman, 2006). The strongest predictor, the variable that produced the greatest positive change in the odds ratio (a change of 0.14924), came from a composite variable called academic resources, which consisted of student curriculum intensity, student class rank/GPA, and student senior year test score. The next strongest predictor was the variable science momentum, which produced a change in the odds ratio of .0927. This was followed by the variable class rank/GPA, which produced a positive change in the odds ratio of .0899, and then the variable curriculum quintile, which produced a positive change in the odds ratio of .0878. These results were similar to Adelman's results in his 1999 study.

The predictive strength of the composite variable academic resources was largely based on its course-related component. Of the three parts making up the composite variable, it was the quintile of curriculum intensity, with an odds ratio of 1.87, that was the strongest predictor of degree completion; this was followed by class rank/GPA (odds ratio of 1.60) and finally senior test score (odds ratio of 1.44). Finally, Adelman used the academic resources variable in a penultimate logistic regression that evaluated approximately 20 independent variables for their relationship to the likelihood of bachelor's degree completion. He found the academic resources variable remained significant throughout the chronological stages of progression toward bachelor's degree completion.

High School Requirements of Nebraska High School Students

Title 92 of Nebraska Administrative Code, Chapter 10 ("Rule 10") and the Nebraska academic content standards govern Nebraska's secondary education by specifying minimum requirements and by specifying what Nebraska high schools must offer. For example, content standards require mathematics skills that are consistent with coursework in geometry and algebra 1, and science skills that are consistent with coursework in introductory life and physical science and does not specify laboratory investigation. Rule 10 stipulates what Nebraska's public secondary schools must offer in order to provide a high school program that consists of at least 400 credit hours. The program must offer 60 credit hours in language arts, 40 credit hours in social science, 40 credit hours in mathematics, 40 credit hours in science, 20 credit hours in foreign language, 80 credit hours in career and technical education, 20 credit hours in personal health and physical fitness, and 40 credit hours in visual and performing arts (Nebraska Department of Education, 2007). To be eligible for graduation from high school, students must have achieved a minimum of 200 total high school credit hours, with 80% of their total hours from the curricular areas mentioned above.

Nebraska's academic content standards determine the academic content skills that students should master by the time they complete high school, but local school boards of each education district in Nebraska specify the academic graduation requirements of their high school students. Nebraska school districts were mandated to adopt measurable academic content standards by July 1, 2003. Local districts were allowed to either adopt the State Board of Education's standards directly or were allowed to create measurable standards that were equal in academic rigor, or were more academically rigorous than

those created by the state. The State Board of Education's standards were called Leading

Educational Achievement through Rigorous Nebraska Standards, or L.E.A.R.N.S. The

content standards were created in writing, reading, science, mathematics, history, and

social studies (Nebraska Department of Education, n.d.) and were measured by the

academic testing system called School-based Teacher-led Assessment and Reporting

System, or STARS (Nebraska Department of Education, 2006). The school assessment

system was changed in 2011 to the Nebraska Statewide Assessment (NeSA) system.

Nebraska's governor Dave Heineman presented goals to strengthen Nebraska education,

which included the goal of having Nebraska school districts require their high school

students to achieve four years of English and three years of mathematics, science, and

social studies before graduating (Nebraska Governor's Office, 2009). The 2010 version

of Rule 10 has stipulated that, by the 2014-2015 school year, students must meet these

requirements to graduate (Nebraska Department of Education, 2010).

Data and Research from Chadron State College Student Cohorts

Roweton and Bare (1991) analyzed pre-college variables of two cohorts of first-

time freshmen at Chadron State College and found that two academic and five non-

academic variables were common characteristics of students who persisted at CSC. One

cohort matriculated as full-time freshmen in the fall of 1987 and was used to analyze

third-year retention. The second cohort matriculated as full-time freshmen in the fall of

1988 and was used to analyze second-year retention rates. The researchers first compared

student academic ability with the second-year and third-year retention rates of both

student cohorts. Categories of academic ability were based on student ACT composite

scores. The high academic ability level category consisted of the upper quartile of the

cohort's composite ACT scores, the middle academic ability category consisted of the middle two quartiles of the cohort's ACT composite scores, and the low academic ability category consisted of the lowest quartile of the cohort's ACT composite scores. A 75% average retention rate was seen for students in the top academic ability category of both student cohorts, a 61% average retention rate was seen for the students in the middle academic ability category, and a 45% average retention rate was seen in the students in the low academic ability category. The ACT scores of the academic ability levels were not reported. The average ACT composite score for students from both cohorts that persisted was 19.3, while the average ACT composite score for the students who dropped out was 16.4.

Discriminant analysis was performed to test for predictors of second-year and third-year student retention (Roweton & Bare, 1991). Fifteen continuous, independent precollege variables were analyzed. The variables were ACT composite score, standardized ACT scores in English, mathematics, natural science, or social science, high school GPA (mean), student age, student interest in business contact careers, business detail careers, creative arts career, science career, social science career, or technical trade career, student's hometown distance from Chadron State College, and the population category of the student's hometown. The dependent variable used was retention and was determined by whether or not the student was enrolled at the time of the study. A student was considered retained if she or he remained enrolled at one year following matriculation for the fall 1988 freshman cohort or two years following matriculation for the fall 1987 freshman cohort. A total of 12 categories of variable analysis were performed. The categories used were student cohort, each gender within a cohort, and

each cohort's three academic ability categories. Two academic variables were the most frequently seen characteristics of persisting student categories. The two academic variables were mean high school GPA and standardized test (ACT) score in natural science; each appeared seven times as predictors. A student age variable appeared as a predictor six times, as did the population category of a student's hometown variable. Variables that appeared five times included student interest in a business contact career, student interest in a business detail career, and student interest in a social science career. Roweton and Bare concluded that the variability made identification of student retention predictors difficult to summarize. They noted that "significant numbers of students in even the most at risk categories" (p. 15) remained enrolled at the college. Roweton and Bare (1991) did not fully define either the terms "significant numbers" or "most at risk;" however, ACT composite scores for student cohorts in the study ranged from 5 to 31 (pp. 9-10)

Pilot Study of Sample Transcripts

The level of high school academic preparation of a sample of CSC graduates was generally below the level of academic preparation required of UNL students. A pilot study of high school transcripts from a sample of students who graduated from CSC was compared to the minimum admission requirements specified by the University of Nebraska-Lincoln in 1997. Categories created for purposes of comparison included the percentage of total high school credits earned in the areas of science, mathematics, language arts, social studies, and foreign languages (Appendix B), the percentage of total high school credits earned in science and mathematics (Appendix C), and the percentage of total high school credits that were earned in language arts, social studies, and foreign

language (Appendix D). A table of each CSC student's total high school credit hours earned, high school GPA and average (composite) ACT score of the four CSC graduates was also created (Appendix E). High school transcripts were randomly selected and represented students who had previously graduated from a Nebraska high school, entered CSC as first-time, full-time freshmen, and had completed a Bachelor's degree at Chadron State College within four, instead of six, years of matriculation. The percentage of total high school credits earned by the four CSC graduates in the areas of science, mathematics, language arts, social studies, and foreign languages ranged from 41.6% to 71.9%. The post-1997 admission requirements at UNL have stipulated that approximately 65% of a student's total high school credits must have been earned in these areas; three of the four CSC graduates had earned at least 65% of their total high school credits in these areas (Appendix B). The percentage of total high school credits earned in science and mathematics by the CSC graduates ranged between 20.5% and 35.1%. The post-1997 admission requirements at UNL have stipulated that approximately 35% of the student's total high school credits must be earned in the areas of science and mathematics (Appendix C). One of the four CSC graduates earned 35% of his or her total high school credits in the areas of science and mathematics; two of the four earned less than 25% of their total credits in science and mathematics. The percentage of total high school credits earned in social studies, foreign language, and language arts by these CSC graduates ranged from 35.7% to 44.4% (Appendix D). The post-1997 admission requirements at UNL have stipulated that approximately 45% of a student's total high school credit hours be earned in the areas of social studies, foreign language, and language arts. All four of the CSC graduates earned less than 45% of their total high school credit in social studies,

foreign language, and language arts. The total high school credits earned by the CSC graduates ranged from 252.5 to 300 (Appendix E). Their cumulative high school grade point averages ranged from 97.1% to 93%. Their average, composite ACT scores, calculated as an average of the composite scores of all student attempts at the ACT, ranged from 23 to 26.7. The post-1997 minimal admission requirements stipulated an ACT composite score of 20 or higher.

Summary

National level studies have established the principal importance of academically intense high school courses to the likelihood of bachelor's degree completion. Adelman (1999, 2006) and Trusty (2004) used data from national-level high school samples taken by the U.S. Department of Education, and relied on the transcript data of students who graduated from a spectrum of post-secondary institutions, which included selective-admissions institutions. The students who had graduated from selective-admissions post-secondary institutions would have met academic admission standards in order to matriculate, and this likely informed their selection of courses during high school. Greater variability in the academic preparation of high school students in a local-control state, such as Nebraska, could be possible. Further, those high school students who decide to attend an open-admissions institution such as Chadron State College may not fully understand the importance of taking academically intensive high school curricula, since it was not required for admission to the college of their choice. Thus, differing elements of a student's academic preparation could have a strong influence on the likelihood of obtaining a bachelor's degree and make it difficult to predict how strongly

high school academic preparation will affect the likelihood of graduating within six years of matriculation.

The results of the preliminary sample of Nebraska high school graduates who successfully obtained a Bachelor's degree from Chadron State College within four years of matriculation indicated that the students in the sample had not achieved the level of high school academic preparation stipulated for admission (post-1997) to the University of Nebraska-Lincoln. While three of the four students earned 65% or more total high school credits in the combined areas of science, mathematics, language arts, social studies, and foreign languages, none took the appropriate amount (45%) recommended by UNL in the combined area of social studies, foreign language, and language arts. The level of high school mathematics preparation of the sampled CSC graduates generally compared predictably to the amount of mathematics recommended by Adelman (1999). Adelman found that over 74% of the students who took high school mathematics through pre-calculus (approximately 35 credits of high school mathematics) completed a bachelor's degree. Three of the four of the four CSC graduates in the preliminary sample achieved 40 high school credits in mathematics, while one student achieved 30 high school mathematics credits. However, only one in four of the CSC graduates sampled took the recommended 35% (of total high school credits) in the combined area of high school science and mathematics required by UNL, which indicated that the CSC graduates students may have lacked such courses. A larger study of Nebraska high school graduates who either completed a bachelor's degree from Chadron State College within six years, or did not complete a bachelor's degree in six years, was needed to complete this picture.

Chapter 3

Methodology

Introduction

The purpose of this study was to analyze the high school transcripts of students who graduated from a Nebraska high school, subsequently enrolled at Chadron State College (CSC) as first-time, full-time undergraduate students, and within six years of matriculation either did or did not graduate with a bachelor's degree from CSC.

Research Design

Data from student transcripts were collected into an Excel spreadsheet and averaged numbers for each independent variable were generated. To maximize the cohesiveness of the sample, transcripts from two consecutive enrolling cohorts, which had either graduated or not graduated within six years, were used. When individual student transcripts contained more than one ACT score, the averaged ACT score for that student was used. Although identifying information was not entered on the spreadsheet, a column A contained the high school name and column B contained an alpha-numeric code so a specific transcript could be located and checked, if necessary. Logistic regression was employed to determine the impact that each of the independent variables may have had on the dichotomous dependent variable. An independent variable that generates a larger odds ratio than other variables indicates a stronger correlation to the dependent variable. The relative strength of the independent variables allowed the construction of a predictive regression model of the effect of the independent variables on the dependent variable of graduation from CSC with a bachelor's degree within six years.

The strength of the predictive regression model will be tested using a Hosmer-Lemeschow chi square goodness of fit.

Population and Sample

The population in this study included cohorts of undergraduate students who either graduated or did not graduate with a bachelor's degree from Chadron State College. The sample was constructed from two consecutive student cohorts who matriculated as full-time, first-time students and who graduated or did not graduate within six years of matriculation. The total sample size consisted of approximately 300 – 450 students, and was sorted into two groups, based on whether the student graduated within six years of matriculation or did not. From this grouping, an equal number of student transcripts was selected from groups that matriculated in either the year 2001 or 2002.

Data Collection from Existing Data Base

This study utilized Chadron State College's existing database to access high school transcripts of first-time, full time students who matriculated and who graduated between 2002 and 2007 with a bachelor's degree any time before six years has passed, or who failed to graduate within six years after matriculation. Relevant information was entered onto an Excel spreadsheet and all identifying information was removed.

