Predicting Success of Minority Nursing Students on the "New" NCLEX-RN.

Janet Simmons Rami
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Predicting success of minority nursing students on the “new” NCLEX-RN

Rami, Janet Simmons, Ph.D.
The Louisiana State University and Agricultural and Mechanical Col., 1992

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PREDICTING SUCCESS OF MINORITY NURSING STUDENTS ON THE "NEW" NCLEX-RN

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy in

The Department of Administrative and Foundational Services

by
Janet S. Rami
B.S., Dillard University, 1970
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August 1992
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Finally, my mother must be humbly acknowledged for she taught me that I could do anything I put my mind to; my completion of this project supports her thesis.
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ABSTRACT

The purpose of this study was to identify academic variables that could be used to forecast success for minority, baccalaureate (BSN) students enrolled in higher education in the south. A second purpose was to develop a methodological framework for predicting success on the post-1988 versions of the National Council Licensure Examination for Registered Nurses (NCLEX-RN), that enhanced external validity, and generalizability.

The best predictors of success for minority BSN nursing students were the Mosby assessment, school comprehensive exit exams, GPA microbiology, the college cumulative GPA, nursing course cumulative GPA, and ACT composite. The sample included 216 Black graduates of three BSN programs located in Louisiana, who took the July 1988 through July 1991 versions of NCLEX-RN. The findings indicated that high ACT scores are not necessarily predictive of NCLEX success, and the ACT and pre-admit GPAs should be used cautiously in eliminating minority students from nursing education.

A methodological design that incorporated discriminant analysis, factor analysis and a four stage variable selection process, employed prior to a stepwise procedure was used. The equation derived was externally valid, stable across schools, and correctly classified 96% of the students.
used in the variable analysis. Only two of forty-two subjects (4.8%),
known to belong to the fail group, were misclassified. The cross-validation,
correct classification rate for BSN graduates of a different school was
76%, and showed 26% improvement over what was expected by chance
alone.
CHAPTER 1
INTRODUCTION

The national failure rate for first-time U.S. candidates writing the nursing licensure exam was 16.4% in July 1988, the highest in the seven-year history of the National Council Licensure Exam for Registered Nurses (NCLEX-RN). According to The American Journal of Nursing (1988), the failure rate had never previously exceeded 11%. The Journal issue reported that in 1988 the University of Kentucky Medical Center, for example, had 29 of 73 new graduates fail to pass the exam. This failure rate, for this hospital, was three times higher than their 1987 rate. The impact of continued NCLEX failure on the current nurse shortage could be devastating, since graduates who succeed in college but fail to pass the licensure exam, cannot contribute to the nation’s supply of registered nurses.

According to Hodgkinson (1985) the American society of the future, including nursing students, will consist of a larger number of minority students. The future supply of nurses will depend on the willingness, on the part of nursing education, to move beyond strategies to recruit and retain non-traditional students, to a system designed to graduate these students and place them in the workforce. Louisiana faces a unique situation. This southern state is predicted to have a greater shortage of nurses, when compared to the eastern and western states.
Hussey et al (1991) found that as the numbers of non-traditional students in an eastern state university changed, the college of nursing experienced a drastic decrease in success of their graduates on NCLEX. These authors warned that the future increases in minorities in higher education should not be necessarily perceived as an automatic decrease in the quality of the graduates of the future. The implication is that in the future educational systems must change their usual educational practices, to avoid the negative effects that would result from thrusting non-traditional students into traditional settings.

An educational system designed to address the student nurse of the future, would make use of educational research, that provided insight into minority student success in nursing education. The move to a pass/fail reporting schema for graduates taking the NCLEX-RN in 1989, and the major changes in the NCLEX-RN test plan in 1988 resulted in a decrease in the ability to generalize results of previous research studies to populations taking the exam after 1988. The need for additional research is clear.

This study will attempt to determine which academic variables are best in predicting success of minority nursing students. This investigation is designed to provide a methodological framework for predicting success on the new version of NCLEX-RN, and address several validity issues related to prediction.
Nurse Supply and Demand

One major area of concern, related to an insufficient supply of nurses to meet the demand for services, is the anticipated economic impact. The economic viability of a state or nation is dependent on an adequate workforce to produce goods or services and contribute to the tax base (Rami, 1991). When the available manpower supply for a required service is less than the demand, several economic factors arise. Along with an increase in the cost of services, a shortage of nurse supply impacts the health state of citizens. The lack of personnel to provide health care could negatively influence the community's ability to produce a healthy workforce, with a resulting loss in potential revenue.