Data Analysis

This research employed regression analysis to identify the relative strength of the relationship of various high school academic variables on the likelihood of graduation within six years of matriculation. Student data were categorized into Excel spreadsheet columns to establish the number of high school credit hours taken, per student, in the

areas of mathematics, science, language arts, social studies, and foreign language. A column for the number of credit hours taken in areas other than those five named were also recorded. High school GPA and the composite scores of all ACT attempts were recorded, and a separate column of the average of a student's composite ACT scores was created. Column values were added to generate an average value for each category. Category values included: academic (core curriculum) credit units of students who graduated; academic (core curriculum) credit units of students who did not graduate; mathematics and science credit units of students who graduated; mathematics and science credit units of students who did not graduate; language arts, foreign language, and social studies credit units of students who graduated; language arts, foreign language, and social studies credit units of students who did not graduate; total high school credit units of students who graduated; total high school credit units of students who did not graduate; student high school GPA, and average student composite ACT score. Independent variables generated for analysis included six categories: the ratio of academic credit units to total credit units; the ratio of mathematics and science credits units to total credit units; the ratio of language arts, foreign language, and social studies credit units to total credit units; total credit units; high school GPA; and average (mean) composite ACT score. Logistic regression was run on independent variables for both students who graduated within six years and students who did not graduate within six years. Logistic regression determined the amount of variance in the dependent variable that can be explained by the independent variables examined. An independent variable that can explain more variance then other variables was considered to be a strong predictor of graduation with a bachelor's degree within six years. Logistic regression can also be

used to rank the relative predictive strength of each independent variable. A variable with the largest odds ratio will have the strongest relationship to the dependent variable, and a model resulted from ranking the independent variables based on relative strength. The appropriateness of the model was tested using a Hosmer-Lemeschow chi square goodness of fit.

Delimitations and Limitations

The purpose of this study was to analyze the high school transcripts of students who graduated from a Nebraska high school, subsequently enrolled at Chadron State College as first-time, full-time undergraduate students, and within six years of matriculation either did or did not graduate with a Bachelor's degree from CSC.

This study was delimited to undergraduate students of Chadron State College who matriculated between the years 1999 and 2002 and either achieved a Bachelor's degree within six years of matriculation or did not. The results of this study are not intended to apply to other open-enrollment post-secondary institutions. This study is also delimitated to CSC undergraduates who graduated from a Nebraska high school prior to attending college; this study does not consider records of students who graduated from non-Nebraska high schools, or who did not graduate from high school but instead obtained a GED.

This study was delimited to students who graduated with a Bachelor's degree from Chadron State College between 2005 and 2008. High school transcripts of student from the same cohort and who either graduated within six years of matriculation or did not graduate within six years of matriculation was selected for analysis.

The records used for this study were also delimited to those Chadron State College undergraduate students who graduated from a Nebraska high school and had complete high school transcripts that included coursework titles, the amount of credit earned in each course, the student's ACT scores, and the student's high school GPA.

Undergraduate students who transferred from CSC, or transferred to--and subsequently graduated from--CSC were not included in this study. Only records from students who were first-time, full-time students at the time of matriculation at CSC will be used.

Records from undergraduate students who transferred from CSC to professional school (such as Medical School) and were graduated following their first successful year at UNMC were included.

Chapter 4

Results

Introduction

The purpose of this study was to examine the predictive strength of independent variables from Nebraska high school transcripts in relation to bachelor's degree completion at Chadron State College. An extensive review of the literature revealed that, at a national level, student high school mathematics and science credits were more significant to the prediction of bachelor's degree completion than any other high school data, including student high school GPA or ACT scores. The results of those studies led to the development, in this study, of independent variables that were based on Nebraska high school student transcripts. The six independent variables were entered into logistic regression equations to evaluate what affect, if any, they had on the likelihood of degree completion at CSC, an open-enrollment Nebraska state college.

Data Collection

Four equal groups of high school transcripts were obtained from Chadron State College's database. Data included in the study were from complete high school transcripts of students who had graduated from a Nebraska high school, matriculated at Chadron State College in 2001 or 2002 as first-time, full time students, and by the end of six years had either (a) had graduated (n = 90; 45 from each year), or (b) had not graduated (n = 90; 45 from each year) from CSC. The total size of the sample (180 student transcripts) was less than the 300-450 transcripts originally proposed, due to cost. Chadron State College charged $500.00 for the transcript data from 180 students. Transcripts were randomly selected by the college (Terie Dawson, personal

communication, 2010) and given an alpha-numeric code before being photocopied and released.

Transfer students were not included in this study, as stated earlier, and data from the transcripts of students who matriculated at CSC in 2001 or 2002 but transferred before graduating within six years were not used. The exclusion of transfer students from this study meant that students who participated in the Rural Health Opportunity Program (RHOP) were not part of this study. RHOP students were eliminated from this study because they transferred from CSC before they graduated.

Exclusion of RHOP students from this study did not compromise the integrity of this study, nor was it likely to have affected the outcome. This study intended to find predictors of bachelor's degree completion for general enrollment students at CSC, the majority of whom were not recruited. RHOP is an academic program that recruits eligible rural high school students for science-oriented career training in the field of medicine. Students apply for RHOP as high school juniors, and because they were recruited while still in high school, it was possible these students would have had taken a greater number of credits in mathematics or science than high school students without specific plans for a career in a medical field. It was also possible that students who intended to apply for an RHOP position took more upper-division mathematics and science courses to increase their chances for acceptance. Students considered for acceptance to the RHOP program were evaluated for their academic achievements and their ability to complete the academic requirements of the program. Once accepted to the program, and following high school graduation, RHOP students matriculated at CSC already enrolled in a pre-determined program of study designed to prepare them for a career in a medical field.

RHOP students who successfully completed their studies at CSC were transferred to a medical professional program, such as those offered by the University of Nebraska Medical Center (UNMC); RHOP students do not graduate from CSC. This study sought to establish the academic predictors of bachelor's completion of all of the approximately 800 freshmen that matriculated at an open-enrollment institution between 2001 and 2002, the majority of whom were not recruited for academic programs (such as RHOP).

Furthermore, because comparatively few of the matriculating freshmen cohorts were enrolled in RHOP, it was unlikely that their high school transcript data, if included, would have had much impact on the final outcome of this study. Approximately 31 RHOP positions had been made available to first-time full-time freshmen at CSC each year (although not all positions were always filled). In the fall of 2001, a total of 388 first-time full-time freshmen enrolled at CSC (Rural Health Education Network, 2009), which meant that up to 7.9% (31/388) of the enrolling freshmen that fall could have been RHOP students. In the fall of 2002, 406 first-time full-time freshmen enrolled, which meant that up to 7.6% (31/406) that fall could have been RHOP students. For both 2001 and 2002 freshman cohorts, approximately 7.8% of the enrollments could have been RHOP (62/794). The sample for this study consisted of transcripts of 180 students from the 2001 and 2002 fall enrollments, or 22.7% (180/794) of the two cohorts. Even if RHOP students were not excluded because they did not graduate from CSC, it was likely that few would have been randomly selected for inclusion in this study.

Appropriate data were identified from each transcript and was then entered into Excel spreadsheets (Appendix F). Values for all the variables were taken directly from the information on the transcripts, although occasionally the CSC database provided the

ACT score; transcripts that did not otherwise have complete information were not used and were replaced by CSC.

Data Analysis

Logistic regression was selected as the appropriate statistical method to analyze the data (Adelman, 1999; Trusty, 2004). Logistic regressions were conducted by the Nebraska Evaluation and Research (NEAR) center at the University of Nebraska-Lincoln.

Model Strength and Goodness-of-Fit Tests. Each logistic regression equation created self-analysis tests to assess the strength of the regression model it created. The tests of model strength that were analyzed in this study included the omnibus test of model coefficients, the Nagelkerke R square, and the model's correct classification rate.

A Hosmer and Lemeshow goodness of fit test was also conducted for each regression to analyze how well the regression models fit the data. The Hosmer and Lemeshow tests were also conducted by the NEAR center. Additionally, a Pearson's product-moment correlation analysis of all of the variables was conducted to help interpret the results of the logistic regressions. The Pearson's correlation analysis was conducted by the NEAR center.

Regression Variables Analyzed. The dependent, or outcome, variable for the analysis was completion (or non-completion) of a bachelor's degree within six years of matriculation at Chadron State College, and was a dichotomous (or categorical) variable. The independent variables were continuous variables.

Analysis of the predictive strength of each independent variable was based on the output of the regression equations. Each regression equation generated a set of values

based on the set of independent variables entered into it. The regression judged the predictive strength of an independent variable relative to the other independent variables in the equation. For each independent variable, a parameter estimate (b), a standard error of the parameter estimate (S.E.), a Wald statistic, the significance (sig.) of the Wald statistic, and log odds were generated.

Parameter Estimate (b). The maximum likelihood, or regression, equation used by the logistic regression program generated logistic regression coefficients, or parameter estimates (b), for each of the independent variables (Garson, 2009). A parameter estimate (b) of zero would have indicated that the predictor variable did not affect, or was independent of, the probability of the outcome. A positive parameter estimate would have indicated a positive relationship between the predictor variable and the outcome, meaning that an increase in the independent variable also increased the likelihood of the outcome. A negative parameter estimate would have indicated a negative relationship, meaning that the variable decreased the likelihood of the outcome (Trusty 2004).

Significance of the Wald Statistic. The significance of the Wald statistic was essential to the evaluation of whether or not a predictor variable made a significant contribution to the likelihood of the outcome (Field, 2009, p. 287). If a variable's Wald statistic was significant ($p < 0.05$), then the independent variable was a significant predictor, in that model, of graduation with a bachelor's degree from CSC within six years. Independent variables that were significant to the prediction equation were subsequently referred to as predictors. Predictors were further analyzed for the amount of influence they exerted in the prediction equation.

An independent variable that was insignificant to the prediction equation did not typically merit further consideration. However, the significance of an independent variable could and did change in different iterations of the regression equation. For example, the independent variable ACT score was significant in all outcomes except regression three (Table 6), where it was estimated to be insignificant. This result was largely because of multicollinearity between the independent variables ACT and GPA. Multicollinearity, which will be discussed at length below, occurred when some of the independent variables shared a correlation (Table 11) of greater strength than $r = .50$ (Tompkins, 1992).

Odds Ratio. The odds ratio (Exp(B)) was used to indicate the direction and the predictive strength that significant independent variables had in relation to prediction of the dependent variable (Garson, 2010). The odds ratio has been defined as the ratio of occurrence over non-occurrence, or odds = probability/ 1-probability (American College of Physicians, 2000). The odds were used to indicate whether a one-unit change in a predictor variable would increase, decrease, or have no effect on the chance of the occurrence of the dependent variable (holding all the other independent variables constant). An independent variable that exhibited an odds ratio of 1.0 had no effect on the dependent variable (graduation). An odds ratio of more than 1.0 meant that as the independent variable increased, there were increased odds of the occurrence of the dependent variable (Garson, 2010). An odds ratio of less than 1.0 meant that as the independent variable increased there were decreased odds of the occurrence of the dependent variable.

Interpretation of the predictive strength of an independent variable was limited to those independent variables that were significant. However, an unusually large odds ratio could also indicate that multicollinearity might be affecting an independent variable. Because the odds ratio was calculated by finding the exponential value (e^x) of the regression coefficient, regression coefficients that were inflated by multicollinearity had unreliable and inflated odds ratios.

Multicollinearity. When two or more of the independent variables used in a regression equation shared a strong correlation with each other, multicollinearity (or collinearity) resulted (Burnham & Anderson, 2002). An independent variable that accounted for a significant amount of variability in the prediction of an outcome was considered a significant predictor of the outcome. However, when independent variables in a logistic regression are strongly correlated, they account for the same (collinear) variability instead of representing unique variability. If strongly correlated independent variables were used in the same regression equation, the amount of variance that an affected variable accounted for was estimated by the equation to be insignificant; consequently, the independent variable itself was estimated to be insignificant. A logistic regression affected by multicollinearity is known to generally underestimate the significance of multicollinear independent variables (Field, 2009). Therefore, multicollinearity made it difficult to determine how important, or significant, a variable was to prediction of the outcome.

The effects of multicollinearity could be seen in inflated and unstable estimates of an independent variable's regression coefficient (b), the standard error (S.E.), the significance (p), and the odds ratio (Exp(B)). A Pearson's correlation matrix (Table 15)

indicated that multicollinearity was likely between the independent variables mathsci ratio and academic ratio ($r = .845$); lsf ratio and academic ratio ($r = .794$); and GPA and ACT ($r = .616$). Potentially multicollinear independent variables were analyzed in separate regression equations. However, the independent variable ACT was included in all regression equations including regression three (Table 6), where multicollinearity contributed to the estimation of non-significance for the ACT variable.

Data Organization

Independent variables were evaluated for significance in four logistic regressions: logistic regression one (Table 2); logistic regression two (Table 4); logistic regression three (Table 6); and logistic regression four (Table 8). The results of the regression, as well as the tests of model strength for that regression, were listed in the same table or in a table immediately following. For example, the results for regression one, its Nagelkerke R square test results (found in the Overall Model Evaluation table), and its omnibus test of model coefficients were listed in Table 2. The correct classification rate table of observed and predicted frequencies for regression one was listed in Table 3. This pattern was repeated for all four regressions.

Different combinations of the independent variables were used in an attempt to avoid complications due to multicollinearity. It was not possible to evaluate all six independent variables in the same regression equation, so variables were analyzed in combinations to obtain a complete picture of their predictive strengths. Regression one (Table 2) evaluated five of the independent variables but did not attempt to evaluate the variable academic ratio. Regression two (Table 4) evaluated four independent variables, and regression three (Table 6) evaluated three independent variables. Logistic regression

four (Table 8) attempted to evaluate all six variables in the same equation. Although all six independent variables were initially included (Block 0) for analysis, the independent variable lsf ratio was dropped from the model by the statistical analysis software.

There were six independent variables analyzed in this study:

1. the total number of credits earned by the time of high school graduation ("total");

2. the ratio of credits earned in mathematics + science / total credits earned ("mathsci ratio");

3. the ratio of credits earned in foreign language + language arts + social studies / total credits earned ("lsf ratio");

4. the ratio of the total number of credits earned in mathematics + science + language arts + foreign language + social studies / total credits ("academic ratio");

5. student final grade, on a 4-point scale, at the time of high school graduation ("GPA");

6. student average score on the composite portion of the ACT ("ACT"; if a student took this exam more than once, the average of the reported scores was used).

Research questions one through six sought to assess the predictive strength, if any, of the six independent variables in relation to the likelihood of bachelor's degree completion at Chadron State College. Research questions were listed below and relevant information from the statistical analysis was used to answer them following each question. The research questions asked if variables were 'different' between those

students who completed a bachelor's degree and those who did not. A variable that was found to be significant to the logistic regression model of degree completion was considered to be different between the two groups of students

Data

The averaged value of each variable for both groups of students was listed in Table 1 (the Excel spreadsheet of the collected transcript data is available in Appendix F).

Table 1

Averaged Values for Each Variable

Averaged Ratios, Credit Units, GPA, and ACT Scores of students who graduated within six years of matriculation and students who did not graduate within six years of matriculation.

	Academic*/total Credit units (averages)	Math + Science/ total credit units (averages)	Language Arts + Foreign language+ Social Studies/total credit units (averages)	Total # of Credit Units	High School GPA (av.)	Average (mean) ACT score
Graduated in six years (N = 89)	179.22/283.04 = .6332	79.38/283.04 = .2804	99.84/283.04 = .3527	283.04	3.481	23.071
Did not grad in six years (N = 89)	155.55/269.24 = .5777	66.41/269.24 = .2467	89.17/269.24 = .3311	269.24	2.946	19.296

*Academic = total credit units (averages) of mathematics, science, language arts, foreign language and social studies.

Table 2

Logistic Regression One, Overall Model Evaluation, and Omnibus Tests of Model

Coefficients

Independent Variable*	B	S.E.	Wald	df	Sig.	Exp(B)
Constant	-18.371	3.399	29.216	1	0.000	0.000
Year	-0.459	0.390	1.381	1	0.240	0.632
mathsci ratio	3.342	4.320	0.599	1	0.439	28.282
1sf ratio	5.448	4.335	1.580	1	0.209	232.341
total	0.024	0.008	8.107	1	0.004	1.024
ACT	0.142	0.064	4.944	1	0.026	1.153
GPA	1.948	0.557	12.236	1	0.000	7.014

*note: the variable academic ratio was not included for analysis in regression one

Overall model evaluation

-2 LogLikelihood	169.438
Cox & Snell	000.349
Nagelkerke R square	000.465

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	75.931	6	0.000
	Block	75.931	6	0.000
	Model	75.931	6	0.000

Table 3

Correct Classification Rate Table for Logistic Regression One

Observed and predicted frequencies for graduation within six years by logistic regression with the cutoff at 0.50

	Predicted		
Observed	Yes	No	% Correct
Yes	70	19	78.7
No	20	68	77.3
Overall % correct			78.0

Table 4

Logistic Regression Two, Overall Model Evaluation, and Omnibus Tests of Model

Coefficients

Independent Variable*	B	S.E.	Wald	df	Sig.	Exp(B)
Constant	-17.439	3.345	27.172	1	0.000	0.000
Year	-0.448	0.371	1.455	1	0.228	0.639
mathsci ratio	6.768	4.013	2.844	1	0.092	869.939
1sf ratio	7.280	4.179	3.043	1	0.082	1450.265
total	0.030	0.008	13.580	1	0.000	1.030
ACT	0.242	0.057	18.189	1	0.000	1.274

*note: the variables GPA and academic ratio was not included for analysis in regression two

Overall model evaluation

-2 LogLikelihood	169.438
Cox & Snell	000.349
Nagelkerke R square	000.465

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	75.931	6	0.000
	Block	75.931	6	0.000
	Model	75.931	6	0.000

Table 5

Correct Classification Rate Table for Logistic Regression Two

Observed and the predicted frequencies for graduation within six years by logistic regression with the cutoff at 0.50

	Predicted		
Observed	Yes	No	% Correct
Yes	70	19	78.7
No	20	68	77.3
Overall % correct			78.0

Table 6

Logistic Regression Three, Overall Model Evaluation, and Omnibus Tests of Model

Coefficients

Independent Variable*	B	S.E.	Wald	df	Sig.	Exp(B)
Constant	-17.757	3.265	29.580	1	0.000	0.000
Academic Ratio	4.033	2.718	2.201	1	0.138	56.407
ACT	0.136	0.063	4.652	1	0.31	1.145
GPA	1.928	0.553	12.171	1	0.000	6.878

*note: the variables mathsci ratio, 1sf ratio and total were not included for analysis in regression three

Overall model evaluation

-2 LogLikelihood	171.006
Cox & Snell	000.343
Nagelkerke R square	000.457

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	74.363	4	0.000
	Block	74.363	4	0.000
	Model	74.363	4	0.000

Table 7

Correct Classification Rate Table for Logistic Regression Three

Observed and the predicted frequencies for graduation within six years by logistic regression with the cutoff at 0.50

| | Predicted | | |
Observed	Yes	No	% Correct
Yes	69	19	78.4
No	17	72	80.9
Overall % correct			79.7

Table 8

Logistic Regression Four, Overall Model Evaluation, and Omnibus Tests of Model

Coefficients

Independent Variable*	B	S.E.	Wald	df	Sig.	Exp(B)
Constant	-18.371	3.399	29.216	1	0.000	0.000
Year	-0.459	0.390	1.381	1	0.240	0.632
academic_ratio	5.448	4.335	1.580	1	0.209	232.341
mathsci_ratio	-2.106	6.672	0.100	1	0.752	0.122
total	0.024	0.008	8.107	1	0.004	1.024
GPA	1.948	0.557	12.236	1	0.000	7.014
ACT	0.142	0.064	4.944	1	0.026	1.153

*the independent variable lsf ratio was included for analysis in regression four and was entered in Block 0 along with independent variables year, academic_ratio, mathsci_ratio, total, GPA, ACT. However, lsf ratio was dropped from the analysis by the software program SPSS

Overall model evaluation
-2 LogLikelihood   169.438
Cox & Snell   000.349
Nagelkerke R square   000.465

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	75.931	6	0.000
	Block	75.931	6	0.000
	Model	75.931	6	0.000

Table 9

Correct Classification Rate Table for Logistic Regression Four

Observed and predicted frequencies for graduation within six years by logistic regression with the cutoff at 0.50

	Predicted		
Observed	Yes	No	% Correct
Yes	70	19	78.7
No	20	68	77.3
Overall % correct			78.0

Research Question One

Is there a difference between the ratio of academic credit units to total credit units for students who graduate and the ratio of academic credit units to total credit units for students who did not graduate?

There was no difference in the ratio of academic credit units to total credit units for students who graduated from Chadron State College within six years of matriculation and those students who did not graduate from Chadron State College within six years of matriculation. Logistic regression three (Table 6) and logistic regression four (Table 8) evaluated the variable "academic ratio." The parameter estimate (b) of the variable "academic ratio" was positive, at 4.033 with a standard error of 2.718 in Table 6 and b =

5.448 with a standard error of 4.335 in Table 8. The level of significance of the academic

ratio variable was $p = 0.138$ in table 6 and $p = .209$ in table 8. Both values of significance

(p) were greater than 0.05, therefore the variable "ratio of academic credit units / total

credit units" did not make a significant contribution to the prediction of the likelihood of

graduation in either model.

The odds ratio (Exp(B)) for the independent variable academic ratio was large and

fluctuated in value from 56.407 in regression three (Table 6) to 232.341 in regression

four (Table 8).

Research Question Two

Is there a difference between the ratio of mathematics and science credit units to

total credit units for students who graduate and the ratio of mathematics and science

credit units to total credit units for students who did not graduate?

There was no difference in the ratio of math + science credit units ("mathsci

ratio") to total credit units for students who graduated within six years of matriculation

and those students who did not graduate within six years of matriculation at Chadron

State College. The evaluation of this variable is found in logistic regressions one

(Table 2), two (Table 4), and four (Table 8). The parameter estimate (b) of the variable

"mathsci ratio" was positive, at $b = 3.342$ with a standard error of 4.320 in Table 2 and

$b = 6.768$ and standard error of 4.013 in Table 4. However, the parameter estimate was

negative in Table 8, where $b = -2.106$. The significance of the Wald statistic for this

variable was $p = 0.439$ and $p = 0.092$ for Tables 2 and 4, respectively, and $p = .209$ in

Table 8. All three values of significance (p) were greater than 0.05, therefore the variable

"mathsci ratio" did not make a significant contribution to the prediction of the likelihood of graduation in the three logistic regressions.

The odds ratio (Exp(B)) of the independent variable mathsci ratio fluctuated between 28.282 in regression one (Table 2), 869.939 in regression two (Table 4), and 0.122 in regression four (Table 8).

Research Question Three

Is there a difference between the ratio of total credits earned in language arts, foreign language, and social studies to total credit units earned by students who graduated and the ratio of total credits earned in language arts, foreign language, and social studies to total earned credit units for students who did not graduate?

There was no difference in the ratio of total high school credits earned in language arts, foreign language, and social studies ("lsf ratio") to total high school earned credit by students who graduated from Chadron State College within six years of matriculation and those who did not graduate from Chadron State College within six years of matriculation. The evaluation of this variable is found both in logistic regressions one (Table 2) and two (Table 4). This variable was entered into logistic regression four (Table 8) but was dropped by the statistical software from the regression equation. The parameter estimate (b) of the variable "lsf ratio" was positive, at $b = 5.448$ with a standard error of 4.335 in Table 2 and $b = 7.580$ with standard error of 4.179. The significance was $p = 0.209$ and $p = 0.082$, respectively. Both values of significance (p) were greater than 0.05 meaning that the variable "lsf ratio" did not make a significant contribution to the prediction of the likelihood of graduation.

The odds ratio (Exp(B)) of the independent variable lsf ratio fluctuated between 232.341 in regression one (Table 2) and 1450.265 in regression two (Table 4).

Research Question Four

Is there a difference in the number of total credit hours taken by students who graduated and the number of total credit hours taken by students who did not graduate?

There was a difference in the number of total credit hours ("total") taken by students who graduated from Chadron State College within six years of matriculation and those who did not graduate from Chadron State College within six years of matriculation. The evaluation of this variable is found in logistic regressions one (Table 2), two (Table 4) and four (Table 8). The parameter estimate (b) of the variable "total" was positive, at $b = .024$ with a standard error of .008 in Table 2, $b = .030$ with a standard error of .008 in Table 4, and $b = .024$ with a standard error of .008 in Table 8. This variable was significant ($p < .05$) for all three models, with $p = 0.004$, $p = 0.000$, and $p = .004$, respectively.

The odds ratio [Exp(B)] of the independent variable total credit hours was stable. It was 1.024 in regression one (Table 2), 1.030 in regression two (Table 4), and 1.024 in regression four (Table 8). The positive value of all three odds ratios indicated a positive increase in the odds of graduating as the independent variable increased. An odds ratio of 1.0 corresponds to a 50/50 probability.

Research Question Five

Research question number five asks: is there a difference between the high school GPA of students who did graduate and the high school GPA for students who did not graduate?

There was a difference in the high school GPA of students who graduated from Chadron State College within six years of matriculation and those who did not graduate from Chadron State College within six years of matriculation. The evaluation of this variable is found in logistic regressions one (Table 2), three (Table 6) and four (Table 8). The parameter estimate (b) of the variable "GPA" was positive, at b = 1.948 with a standard error of .557 in Table 2, b = 1.928 with a standard error of .553 in Table 6, and b = 1.948 with a standard error of .557 in Table 8. This variable was highly significant (p < .05) for all three models, with p = 0.000 for all three regressions.

The odds ratio (Exp(B)) of the independent variable GPA was 7.014 in regression one (Table 2), 6.818 in regression three (Table 6), and 7.014 in regression four (Table 8). The positive value of all three odds ratios indicated a positive increase in the odds of graduating as the independent variable increased.

Research Question Six

Is there a difference in the average (mean) composite ACT scores of students who did graduate and the average (mean) composite ACT scores of students who did not graduate?