Since nurses make-up 50% of the health care manpower in the United States, the economic impact of a nurse shortage becomes momentous. Using data supplied by the Louisiana State Nurses Association, for example, it was estimated that the economic loss in taxes to Louisiana in the year 2000, would be over 18 million dollars, if the state failed to meet the projected demand for nurses. The estimated buying power of 13,000 nurses (the predicated RN deficit expected for Louisiana for the year 2000) would be over 600 million dollars (Rami, 1991). Supply and demand ratios for nurses should be considered in relation to the economic impact as well as the impact on the health state of a population.
According to The Seventh Report To Congress (US DHHS, 1990), the regional nurse supply, measured by the number of RNs per 100,000 population, is lowest in the southern states with a mean of 421. The New England states had the highest RN population, or 798 per 100,000 population. The state level RN full-time equivalent (FTE) supply, per 100,000 population was highest in Florida with 1,454 RNs/100,000 population, and lowest in Louisiana with 406 RNs/100,000. The national average was 560 RNs/100,000 population. Table 1 shows the relationship between baccalaureate level RN supply and demand for the year 2020, as projected by the US Department of Health and Human Services (1990). The supply/demand percentage in Table 1 represents the projected percent of the demand met by the projected supply. This data reveals that the ratio of supply/demand is smallest for Louisiana and Mississippi. According to this ratio, these southern states will have a greater shortage of nurses than the state of Massachusetts, for example.
### TABLE 1.1
PROJECTED SUPPLY AND DEMAND FOR BACCALAUREATE RNS FOR SELECTED STATES FOR 2020

<table>
<thead>
<tr>
<th>STATE</th>
<th>SUPPLY</th>
<th>DEMAND</th>
<th>SUPPLY/DEMAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALA</td>
<td>7,200</td>
<td>17,500</td>
<td>41%</td>
</tr>
<tr>
<td>MS</td>
<td>3,650</td>
<td>10,840</td>
<td>34%</td>
</tr>
<tr>
<td>LA</td>
<td>5,600</td>
<td>17,360</td>
<td>32%</td>
</tr>
<tr>
<td>FL</td>
<td>27,560</td>
<td>53,320</td>
<td>52%</td>
</tr>
<tr>
<td>MA</td>
<td>20,080</td>
<td>28,180</td>
<td>71%</td>
</tr>
<tr>
<td>CA</td>
<td>57,530</td>
<td>99,340</td>
<td>58%</td>
</tr>
<tr>
<td>NY</td>
<td>47,020</td>
<td>77,800</td>
<td>60%</td>
</tr>
</tbody>
</table>

Note: The Seventh Report To Congress (US DHHS, 1990)

The US Public Health Service's 2020 projections also indicate that the RN shortage will be most severe at the BSN and higher degree levels. The projected supply/demand ratios for RNs, according to highest earned credential is: Associate Degree-52/32 (162%); Baccalaureate-36/48 (75%); Masters & PhD-11/21 (52%). These data indicate that the supply of BSN and higher degree nurses, will be far less than the projected demand.
The future demand for nursing personnel is strongly linked to the health care needs of a changing society. The predictions for health point to a nation replete with challenges including: (1) 37 million Americans without health insurance; (2) the highest infant death rate in the developed world or 10.1%, resulting mainly from lack of prenatal health care; (3) a mortality rate for Black infants of 17.9%, which is almost twice the rate for White infants; and (4) a decline in the life expectancy for some minority citizens, despite an explosive growth in the nation's health care technology (Kennedy 1989; Reed & Sautter 1990).

The United States Secretary of the Department of Health Services, Dr. Louis Sullivan, proposed a plan called "Healthy People 2000" to address the nation's health care crisis (American Public Health Assoc., 1990). This document cites 22 priorities for improving the health of Americans and includes as a priority the need to target health care needs of minorities and other underserved populations. The secretary posits that the health needs of these underserved populations are often met by health professionals that are themselves minorities. A resulting national goal of "Healthy People 2000" is to increase the proportion of degrees in the health professions awarded to under-represented racial and ethnic groups.