This variable was evaluated in all four regressions. Regression one (Table 2), regression two (Table 4), and regression four (Table 8) indicated that there was a difference in the average (mean) composite ACT scores of students who graduated from Chadron State College within six years of matriculation and those who did not graduate from Chadron State College within six years of matriculation. Logistic regression three (Table 6) indicated that there was no difference in the ACT scores of the two student groups. The parameter estimate (b) of the independent variable ACT was positive in all

four regression equations, at b = .142 with a standard error of .064 in Table 2, b = .242 with a standard error of .057 in Table 4, b = .136 with a standard error of .063 in Table 6, and b = .142 with a standard error of .064 in Table 8. This variable was significant ($p < .05$) for three models: in logistic regression one (Table 2) p = 0.026; in logistic regression two (Table 4) p = 0.000; and in logistic regression four (Table 8) p = 0.026. In logistic regression three (Table 6), where p = 0.310, this variable was not a significant predictor of the likelihood of graduation because of multicollinearity.

The odds ratio (Exp(B)) of the independent variable ACT was 1.153 in regression one (Table 2), 1.274 in regression two (Table 4), 1.145 in regression three (Table 6), and 1.153 in regression four (Table 8). The positive value of all three odds ratios indicated a positive increase in the odds of graduating as the independent variable increased.

Model Evaluation

Model strength was assessed through three model evaluation tests that were generated by the regression equation: the omnibus test of model coefficients; the Nagelkerke R square; and the correct classification rate from the model classification tables. The Hosmer and Lemeshow goodness of fit test was used to determine whether the regression model could be accurately applied to the population from which the sample was drawn (Giancristofaro & Salmaso, 2003; Hosmer & Lemeshow, 1989).

Omnibus Test of Model Coefficients. The omnibus test of model coefficients measured the improved predictive power achieved by the regression equation once the independent variables had been added. The test results indicated whether or not the regression model without independent variables (Block 0) was significantly different from the model with the independent variables (Block 1). If the Chi-square value was

zero, then the independent variables improved the predictive power of the regression equation.

For all four models, the addition of independent variables to the Block 0 model was significant. Logistic regression one entered six variables to create the final model, which had six degrees of freedom and achieved a Chi-square significance of 0.000 (Table 2). Logistic regression two entered five variables to the final model, which had six degrees of freedom and achieved a Chi square significance of 0.000 (Table 4). Logistic regression three entered three predictor variables to the final model, which had four degrees of freedom and achieved a Chi-square significance of 0.000 (Table 6; Center for Family & Demographic Research, 2006). Logistic regression four entered seven variables, but retained only six variables; the final model had six degrees of freedom and achieved a Chi-square significance of 0.000 (Table 8). The addition of independent variables resulted in an increased ability to predict the likelihood of graduation in all four regression equations.

Nagelkerke R Square. The Nagelkerke R square indicated the total amount of variability that each regression equation could explain. The results of a Nagelkerke R square test will range between 0.00, where no variability has been explained, and a maximum value of 1.00, where all variability has been explained (Center for Family & Demographic Research, 2006). Logistic regression one (Table 2) used the variables year, mathsci ratio, lsf ratio, total, ACT, and GPA. It achieved a Nagelkerke R square value of 0.465, therefore accounted for approximately 47% of the variability in predicting the likelihood of graduating from CSC within six years with a Bachelor's degree. Logistic regression two (Table 4) used the variables year, mathsci ratio, lsf ratio, tota,l and ACT.

It achieved a Nagelkerke R square value of 0.465, therefore accounted for approximately 47% of the variability in predicting the likelihood of graduating from CSC within six years with a Bachelor's degree. Logistic regression three (Table 6) used the variables academic ratio, ACT, and GPA. It achieved a Nagelkerke R square value of 0.457, therefore accounted for approximately 46% of the variability in predicting the likelihood of graduating from CSC within six years with a Bachelor's degree. Logistic regression four (Table 8) used the variables academic ratio, mathsci ratio, total, GPA, and ACT, but dropped lsf from the final model. It achieved a Nagelkerke R square value of .465, therefore accounted for approximately 47% of the variability in predicting the likelihood of graduating from CSC within six years with a Bachelor's degree.

Correct Classification Rates. An effective final (Block 1) regression model should exhibit acceptable predictive accuracy. The level of discrimination achieved by each final regression model was indicated by the correct classification rate tables (Giancristofaro & Salmaso, 2003). The correct classification rate tables were generated for each regression equation and were listed in Tables 3, 5, 7, and 9 Each classification rate table listed the percentage of positive cases that were correctly classified as positive and the percentage of negative cases that were correctly classified as negative. These properties were referred to as sensitivity and specificity, respectively.

Sensitivity = number of positive cases that were both observed and predicted
                 number of observed and predicted positive cases + number of cases that were observed but not predicted

Specificity = number of negative cases that were both observed and predicted
                 number of observed and predicted negative cases + number of cases that were observed but not predicted.

The final model of logistic regression one (Table 2) correctly predicted graduation with a frequency of 78% (Table 3), compared to an initial (Block 0) prediction rate of 50.3%. Its sensitivity was 78.7% and its specificity was 77.3%.

The final model of logistic regression two (Table 4) correctly predicted graduation (Table 5) with a frequency of 78.0%, compared to an initial (Block 0) prediction rate of 50.3%. Its sensitivity was 78.7% and its specificity was 77.3%.

The final model of logistic regression three correctly predicted graduation (Table 7) with a frequency of 79.7%, compared to an initial (Block 0) prediction rate of 50.3%. Its sensitivity was 78.4% and its specificity was 80.9%.

The final model of logistic regression four predicted graduation (Table 9) with a frequency of 78.0%, compared to an initial (Block 0) prediction rate of 50.3%. Its sensitivity was 78.7% and its specificity was 77.3%.

An acceptable level of discrimination was achieved by the final model of each logistic regression, as evaluated using the C-statistic index. The C statistic refers to the level of concordance between predicted and actual outcomes for student pairs (Sullivan, 2004). For this study, this meant how well the model predicted bachelor's completion for a student who actually completed a bachelor's degree. The value of the C statistic ranges between $0 - 1$, and higher values indicated better discrimination. Levels of model discrimination based on the C statistic were listed in Table 10 (Giancristofaro & Salmaso, 2003).

Table 10

C Statistic Index for Level of Discrimination

C $\geq$ 0.9 outstanding discrimination
0.8 $\leq$ C < 0.9 excellent discrimination
0.7 $\leq$ C < 0.8 acceptable discrimination
If C = 0.5 no discrimination

The C statistic was calculated from the correct classification rate tables (Tables 3, 5, 7,

and 9) of each regression according to the following equation:

$$C = \frac{\text{\# concordant pairs} + 0.5(\text{\# of ties})}{\text{\# concordant pairs} + \text{\# of discordant pairs} + 0.5(\text{\# of ties})}$$

For regression one, C = 70 + 68 / (70 + 68 + 39 + 19) = 138 / 196
      = .70 concordance

For regression two, C = 70 + 68 / (70 + 68 + 20 + 19) = 138 / 177
      = .78 concordance

For regression three, C = 69 +72 / (69 + 72 + 19 + 17) = 141 / 177
      = .80 concordance

For regression four, C = 70 + 68 = (70 + 68 + 20 + 19) = 138 / 177
       = .78 concordance

Regression three achieved an excellent level of discrimination, at 0.80

concordance. Regressions one, two, and four achieved an acceptable level of

discrimination; their concordance ranged from 0.7 to 0.78.

Hosmer-Lemeshow Goodness of Fit Test. The Hosmer and Lemeshow chi-

square goodness-of-fit test was conducted on each regression equation in order to

evaluate whether each regression's final model could reliably predict graduation in a

student population. Goodness of fit refers to the accuracy with which a mathematical

model can describe the relationship between an dependent variable and the independent variables. If the final regression model does not fit the data, it does not describe the observed data well; consequently, the inferences that were drawn from the regression may be invalid (Hosmer, Taber, & Lemeshow, 1991).

Unlike the other test statistics discussed in this study, a result of nonsignificance was desirable in the Hosmer and Lemeshow goodness-of-fit test. A result of nonsignificance (p > .05) of the chi-square test statistic meant that the model's predictions were not significantly different from the observed values (Wuensch, 2009). If the final model fit the data well, the value of the Hosmer and Lemeshow chi-square would be low, while the value for significance (the p-value) would be high (Kinnear & Gray, 2008). A model that satisfied the Hosmer and Lemeshow test explained significant variance, whether the amount of variance explained was a large or a small amount (Garson, 2009). The results of the Hosmer and Lemeshow Goodness of Fit tests were presented in Tables 11 – 14.

Regression models one and four failed the Hosmer and Lemeshow test, while models two and three did not fail. The Hosmer and Lemeshow goodness-of-fit test for logistic regression one produced a chi-square value of 16.713 with a significance of p = .033; this meant the final model was not a good fit of the data. The Hosmer and Lemeshow chi square value for logistic regression two was 6.720 and its significance was p = 0.567. This meant the final model of logistic regression two was a good fit of the data. The Hosmer and Lemeshow chi square value for logistic regression three was 8.138 and its significance was p = 0.420. This meant the final model of logistic regression one

Table 11

Hosmer and Lemeshow Goodness of Fit for Regression One

Result Table

Step	Chi square	df	Sig.
1	16.713	8	0.33

Contingency Table

		Graduate = No		Graduate = Yes		
		Observed	Expected	Observed	Expected	Total
Step 1	1	15	17.241	3	0.759	18
	2	17	15.842	1	2.158	18
	3	16	13.987	2	4.013	18
	4	10	11.877	8	6.123	18
	5	13	9.808	5	8.192	18
	6	6	7.404	12	10.596	18
	7	6	5.204	12	12.796	18
	8	3	3.502	15	14.498	18
	9	0	2.225	18	15.775	18
	10	2	0.909	13	14.091	15

Table 12

Hosmer and Lemeshow Goodness of Fit for Regression Two

Result Table

Step	Chi square	df	Sig.
1	6.720	8	0.567

Contingency Table

		Graduate = No		Graduate = Yes		
		Observed	Expected	Observed	Expected	Total
Step 1	1	16	17.026	2	0.974	18
	2	16	14.819	2	3.181	18
	3	14	12.850	4	5.150	18
	4	10	11.100	8	6.900	18
	5	9	9.654	9	8.346	18
	6	9	8.483	9	9.517	18
	7	8	6.366	10	11.634	18
	8	4	4.135	14	13.865	18
	9	0	2.450	18	15.550	18
	10	2	1.117	13	13.883	15

Table 13

Hosmer and Lemeshow Goodness of Fit for Regression Three

Result Table

Step	Chi square	df	Sig.
1	8.138	8	0.420

Contingency Table

		Graduate = No		Graduate = Yes		
		Observed	Expected	Observed	Expected	Total
Step 1	1	17	17.120	1	0.880	18
	2	15	15.808	3	2.192	18
	3	16	13.975	2	4.025	18
	4	10	11.989	8	6.011	18
	5	12	9.674	6	8.326	18
	6	5	7.432	13	10.568	18
	7	8	5.255	10	12.745	18
	8	2	3.588	16	14.412	18
	9	2	2.166	16	15.834	18
	10	1	0.992	14	14.008	15

Table 14

Hosmer and Lemeshow Goodness of Fit for Regression Four

Result Table

Step	Chi square	df	Sig.
1	16.713	8	0.033

Contingency Table

		Graduate = No		Graduate = Yes		
		Observed	Expected	Observed	Expected	Total
Step 1	1	15	17.241	3	0.759	18
	2	17	15.842	1	2.158	18
	3	16	13.987	2	4.013	18
	4	10	11.877	8	6.123	18
	5	13	9.808	5	8.192	18
	6	6	7.404	12	10.596	18
	7	6	5.204	12	12.796	18
	8	3	3.502	15	14.498	18
	9	0	2.225	18	15.775	18
	10	2	0.909	13	14.091	15

was a good fit of the data. The Hosmer and Lemeshow chi square value for logistic regression four was 16.713 and its significance was $p = .033$. This meant that the final model was not a good fit of the data. Consequently, the results of the Hosmer-Lemeshow test indicated that predictions based on the results of regression equations one and four were not likely to be accurate. Predictions based on the results of regression equations two and four were reliable and were interpreted in Chapter 5 of this study.

Effect of Multicollinearity on Regression Model Strength. The model stability

of regression three (Table 6) was unaffected, even though the ACT variable results were

unstable. Multicollinearity, which affected the value of the individual parameter estimate,

did not affect the reliability of the model itself (Tompkins, 1992). The overall amount of

variability that was accounted for by the model, as well as the goodness-of-fit of the

model with the data, were not affected (Burnham & Anderson, 2002). Because of these

considerations, the independent variables that achieved significance in regression model

three were of predictive use even though multicollinearity was present.

A model affected by multicollinearity underestimates the importance of the

affected independent variables. This is because the variability described by strongly

related independent variables overlaps and is not unique. Consequently, strongly related

independent variables do not fully account for as much variability as they could have

(had they been truly unique independent variables). In regression three (Table 6),

multicollinearity was indicated by the estimate of insignificance for the independent

variable ACT; this variable was significant in the other three regression models (Tables 2,

4, and 8). The level of correlation (see Table 15, and discussion below) between the

independent variables ACT and GPA, which was above r = .50, was strong enough

(Tompkins, 1992) to lead to its estimation of insignificance. Without multicollinearity in

regression three, the ACT variable would have gained in predictive strength and stability,

because unrelated (unique) independent variables account for more variability.

Correlations

A Pearson correlation (Table 15) was conducted to find significant relationships

between the independent and the dependent variables, and to also describe the strength of

those relationships. Significance meant that a real relationship existed between the

variables, instead of a relationship that occurred by chance. The amount of covariance

that occurred between two variables indicated how much the variables behaved the same

or varied the same. However, co-variance does not indicate cause and effect, therefore

does not indicate predictive relationships. A predictive relationship between variables

was indicated, in this study, through logistic regression analysis.

Table 15

Strength of Association

Correlation Value	Interpretation of Association
0.8 – 1.0	Strong
0.6 – 0.8	Moderately strong
0.4 – 0.6	Moderate
0.2 – 0.4	Weak
0.1 – 0.2	Very weak

Strength of association was based on the value of 'r' and was interpreted based on

the guidelines listed in Table 15 (Block, 2003). Strength of association ranged between

+1 and -1. Two variables with a Pearson correlation coefficient of +1 would have a

perfect, positive correlation. This would have meant that a change in one variable would

be accompanied by a change, in the same direction and by the same amount, in the

correlated variable. Two variables with a Pearson correlation coefficient of -1 would have

a perfect, negative correlation. This would have meant that as one variable increased, the

Table 16

Pearson Correlation between Independent Variables and between the Dependent

Variable

		academic ratio	mathsci ratio	lsf_ratio	total	GPA	ACT
academic ratio	Pearson Correlation	1	.845**	.794**	-.118	.417**	.463**
	Sig. (2-tailed)		.000	.000	.119	.000	.000
	N	177	177	177	177	177	177
mathsci ratio	Pearson Correlation	.845**	1	.346**	-.092	.412**	.465**
	Sig. (2-tailed)	.000		.000	.224	.000	.000
	N	177	178	177	178	178	178
lsf_ratio	Pearson Correlation	.794**	.346**	1	-.099	.262**	.285**
	Sig. (2-tailed)	.000	.000		.192	.000	.000
	N	177	177	177	177	177	177
total	Pearson Correlation	-.118	-.092	-.099	1	.216**	.116
	Sig. (2-tailed)	.119	.224	.192		.004	.124
	N	177	178	177	178	178	178
GPA	Pearson Correlation	.417**	.412**	.262**	.216**	1	.616**
	Sig. (2-tailed)	.000	.000	.000	.004		.000
	N	177	178	177	178	179	179
ACT	Pearson Correlation	.463**	.465**	.285**	.116	.616**	1
	Sig. (2-tailed)	.000	.000	.000	.124	.000	
	N	177	178	177	178	179	179
Grad- uation	Pearson Correlation	.314**	.286**	.226**	.275**	.546**	.470**
	Sig. (2-tailed)	.000	.000	.002	.000	.000	.000
	N	177	178	177	178	179	179

**. Correlation is significant at the 0.01 level (2-tailed).

other would decrease by the same amount. A Pearson correlation coefficient of zero would have indicated that there was no linear relationship between the two variables, and that the two were independent of each other. Only significant relationships ($p = 0$) were assessed for strength of association.

Strength of Association between the Independent Variables. The independent variables shared positive correlations that ranged in strength between very strong associations to very weak. All associations listed below were significant with $p = .000$, except where noted.

The independent variable academic ratio had a significant positive relationship with four other independent variables. Its strength of association with the variable mathsci ratio ($r =. 845$) was strong. Its strength of association with the variable lsf ratio ($r = .794$) was moderately strong. Its strength of association with the variable ACT ($r = .463$) and with the variable GPA ($r = .417$) was moderate. All were significant at the .01 level (2-tailed).

The independent variable GPA had a significant, positive relationship with the independent variable ACT. Their strength of association ($r = .616$) was moderately strong. This was significant at the .01 level (2-tailed).

The independent variable mathsci ratio had a significant positive relationship with three independent variables besides academic ratio ($r =. 845$). Its strength of association with the variable ACT ($r = .465$) was moderate. Its strength of association with the variable GPA ($r = .412$) was also moderate. Its strength of association with the variable lsf ratio ($r = .346$) was weak. All were significant at the .01 level (2-tailed).

The independent variable lsf ratio had a significant positive relationship with two other independent variables. Its strength of association with the variable ACT (r = .285) was weak, and its strength of association with the variable GPA (r = .262) was also weak. All were significant at the .01 level (2-tailed).

The independent variable total credit hours had a significant, positive relationship with the independent variable GPA. Their strength of association (r = .216) was weak. This was significant (p = .004) at the .01 level (2-tailed).

Strength of Association of the Dependent and the Independent Variables. The strength of association between the dependent, or outcome, variable (bachelor's degree completion) and the independent variables ranged between moderate and very weak. All of the independent variables had a significant positive relationship to the dependent variable. The level of correlation between the independent variables and bachelor's degree completion were ranked from strongest to weakest: GPA (r = .546); ACT (r = .470); academic ratio (r = .314); mathsci ratio (r = .286); total (r = .275); and lsf ratio (r = .226). All were significant at p = .000, except for lsf ratio, where p = .002.

Summary of Results

Logistic regression analysis was used to evaluate the predictive strength of independent variables from Nebraska high school transcripts in relation to graduation with a bachelor's degree from CSC, an open-enrollment Nebraska state college. Three independent variables were found to be significant predictors of this outcome: high school GPA; total number of high school credits taken by the time of high school graduation; and average composite ACT score. Three variables were found to not be significant predictors of this outcome: the ratio of the number of mathematics and science

credits to total credits; the ratio of the number of language arts, social studies, and foreign language credits to total credits; and the ratio of academic credits to total credits.

The independent variables were tested in four sequential logistic regressions using different combinations of the variables to avoid complications due to multicollinearity. The addition of the independent variables significantly increased the predictive power of all of the regression models, as based on the Omnibus Tests of Model Coefficients. The amount of variability accounted for by the regression models ranged between 46 and 47%, as estimated by the Nagelkerke R square. Further, the level of discrimination achieved by the regression models improved from approximately 50% to 77 – 80%, with sensitivity reaching approximately 78%, and specificity ranging from 77 to 80%. The models reached acceptable levels of discrimination, with regression three reaching an excellent level of discrimination. However, a Hosmer and Lemeshow goodness of fit test found that logistic regression models one and four failed to achieve nonsignificance, therefore were not a good fit of the data; regression models two and three achieved acceptable levels of fit.

A Pearson correlation indicated that significant and strong correlations existed between several of the independent variables. The predictor variable GPA demonstrated the strongest level of significant correlation with bachelor's completion at CSC, with r = .546. The predictor variable ACT had the second strongest level of significant correlation, with r = .470; the predictor variable total had the weakest level of significant correlation with bachelor's completion, with r = .275. The independent variables academic ratio, mathsci ratio and lsf ratio also demonstrated significant positive correlations with bachelor's completion, all of which were classified as weak.

The Pearson correlation also indicated that there were stronger associations between some of the independent variables than the correlation these variables had with the dependent variable, bachelor's degree completion. The predictor variable GPA shared a moderately strong association with ACT, but a moderate strength of association with bachelor's degree completion. The independent variable academic ratio demonstrated stronger associations with mathsci ratio, lsf ratio, ACT, and GPA than with bachelor's completion. The independent variable mathsci ratio demonstrated stronger associations with lsf ratio, ACT, and GPA (as well as with academic ratio) than with bachelor's completion. The independent variable lsf ratio, besides those correlations mentioned above, also demonstrated a stronger association with GPA than with bachelor's completion.

The odds ratio value was used to indicate the strongest of the three predictors of bachelor's degree completion at CSC. Results were based on regressions two and three, which passed the Hosmer and Lemeshow test. The independent variable GPA was the strongest predictor, with an odds ratio value of 6.818 (regression three). The independent variable ACT was the second strongest predictor of bachelor's completion, with an odds ratio value (in regression two) of 1.274. The independent variable total credit hours was the weakest predictor of bachelor's completion, with an average odds ratio value of 1.026. These results were discussed at length in Chapter 5.

Chapter 5

Discussion and Recommendations

Introduction

Chadron State College (CSC), one of the three colleges in Nebraska's State College System and the only four-year public institution in western Nebraska, serves a student body of approximately 2,500 students. Because of its mission as an open-enrollment institution, Chadron State College has no academic course requirements for admission, and any student who has completed high school or has attained the equivalent of a high school degree has been eligible for enrollment and the pursuit of a post-secondary education. How elements of a Nebraska high school student's education relate to the completion of a Bachelor's degree at an open enrollment institution such as Chadron State College needed further investigation.

The purpose of the study was to find whether or not there was a relationship between the selected characteristics of a Nebraska student's high school education and the probability of that student's graduation from Chadron State College within six years of matriculation.

A sample of 180 high school records were retrieved from the Chadron State College data base, 90 for students who had graduated within six years and 90 for students who had not. Six independent variables were analyzed using logistic regression.

Six specific research questions were addressed:

1. Is there a difference between the ratio of academic credit units to total credit units for students who graduate and the ratio of academic credit units to total

credit units for students who did not graduate? No predictive relationship was found.

2. Is there a difference between the ratio of mathematics and science credit units to total credit units for students who graduate and the ratio of mathematics and science credit units to total credit units for students who did not graduate? No predictive relationship was found.

3. Is there a difference between the ratio of Language Arts, foreign language and social studies credit units achieved by students who graduate and the ratio of Language Arts, foreign language and social studies credit units achieved for students who did not graduate? No predictive relationship was found.

4. Is there a difference in the number of total of credit hours taken by students who graduate and the total number of credit hours taken by students who did not graduate? A predictive relationship was found.

5. Is there a difference between the high school GPA of students who graduate and the level of mathematics achieved for students who did not graduate? A predictive relationship was found.

6. Is there a difference in the average (mean) composite ACT scores of students who graduate and the average (mean) composite ACT scores of students who did not graduate? A predictive relationship was found.

Discussion

Logistic regression was used to examine the predictive influence of Nebraska high school academic variables on the likelihood of bachelor's completion at Chadron State College. The explanation, based on literature (Adelman, 1999, 2006; Trusty, 2004),

was that high school mathematics and science credits would be not only significant to the prediction of graduation, but would have greater statistical importance to the predictive equation than either high school GPA or ACT scores. Various combinations of the predictor variables were tested in four regressions, which estimated significance for only three (of the six tested) independent variables: high school GPA; ACT score; and the total number of high school credit hours. These results were contrary to the findings of Adelman and of Trusty.

Model Effectiveness

The quality of fit achieved by the models demonstrated that logistic regression analysis of Nebraska high school student transcripts was an effective and illuminating method to establish predictors of success at Chadron State College. The quality of fit of the regression models was assessed through the omnibus test of model coefficients, the Nagelkerke R square, the model classification tables, and a Hosmer-Lemeshow goodness-of-fit test. The omnibus test of coefficients indicated that the independent variables added predictive strength to the models. The Nagelkerke R square indicated that the final models accounted for a reasonable amount of variability in the prediction of college graduation. Discrimination, or how well the models distinguished between the two groups of students (those that graduated and those that did not), was indicated by the correct classification rate tables and was close to 80%. Two of the four regression models achieved acceptable calibration, meaning their results could be applied to predict likelihood of in a population; this was determined by the Hosmer and Lemeshow goodness-of-fit test.

Omnibus Test of Model Coefficients. The final model for each regression was able to predict significantly better following addition of the independent variables (Friel, n.d.). This result was interpreted from the omnibus test of model coefficients, which measured whether the independent variables added a significant improvement to the prediction of the dependent variable, compared to the null (Block 0) baseline model. All four regressions were highly significant at $p = .000$, which meant that the addition of the independent variables to the models significantly increased their ability to predict the likelihood of graduation (Wuensch, 2009) and further indicated that at least one of the predictors had a significant relation to the outcome, which was bachelor's degree completion (Garson, 2009).

Nagelkerke R Square. There was a higher amount of variability accounted for by the regression models of this study than the regression models used in the national-level studies. The Nagelkerke R square, which indicated how much variation in the dependent variable was explained by the final regression model, varied between 46 and 47%. The averaged value of all four regressions was 0.463, which meant that the predictor variables accounted for approximately 46% of the variability in predicting the likelihood of graduation from CSC.

The final logistic regression models in Adelman's 1999 study, *Answers in the Toolbox*, which used both high school and college level variables to predict graduation, accounted for almost 43% of the variability in degree completion at a national level. The logistic regressions in Adelman's 2006 study, *The Toolbox Revisited*, did not account for a higher amount. Adelman (1999) felt that 43% could not be exceeded. Trusty (2004) was able to account for 39% of the variability in degree completion when he used

background, middle school and high school variables for a logistic regression. The higher amount of variability accounted for by this study as compared to these national-level studies likely reflected the fact that the sample drawn was more narrowly defined.

Correct Classification Rates. The classification rate achieved by the final models in this study compared favorably to Trusty's 2004 study. The levels of classification achieved in this study and in Trusty's study, which used national-level student data, were comparable. Trusty's (2004) logistic regression achieved an average correct classification rate of 74%. Discrimination in the final models of this study improved to almost 80%, compared to the null of all four models, each of which correctly classified 50.3% of the cases. The final models of regressions one and two correctly classified 78.0% of the cases, an improvement of 27.7% over the original model. The final model of regression three correctly classified 79.7% of the cases, an improvement of 29.4%. The final model of regression four correctly classified 78.0 % of the cases, an improvement of 27.7%. This meant that addition of the independent variables generally increased the model's level of discrimination from 1 in 2 correct to approximately 4 in 5 correct.

Further, when evaluated for concordance, the models achieved an acceptable level of discrimination. All four models achieved over 78% sensitivity (the measure of positive subjects classified as positive). All four models achieved over 77% specificity (the measure of negative subjects classified as negative).

Hosmer and Lemeshow Goodness of Fit. The Hosmer and Lemeshow goodness of fit test was used to assess the level of fit achieved by the regression models, and measured how much the fit of the model improved when the predictor variables were

included. Goodness of fit tests provide necessary assessments of whether a logistic regression model adequately fits its data (Hosmer et al., 1991). A model that does not accurately describe the relationship between the independent (predictor) variables and the dependent (outcome) variables will not be a useful tool for predicting actual outcomes in a population.

A regression model that exhibited good fit with its data, according to the Hosmer and Lemeshow Goodness of Fit test, would have a low chi-square test statistic value and a high (or non-significant) p-value (Kinnear & Gray, 2008). A model that achieved nonsignificance (p > .05) of the chi-square test statistic in the Hosmer and Lemeshow test was able to predict values that were not significantly different from observed values (Wuensch, 2009). Therefore, a model that has satisfied the Hosmer and Lemeshow test was assumed to explain significant variance, whether or not the amount of variance explained was large or small (Garson, 2009).

Both regression two and regression three passed the goodness of fit test, and predictions made using data from them were likely to be accurate. However, data from regression one and regression four, which failed the Hosmer-Lemeshow test, could not be reliably used to predict outcomes in the population. The Hosmer and Lemeshow chi square value for regressions one and four were both 16.713, much higher than the chi square values for regressions two and three (6.720 and 8.138, respectively). The significance of models one and four was also the same, at p = 0.033, well beneath the .05 significance level. The significance of model two was p = 0.567 and of model three was p = 0.420, both acceptably higher than the .05 significance level. Based on these results the

equation estimates for the independent variables in models two and three were considered reliable.

Outcome of the Regressions

The regression coefficient (*b*), the standard error (SE*ß*), the Wald statistic and its significance, and the odds ratio, were analyzed for all four regressions. There was evidence that multicollinearity existed between the independent variables mathsci ratio, lsf ratio, and academic ratio; multicollinearity was also suspected to exist between the independent variables GPA and ACT.

Multicollinearity occurred in this study because several of the independent variables shared stronger correlations with each other than with the dependent (outcome) variable. The consequence was that the affected independent variables, when included together in a regression equation, could not uniquely describe and represent variability in the prediction equation. Instead, the affected independent variables accounted for the same type of variability and were estimated by the regression equation to account for an insignificant amount of variability. A regression model suffering from multicollinearity therefore underestimate the predictive importance of an independent variable (Tompkins, 1992). The Pearson correlation matrix (Table 11, and discussed below) between the dependent and the six independent variables confirmed the likelihood of multicollinearity. To minimize the effects of multicollinearity, several different regression equations were modeled using different combinations of independent variables.

The Regression Coefficient (b). Three independent variables academic ratio, lsf ratio, and mathsci ratio, typically had unstable regression coefficients. In some of the

regressions, the instability could be attributed to multicollinearity, which is known to affect the sign, magnitude, and stability of regression coefficient estimates (*b*) (Burnham & Anderson, 2002). Multicollinearity was responsible for the change of sign for the independent variable mathsci ratio in regression four (Table 8), where *b* = -2.106; its regression coefficient otherwise ranged from 3.342 (Table 2) to 6.768 (Table 4). The regression coefficient for the independent variable lsf ratio was dropped from consideration by the software program in regression four (Table 8) due to multicollinearity; otherwise its parameter estimate ranged from 5.448 (Table 2) to 7.280 (Table 4). The regression coefficient for the independent variable academic ratio was comparatively less unstable, at *b* = 4.033 in regression three (Table 6) and *b* = 5.448 in regression four (Table 8).

Greater stability was evident in the regression coefficients for the independent variables that were estimated to be significant in the models. The regression coefficient for GPA was 1.984 (Table 2), 1.982 (Table 6), and 1.984 (Table 8). The regression coefficient for total was .024 (Table 2), .030 (Table 6), and .024 (Table 8). The regression coefficient for ACT was somewhat less stable. It was .142 (Table 2), .242 (Table 4), and .142 (Table 8) in the models where the variable was significant; the coefficient was .136 in Table 6, where the variable was estimated to be not significant.

Standard Error. Inflated standard errors could be seen in all four regressions for the variables mathsci ratio, lsf ratio, academic ratio and, at times, ACT. In regressions one and four the variability could be attributed to multicollinearity, which increased the standard error of the affected coefficients (Tompkins, 1992). Large standard error values indicated unreliable regression coefficient estimates, since standard error represented the

standardized difference between the estimated and the true value of the regression

coefficient. Therefore, increased standard error meant that the regression coefficients (*b*),

which were based on a sample, were less likely to represent the population from which

they were drawn.

The standard error estimated for the independent variable ACT varied throughout

the four regressions and illustrated, in regressions one, three and four, the destabilizing

effect multicollinearity could have. The standard error for the parameter estimate of ACT

was large, approximately ½ of the value of the regression coefficient in regressions one,

three, and four (Tables 2, 6, and 8 respectively), where both of the independent variables

ACT and the GPA were included in the same equation. In regression one (Table 2), the

standard error of the ACT variable was .064, a little less than ½ the value of the

regression coefficient (*b* = .142). In regression three the predictor variable ACT was

estimated to be insignificant, with a standard error (SEß = .063) that was approximately

½ the value of the regression coefficient (*b* = 0.136). In regression four (Table 8) the

variable ACT was significant but had a regression coefficient of .142 and a standard error

of .064 (approximately ½ the value of *b*). However, in regression two (Table 4), where

the variable GPA was not included in the equation, the ACT variable had a standard error

(SEß = 057) that was approximately ¼ of the value of the regression coefficient (*b* =

0.242).

The standard error values estimated for the independent variables lsf ratio,

mathsci ratio, and academic ratio were also inflated and inconsistent throughout. In

regression four, which attempted to test all three variables together, the instability could

be attributed to multicollinearity. In regression one, Table 2, the variable mathsci ratio

had a standard error of 4.320, which was larger than the value of its regression coefficient

(3.342); the standard error of the variable lsf ratio was 4.335, almost equal to its

regression coefficient estimate of 5.448. The variable academic ratio was not included in

the regression one equation. In regression two (Table 4), the mathsci variable had a

standard error of 4.013, over ½ of its regression coefficient estimate of 6.768; lsf ratio

had a standard error of 4.179, also well over ½ the value of its regression coefficient

estimate of 7.280. The variable academic ratio was not included in regression two. In

regression three (Table 4), which considered the predictor variables academic ratio, GPA,

and ACT, academic ratio had a standard error of 2.178, over ½ of the size of the

regression coefficient of 4.033. Regression four (Table 8) attempted to model all of the

independent variables, but the variable lsf was dropped by the software from the final

model. In this regression, the academic ratio variable had a standard error of 4.335, which

was almost as large as its regression coefficient of 5.448. The standard error of the

mathsci ratio variable was even more inflated, estimated to be 6.672 while its regression

coefficient was -2.106.

By contrast, the independent variables GPA and total had standard errors that

were more consistent in value and less likely to be inflated when compared with their

regression coefficient estimates. In logistic regression one (Table 2), the standard error

of the independent variable GPA was .557, approximately ¼ the value of the regression

coefficient estimate of 1.958. In regression three (Table 4) the standard error of GPA was

.553, less than 1/3 the value of the regression coefficient estimate of 1.928. In regression

four (Table 8) the standard error of GPA was .557, less than 1/3 the value of the

regression coefficient estimate of 1.948. The standard error of the variable total in

regression one (Table 2) was .008, 1/3 the value of the regression coefficient estimate of .024; this improved in regression two (Table 4) where the standard error was again .008 but was less than 1/3 the value of the regression coefficient estimate of .030. In regression four, the standard error of the variable was again .008, again 1/3 the value of the regression coefficient estimate of .024.

Significance of the Wald Statistic. The predictor variables lsf ratio, mathsci ratio, and academic ratio were estimated to be insignificant to the prediction of bachelor's completion throughout the regressions. Variables were found insignificant if $p > .05$ for the Wald statistic (values for significance were found under the regression column heading "Sig."). The significance of the variable lsf ratio ranged between $p = .082$ and $p = .209$. The significance of the variable mathsci ratio ranged between $p = .092$ and $p = .752$. The significance of the variable academic ratio ranged between $p = .138$ and $p = .209$.

Because calculation of the Wald statistic was based on standard error (Wald $= b / SE_b$), any inflated standard error values resulting from multicollinearity increased the probability of finding an independent variable insignificant, even if it was significant (Field, 2009). The insignificance of the three independent variables mathsci ratio, lsf ratio, academic ratio, and, at times, ACT, could be attributed to multicollinearity when they were regressed at the same time, such as was attempted in regression four (Table 8). However, in regressions one, two, and three, the variables lsf ratio and mathsci ratio were run separately from the variable academic ratio variable, and the insignificance of these variables to the prediction of the outcome could no longer be attributed to multicollinearity.

The variable ACT was found significant in all but regression three (Table 6), where its p = .31. The variable approached, but did not reach, insignificance in regressions one (Table 2) and four (Table 8), where, for both models, p = .026. The variable was highly significant (p = .000) in regression two (Table 4), the only regression model that did not test it against the variable GPA. These results indicated that multicollinearity was possible between these the variables ACT and GPA.

Predictor variables that were consistently estimated to be significant to the prediction equation were GPA and total. The significance of the variable GPA was a stable p = .000 in all regressions. The significance of the variable total was also stable and ranged between p = .000 and p = .004.

The Odds Ratio (Exp(B)). The calculation of the odds ratio was based on the estimate of the regression coefficient (the odds ratio is the exponential value (e^x) of the regression coefficient). The odds ratio, or the change in the odds of bachelor's degree completion following a one unit change in the predictor, is considered crucial to the interpretation of a regression model (Field, 2009).

The odds ratios for the independent and significant variables were reliable and reflected the stability of the regression coefficient estimates of these variables. The odds ratio for the independent variable total in regression two (Table 4) was Exp(B) = 1.030. This indicated that a one-unit increase in the total credit hours increased the odds of bachelor's degree completion by 1.030. In regressions one (Table 2) and four (Table 8) the odds ratio was similar, at Exp(B) = 1.024.

The odds ratio for the independent variable ACT in regression two (Table 4) was Exp(B) = 1.274, which indicated that a one unit increase in student ACT scores increased

the odds of graduating with a degree by 1.274. In regressions one (Table 2) and four

(Table 8) the odds ratio was 1.153. In regression three (Table 6) where the variable ACT

was estimated to be insignificant, the increase in the odds of graduating was 1.145.

The change in odds ratio for the variable GPA was very large, and reflected the

unit definition for GPA (i.e. the difference between a 3.0 and a 4.0, or a 1.0 and a 2.0).

The change in odds for the variable GPA in regression one (Table 2) and in regression

four (Table 8) indicated that a one unit increase in high school GPA increased the odds of

graduating with a Bachelor's degree by 7.014. The increased odds of graduating with a

bachelor's degree following a one unit increase in GPA in regression three (Table 6) was

6.878. Using calculations from Field (2009) an increase in a student's high school GPA

by 0.1, for example from 3.0 to 3.1 would have increased the odds of graduating by 1.637

(Field, 2009), as based on the results of regression three (Table 6).

The change in odds for the insignificant independent variables mathsci ratio, lsf

ratio and academic ratio were inflated, unstable and unreliable. For example, in

regression two (Table 4), the odds ratio for the independent variables mathsci ratio and

lsf ratio were highly inflated, at 869.939 and 1450.265, respectively. In regression four,

where lsf was dropped from the equation due to multicollinearity, the mathsci ratio was

more believable, at Exp(B) = .122. The odds ratio for the independent variable academic

ratio in regression 3 (Table 6) was 56.407, and in regression four (Table 8) its odds ratio

had inflated to 232.341.

Correlations

The correlation matrix showed that enough co-variance existed between several of

the predictor variables to create multicollinearity. According to Tompkins (1992), a pair-

wise correlation greater than $r = .50$ signaled a potentially problematic degree of covariance, and could have contributed to multicollinearity and the instability observed in the parameter estimates. Predictor variable pairs that shared correlations greater than $r = .50$ were: mathsci ratio and academic ratio ($r = .845$); lsf ratio and academic ratio ($r = .794$); and GPA and ACT ($r = .616$). Regression of the three variables mathsci ratio, academic ratio and lsf ratio in the same model was attempted in regression 4 (Table 8), a model that did not pass the Hosmer and Lemeshow test. In an attempt to avoid multicollinearity, the academic ratio variable was included in regression three (Table 6), which did not include the variables lsf ratio and mathsci ratio. The latter variables were considered in regression two (Table 4).

Although regressing these variables in different equations helped eliminate multicollinearity, a problem remained because of the comparatively low correlation between the outcome variable, graduation, and the independent variables lsf ratio, mathsci ratio, and academic ratio. For example, there was a higher correlation between the independent variables lsf ratio and mathsci ratio ($r = .346$) than existed between either and the outcome of bachelor's degree completion ($r = .226$, $r = .286$, respectively). The variable academic ratio also demonstrated a stronger association with the variables ACT and GPA (all three independent variables used in regression three) at $r = .463$, $p = .000$ and $r = .417$, $p = .000$, respectively, than its correlation with bachelor's degree completion, at $r = .314$, $p = .000$. Further, the levels of correlation between ACT and academic ratio, as well as between ACT and GPA, contributed to the estimation of non-significance for ACT in regression three (Table 6).

Conclusions

The logistic regressions conducted in this study gained stability when multicollinearity was avoided. Regression two and regression three, where most of the multicollinear independent variables were separated, passed the Hosmer and Lemeshow goodness of fit test. Regression four (Table 8) attempted to evaluate all of the independent variables in the same equation (including the multicollinear mathsci ratio, lsf ratio, and academic ratio variables) but failed to do so, and also failed the Hosmer and Lemeshow test. Regression one (Table 2) attempted to evaluate all the variables except academic ratio; this regression model also failed the Hosmer and Lemeshow test. In his 2006 study, Adelman avoided using independent variables in his logistic regressions that had problematic levels of association between them. Adelman demonstrated that the variables "highest math" and "science momentum" ($r = .869$, $p < .05$) were strongly associated, and that there was an association of moderate strength between the variables "highest math" and "quintile of curriculum intensity" ($r = .777$, $p > .05$) as well as between the variables "science momentum" and "quintile of curriculum intensity" ($r = .774$, $p > .05$). Adelman concluded that the high math variable was so strongly correlated with the science momentum variable that he not only chose to eliminate it from his regression, he went on to use the science variable as a proxy variable for math. In the same study, Adelman also used the curriculum intensity variable only in regression models that did not also contain the science momentum variable.

Three independent variables emerged from these regression analyses as reliable predictors of bachelor's degree completion at CSC: high school GPA, total high school credit hours completed, and, most likely, ACT score. The identification of the

independent variables as predictors was based on the outcome of regressions two and three, which were the models that passed the Hosmer and Lemeshow goodness of fit test. In the Pearson correlation, the variable GPA demonstrated a moderate level of association with graduation at $r = .546$, $p = .000$, which was the highest correlation with bachelor's degree completion of all the independent variables tested. In regression against the other independent variables, high school GPA was a highly significant predictor of bachelor's degree completion at CSC. It achieved a significance of $p = .000$ in regression three (Table 6) where it was included with the variables ACT and academic ratio in the likelihood equation. It remained a significant predictor of graduation in regression three even though there was a moderately strong association between GPA and ACT ($r = .616$, $p = .000$), as well as a moderate association between GPA and academic ratio ($r = .417$, $p = .000$). The odds ratio indicated that a change in GPA from 3.0 to 3.1 increased the odds of bachelor's degree completion by 1.637.

The GPA variable used in this study demonstrated a higher correlation with bachelor's degree completion and also with the ACT score variable than Adelman found using similar variables. In that study, Adelman (2006) reported a positive and statistically significant association of moderate strength ($r = .493$, $p < .05$) between bachelor's degree completion and the composite variable RANK, which was composed of student high school class rank and GPA. He also found an association of moderate strength between RANK and the ACT-like senior level exam ($r = .566$, $p < .05$). The high level of association of the high school GPA variable for bachelor's degree completion at CSC, as well as its high significance as a predictor of degree completion might be interpreted to mean that students who performed well in Nebraska high school grading systems were

more likely to obtain a bachelor's degree at CSC than were students who did not. Both high school GPA and the ACT are measures of student academic performance, and typically both are used as indicators of potential student performance at institutions of post-secondary education. The regression results of this study indicated that students who performed well as measured by high school grades were more likely to complete a bachelor's degree than students who performed well on the ACT. The strength of the GPA variable to the prediction of bachelor's degree completion indicated that the grading system of the Nebraska high schools that produce Chadron State College students articulated well with the academic expectations for completion of a bachelor's degree at CSC. This result could also reflect the possibility that, as an open admissions institution, CSC either does not attract or does not retain those students who perform well on the ACT exam.

The independent variable total was also estimated to be a highly significant predictor of graduation. It was included in the likelihood equation of regression two (Table 4) along with the predictors mathsci ratio, lsf ratio, and ACT score. A one unit increase in the total number of credit units was estimated to return an increase of .30 percent odds in the likelihood of graduating. The variable total had a weak correlation of $r = .275$, $p = .000$ with the outcome variable bachelor's degree completion at CSC; this was the second weakest significant correlation of all the independent variables tested. It also demonstrated no significant correlation with any of the other independent variables except GPA, with which it demonstrated a weak, positive but significant correlation $(r = .216$, $p = .004)$. The variable total was created by totaling up all high school academic credits taken by time of high school graduation. The lack of a significant

Pearson correlation between it and the academic credit-based ratios indicated that the variables were independent of any linear association. In other words, the total number of high school credits taken by time of high school graduation had no relationship to the amount of mathematics and science credits, or to the amount of language arts, social studies, and foreign language credits (or the sum of the credits of all five areas) taken by students. There also was no significant association between total high school credit hours and average ACT score, so it was unlikely that the total credits taken by the time of high school graduation had any affect on such tests of academic performance as the ACT. This interpretation was echoed by the weak association ($r = .216$, $p = .004$) between total credit hours and high school GPA, which, while positive, also barely registered as weak.

Interpretation of the significance of the variable total to the likelihood of graduation at CSC meant that the students with higher total credit hours (average of 283.04 credits, Table 1) were more likely to graduate from CSC than the students with a lower number of total credits (average of 269.24 credits). The predictive strength of the variable total might reflect the possibility that students who completed more high school credits demonstrated persistence in an academic system. Although he did not measure total high school credits completed, Trusty (2004) found that high school attendance was a highly significant predictor of bachelor's degree completion. While this study did not evaluate, so cannot equate, the completion of high school credits and high school attendance, high scores in either area suggests a positive mode of student behavior. While the variable total had a somewhat higher correlation association with variables based on high school science credits than with the other variables, all of the correlation associations were weak. This fact, coupled with the even lower level of positive

association between total and high school GPA, and the lack of significant association with between total and performance on the ACT, meant that the variable total was relatively devoid of any measure of academic achievement.

Although there was instability in the regression results for the variable ACT score, the variable earned its place as a predictor of bachelor's degree completion at CSC. The Nebraska high school students who went on to complete a bachelor's at CSC earned an average ACT score of 23.071; the Nebraska high school students who did not complete a bachelor's degree at CSC earned an average ACT score of 19.296. In regression model two (Table 4), ACT was a highly significant (p = .000) predictor of graduation when compared with the variables mathsci ratio, lsf ratio, and total, and where multicollinearity with the GPA variable was avoided. The ACT variable was highly significant in this regression even though there was a positive association of moderate strength between it and the variable mathsci ratio, at r = .465, p = .000, which was an association of about the same strength as the association between ACT and graduation (r = .470, p = .000). The ACT variable was estimated to be insignificant in regression three (Table 6), where it was included in the likelihood equation with the variables GPA and academic ratio. Here, the moderately strong level of association, r = .616, p = .000, between ACT and GPA contributed to the estimation of its insignificance. Adelman (2006, pg. 38) found a significant correlation of similar strength (r = .469) between an ACT-like variable and graduation with a bachelor's degree.

Contrary to the conclusion of this study, Adelman (2006) found an ACT-like predictor variable was insignificant to the prediction of bachelor's degree completion in a nationally representative sample. Adelman's 2006 logistic regression included the

independent variables curriculum intensity, student score on a high school senior-level ACT-like test, and the composite variable called RANK (the comparable variables of this study were academic ratio, ACT and GPA). Adelman (2006) reasoned that as curriculum quality increased (or intensified) and the grades students earned on that curriculum also increased, students would perform better on the ACT-like test; however, it also meant that the test became "paradoxically less important" (p. 55) as a predictor of degree completion (because the other variables gained in importance). Application of Adelman's logic to the results of this study led to the interpretation that higher student scores on the ACT and high school GPA outweighed the importance of the number of credits earned in the high school academic areas tested. High scores in high school GPA also outweighed scores on the ACT in terms of bachelor's degree completion at CSC. The conclusion again is that the predominant articulation for success at CSC is the one between the academic expectations for bachelor's degree completion at CSC and the academic expectations for Nebraska high schools. This link eclipsed the connection between the academic expectations for degree completion at CSC and the academic expectations of those students who do well on the ACT.

None of the three variables based strictly on high school academic credits-- academic ratio, mathsci ratio, or lsf ratio--emerged as significant in this study's regression analysis. The regression analysis found that completing more high school mathethics and science credits was insignificant to bachelor's completion at CSC, and the Pearson correlation found a weak, positive and significant linear association between the high school mathematics and science ratio and graduation from CSC. The low strength of correlation between the mathsci ratio variable and bachelor's completion at CSC

contributed to the estimation of its insignificance to the prediction of degree completion. The variable mathsci ratio demonstrated a weak correlation of $r = .286$, $p = .000$ with bachelor's completion at CSC, which was lower than its significant correlation with any of the independent variables. In contrast to these findings, Adelman (2006) found a significant, positive correlation of moderate strength ($r = .538$) between his math variable (highest math, a five-level variable) and bachelor's completion. Trusty (2004) found a significant correlation of moderate strength of $r = .44$ between his variable math intensity and bachelor's completion.

The average number of high school mathematics and science credits (see Table 1) earned by those who graduated from CSC was 79 credits (a ratio, to total credits, of 0.28). This was an average of 13 total credits more than the number earned by students who did not go on to graduate from CSC, and who averaged 66 total math and science credits (a ratio of approximately 0.25). If approximately 10 high school credits represented one year of high school coursework, the non-bachelor's degree-completing high school student averaged the equivalent of 6.6 years of total high school mathematics and science. The bachelor's degree-completing student averaged the equivalent of 7.9 years of total high school mathematics and science, approximately 1 1/3 years more of high school mathematics and science per student than those who failed to complete a bachelor's degree. On average, the students who went on to earn a bachelor's degree from CSC took high school mathethics and science credits almost every semester of high school. The weak level of association between the high school mathsci variable and graduation from CSC with a bachelor's degree, as well as the lack of predictive strength of the mathsci variable, meant that more high school math and science credits did not

make bachelor's degree completion at CSC more likely. The reasons could be several.

The design of this study did not include transfer students, such as those students who left

the college before bachelor's degree completion in order to attend, and graduate from,

professional medical programs. Medical program transfer students such as those in the

Rural Health Opportunities Program (RHOP) were recruited while they were in high

school, and matriculated at CSC with the intention of pursuing science related majors.

Presumably, such students would have taken a generally high level of high school math

and science. Not counting such students among CSC graduates meant the sample

represented the remaining student body, which possibly contained few math or science

majors. Other reasons include the possibility that the high school mathematics and

science typically taken by high school students in CSC's service area do not articulate

well with the academic requirements of CSC for bachelor's completion.

The independent variables academic ratio and lsf ratio were also found to be

insignificant to the log regression analysis and the prediction of bachelor's degree

completion at CSC. In the Pearson correlation, the variable academic ratio demonstrated

a weaker association with bachelor's degree completion ($r = .314$, $p = .000$) than with the

predictor variable ACT ($r = .463$, $p = .000$). The variable lsf ratio demonstrated the

lowest of all significant associations ($r = .226$) to graduation. Its association with

graduation was lower than its association with independent variables such as mathsci

ratio and ACT, and this contributed to the regression equation's estimation of

insignificance for the lsf variable. It was included in regression two (Table 4) with the

variables mathsci ratio (with which it had an association of $r = .346$, $p = .000$), total (no

significant association), and ACT ($r = .285$, $p = .000$). The Nebraska high school students

who went on to complete a bachelor's at CSC earned an average of 99.84 total high

school credits in language arts, foreign language, and social studies (a ratio to total credits

of .3527) and earned an average of 179.22 total academic credits (a ratio to total credits

of .6332). The Nebraska high school students who did not complete a bachelor's degree

at CSC earned an average of 89.17 high school credits in language arts, foreign language,

and social studies (a ratio to total credits of .3311) and earned an average of 155.55

academic credits (a ratio to total credits of .5777). The students who completed a

bachelor's degree at CSC averaged 10 more high school credits than the non-completers,

which represented approximately 1 year's worth of extra language arts, social studies,

and/or foreign language. According to the regression analysis, this was not significant to

the completion of a bachelor's degree at CSC. Overall, those students who completed a

bachelor's degree at CSC averaged 23.67 more high school credits in mathematics,

science, foreign language, language arts, and social studies than the students who did not

complete a bachelor's degree at CSC, which represented 2 1/5 years of study at the high

school level in academic areas. The regression analysis found that this was not significant

to completion of a bachelor's degree at CSC, and the Pearson correlation found that the

association between the extra credits and completion of a bachelor's degree at CSC was

weak.

    The lack of significance of the mathsci ratio variable to the prediction of

bachelor's degree completion, as well as the low strength of correlation, seemed

contradictory to the findings of Adelman (1999, 2006) and Trusty (2004). Adelman

(2006) found the variable science momentum (which he used as a proxy—because of its

strong correlation—for the highest mathematics variable) was not only significant to the

prediction of bachelor's completion, but it was more significant than the variable RANK (the composite variable that combined GPA and high school academic standing) or the ACT-like, senior level exam variable. In his 1999 study, when Adelman regressed five levels of high school mathematics (from pre-algebra through calculus) against the likelihood of bachelor's completion he found a significant and increasing odds of degree completion, with the greatest increase following students who completed algebra 2 and went on to complete trigonometry. Trusty (2004) found the variables science intensity and mathematics intensity to be highly significant to the prediction of bachelor's completion; Trusty did not evaluate the significance of high school GPA or ACT performance in his regression analysis. Trusty found that a one-unit increase in intensive science increased the odds of bachelor's completion by 45%; a one-unit increase in intensive high school mathematics increased the odds of completion by 73%.

Recommendations

Nebraska, like many states, has looked to its post-secondary education system to enrich the state's future and to enhance economic well-being for its citizens. It is vital for the institutions that are charged with this mission to fully understand the academic history and capability of the students they seek to educate. Without such baseline knowledge, there is potential to satisfy the need for higher bachelor's degree completion rates without also satisfying the need for students who have broadened and deepened their educational abilities. Few assumptions can be made about the level of high school academic course preparation of matriculating freshmen at an open-admissions college such as CSC. Yet, as demonstrated by Adelman (1999, 2006) and Trusty (2004), effective education at the

post-secondary level rests more on a student's academic history than on high school

G.P.A. or A.C.T. scores.

The results of this study have indicated that Nebraska high school G.P.A., student

ACT scores, and the total credits earned by a student by time of high school graduation

were significant predictors of bachelor's degree completion at Chadron State College.

The question that remains to be answered, however, is why Nebraska high school

mathematics and science credits were not significant predictors of bachelor's completion,

and why the correlation between bachelor's degree completion and the variables

involving mathematics and science, or language arts, social studies, and foreign language

was weak. There are two general possibilities, which include the study itself and the

academic roles of the schools involved.

It was possible that the predictive strength of the mathematics and science

variables may have been more effective if only upper level math credits and upper level

science credits were regressed instead of the mathsci variable. The ratio was used because

this study sought, in part, to establish an uncomplicated method to assess the importance

of high school mathematics and science to bachelor's degree completion at CSC. The

mathsci ratio variable was created by summing all levels of high school mathematics and

science credits (when they could be identified on the transcripts, remedial or technical

math courses were not included). Adelman's studies (1999, 2006) created complicated

constructs of academic intensity to use as regression variables against the likelihood of

graduation. Trusty (2004) created variables by summing credits from upper-division

courses. His mathematics intensity variable represented credits taken in algebra 2,

trigonometry, pre-calculus, and calculus, and his science intensity variable represented

total credits taken in biology, chemistry, and physics. The variables used by both Adelman and Trusty demonstrated a correlation association of moderate strength with graduation. For this study, the two groups of CSC students sampled—those that completed a bachelor's degree at CSC and those that did not—had earned minimum required high school credits in mathematics and science in common. This meant that the major difference between the two groups of students, as far as the mathsci ratio variable was concerned, would have been those high school credits taken beyond the minimally-required mathematics and science credits. (Recall that the denominator that was used to create the mathsci ratio, total credits, as discussed above, had no correlation whatever with the mathsci variable. The lack of relationship meant that the total credits had the same amount of variance whether students took more mathematics and science or not.) For the Nebraska high schools in this study, the mathsci ratio variable appeared to have reasonably isolated for testing the more intensive mathematics and science credits earned.

That a strong bond should exist between academic courses at the high school level and the likelihood of bachelor's degree completion was well illustrated at the University of Nebraska-Lincoln (UNL). When the University of Nebraska raised the number of high school credits required for admission, but not the composite ACT score requirement, not only did bachelor's degree completion rates increase but the composite ACT scores of matriculating freshmen also increased. These results implied that not only were more students graduating on time, they were arriving at college academically prepared to succeed. This meant that throughout high school, students intending to matriculate at UNL heard and acted on an academic expectation. The academic expectations of high school students who intend to attend an open-enrollment college are shaped by a different

message, and it not surprising that students arrive with a less-uniform level of academic preparation. Yet all students who enroll in a post-secondary institution are expected to fulfill studies at that level before they complete a bachelor's degree. Students who take academically intensive high school courses should have an increased likelihood of bachelor's degree completion. Alternately, students who have not taken appropriately intensive high school courses, but who still complete a bachelor's degree, may remain lacking important educational skills.

Interpretation of the relationship between the academic credits earned in Nebraska high schools and the likelihood of bachelor's completion at open-enrollment institutions such as Chadron State College would be further informed by additional studies centered around high school transcripts. Transcript data remains an underused but relatively inexpensive and readily available resource. Student transcripts are available in college databanks, having been already collected when students apply for admission. If the institutions were required to release transcript information for research purposes, it would be a relatively simple process to remove identifying student information. Transcript data provides a primary research resource, and was invaluable to the research of both Adelman (1999, 2006) and Trusty (2004). Use of Nebraska high school transcripts as research resources would be greatly facilitated by state-wide standardized identification of remedial courses. Such courses currently have a great variety of titles; standardization of the names of varying academic levels of courses would help future research that analyze the relationship between high school academic coursework and post-secondary outcomes. Use of high school transcript data to find predictors of bachelor's completion at state post-secondary institutions would promote greater understanding of the nature of

the education delivered both at the level of the state's high schools and at the level of the state's colleges. Analysis of greater numbers of student cohorts and greater numbers of students within the cohorts, as well as inclusion of students from the other two Nebraska state colleges, Wayne State and Peru State, both of which are also open-enrollment institutions, would broaden the picture.

National-level research has demonstrated a strong relationship between the level of high school academic preparation of a student and the likelihood that the student will graduate with a bachelor's degree within six years (Adelman, 1999, 2006; Trusty, 2004). This study did not find that the academic variables established by Adelman and Trusty were predictors of bachelor's completion at Chadron State College. However, this study was in agreement with Adelman and Trusty that there is a strong relationship between post-secondary institutions and the high school preparation of the students that attend them.

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Appendix A

Percentage of Total High School Credits Earned in Language Arts, Social Studies,

Foreign Language, Mathematics and Science of Four Nebraska High School Graduates

who Obtained a Bachelor's Degree within Four Years from Chadron State College

Percentage of Total High School Credits Earned in Language Arts, Social Studies, Foreign Language, Mathematics and Science of Four Nebraska High School Graduates who Obtained a Bachelor's Degree within Four Years from Chadron State College

	FL	LA	M	S	SS	Aca CR/Total CR.	= Percentage
NE 1	30	55	40	50	40	215 / 300	= 71.7 %
NE 2	10	40	40	20	40	150 / 252.5	= 41.6 %
NE 3	20	55	30	30	55	190 / 292.5	= 65 %
NE 4	20	45	40	60	40	205 / 285	= 71.9 %
UNL (post-'97)	**20**	**40**	**40**	**30**	**30**	**130 / 200***	**= 65 %**
UNL (pre-'97)	**0**	**40**	**20**	**20**	**20**	**100 / 200***	**= 50 %**

LA = Language Arts
SS = Social Studies
FL = Foreign Languages
M = Math
S = Science
Aca = combined credits in LA, SS, FL, M & S

*Requirements for Nebraska high school accreditation were defined in 2003 in NE Title 92, Chapter 10 (Nebraska Department of Education, 2008). Currently, Nebraska requires a minimum of 200 total credit hours for high school graduation (Nebraska Department of Education, 2008).

UNL admission requirements (UNL Undergraduate Office of Admissions, 2009 a, 2009b) were converted from Carnegie units (where 1 year of study in high school = 1 Carnegie) to credits (where 1 year of high school study in a particular area = 10 credits in that area).

Appendix B

Percentage of Total Credits High School Credits that were Earned in Science and

Mathematics of Four Nebraska High School Graduates who Obtained a Bachelor's

Degree within Four Years from Chadron State College

Percentage of Total Credits High School Credits that were Earned in Science and Mathematics of Four Nebraska High School Graduates who Obtained a Bachelor's Degree within Four Years from Chadron State College

	Math and Science Credits	Total Credits	Percent of Total
NE1	90	300	30.0%
NE2	60	252	23.8%
NE3	60	292.5	20.5%
NE4	100	285.0	35.1%
UNL (post-'97)	70	200	35%
UNL (pre-'97)	40	200	20.0%

Appendix C

Percentage of Total High School Credits that were Earned in Language Arts, Social Studies and Foreign Language by Four Nebraska High School Graduates who Obtained a Bachelor's Degree within Four Years from Chadron State College

Percentage of Total High School Credits that were Earned in Language Arts, Social Studies and Foreign Language by Four Nebraska High School Graduates who Obtained a Bachelor's Degree within Four Years from Chadron State College

	LA, SS, and FL Credits	Total Credits	Percent of Total
NE1	125	300	41.7%
NE2	90	252	35.7%
NE3	130	292.5	44.4%
NE4	105	285.0	36.8%
UNL (post-'97)	90	200	45%
UNL (pre-'97)	60	200	30.0%

LA = Language Arts

SS = Social Studies

FL = Foreign Languages

Appendix D

Average Composite Enrolling ACT Scores, Six-Year Graduation Rate, and Transfer

Rates of First-Time Full Fime Chadron State College Student Cohorts

Average Composite Enrolling ACT Scores, Six-Year Graduation Rate, and Transfer Rates of First-Time Full Fime Chadron State College Student Cohorts

Year of Cohort enrollment (graduation)	ACT score	6-year graduation rate	Transfer rate
1996 (2002)	21.6	46.9%	na
1997 (2003)	na	46.9%	na
1998 (2004)	na	46.86%	31.44%
1999 (2005)	22.3	46.94%	24.23%
2000 (2006)	22.3	45.19%	17.56%
2001 (2007)	21.5	44.85	20.36%
2002 (2008)	21.7	49.26	30.77%
2003 (2009)	22.1	na	na
2004 (2010)	21.4	na	na
2005 (2011)	21.4	na	na
2006 (2012)	21.0	na	na

*na: not available

Appendix E

Total High School Credits Earned, High School GPA, and ACT of Four Nebraska High

School Graduates Who Obtained a Bachelor's Degree within Four Years from Chadron

State College

Total High School Credits Earned, High School GPA, and ACT of Four Nebraska High School Graduates
Who Obtained a Bachelor's Degree within Four Years from Chadron State College

Student	Total credits taken	GPA	ACT (average composite of all attempts)
NE1	300	93.1	26.7
NE2	252.5	97.1	27
NE3	292.5	93.3*	23
NE4	285.0	94.4	26

*Cumulative GPA given was 3.46, percentage grade estimated based on Appendix E

Appendix F

Conversion chart of Grade Point Average [GPA] to percentage grade

Letter Grade	Grade Point	Percentage
A	4.0	94 - 100%
A-	3.7	90 - 93%
B+	3.3	87 - 89%
B	3.0	83 - 86%
B-	2.7	80 - 83%
C+	2.3	77 - 79%
C	2.0	73 - 76%
C-	1.7	70 - 72%
D+	1.3	67 - 79%
D	1.0	60 - 66%
F	0.0	0 - 59%

Retrieved 24 August 2009 from http://greatcollegeadvice.com/how-to-calculate-your-gpa-letter-grades-and-percentages/comment-page-1/

Calculation: 89% /3.3= X/3.46 ; X = [89/3.3] 3.46; X = 93.3%