The health status of Blacks residing in the southern region of the United States in 1987 was more likely to be described as poor than Blacks or Whites living in other regions (US DHHS 1990). Louisiana and
Mississippi currently have the highest infant mortality rates in the United States. The implication is that the future demand for health services could be greater in these southern states. According to the projected demographics of the populations of these two states, the potential supply of students to meet this increased demand will include larger proportions of minority students. One must also consider the fact that the current registered nurse population in Louisiana is 8.5% Black while the state’s population is approximately 30% Black.

Demographics of Future Students

The demographic trends for the United States indicate that future American citizens will be more diverse. Hodgkinson (1985) predicts that by the year 2020, minorities will become the majority in ten states. These states include; District of Columbia, Hawaii, New Mexico, Texas, California, Florida, New York, Louisiana, Mississippi, and New Jersey.

According to the United States Department of Health and Human Services (US DHHS), Chartbook 1990, minorities, in 1987, were more likely to be below the poverty level than Whites. Blacks were three times as likely to be economically disadvantaged as Whites. In 1987, 33.1% of Blacks were below the poverty level, compared to 10.5% of Whites. The percentage of Blacks with four years of college in 1986 was 10.9, while the percent of the total population with four years of college for the same year was 19.4 (US DHHS 1990). The US DHHS also found that of the
population that completed one or more years of college, 2.9% of Whites were below poverty, and 11.2% of Blacks were below poverty.

*The Chronicle of Higher Education* (August 28, 1991) reported that of all bachelor's degrees conferred in 1988-89, 84% were to whites, 16% were to minorities, and 6% were to Blacks. Table 2 lists data for selected states, and the distribution of college students by race. The states listed in the table represent the southern part of the United States, and/or states identified earlier as having the greatest shortage of nurses. Other states listed in Table 2 are provided for comparison.
<table>
<thead>
<tr>
<th>STATE</th>
<th>POPULATION</th>
<th>ENROLLMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% MINORITY</td>
<td>WHITES</td>
</tr>
<tr>
<td>AL*</td>
<td>26.3</td>
<td>78.5</td>
</tr>
<tr>
<td>CA*</td>
<td>43.6</td>
<td>67.0</td>
</tr>
<tr>
<td>FL*</td>
<td>27.3</td>
<td>77.3</td>
</tr>
<tr>
<td>LA*</td>
<td>32.2</td>
<td>72.1</td>
</tr>
<tr>
<td>MI*</td>
<td>36.6</td>
<td>71.5</td>
</tr>
<tr>
<td>MA**</td>
<td>12.4</td>
<td>89.1</td>
</tr>
<tr>
<td>NY*</td>
<td>25.6</td>
<td>76.4</td>
</tr>
</tbody>
</table>

* Southern States and/or states with predicted increases in minority population for the year 2000

** State representing the least predicted shortage in nurses for the year 2000

The American Academy of Colleges of Nursing (AACN, 1989) reported that minorities represented 22% of nursing students enrolled in baccalaureate programs for 1988-89. The National League for Nursing (NLN, 1991) reported that graduations in nursing in 1986 represented 10.5% minorities and 89.5% Whites. Blacks represented 6.0% of the 1986 nursing graduates. Minority nursing graduates from Louisiana and Mississippi represented 23% and 13% of their classes in 1986, respectively.

Because future populations of higher education students, will be more culturally diverse, nurse educators must prepare. Two of the challenges, according to the Vice Chancellor of the University of California at Berkeley, resulting from the demographic changes, include; effective retention and graduation rates, and eradication of the myth that a diverse student population is synonymous with lowering quality (Smith, 1989).

During the national conference titled "Nursing Education and Practice for the 21st Century" (1989), Dr. Gloria Smith, Dean of Nursing, Wayne State University, stated that nursing faculty of the future must be prepared to teach, guide and support a more diverse student population. She explained that universities will continue to compete for students in the future, but, students will learn which institutions have developed plans, that are based on empirical evidence, to assist them to succeed. Dr. Smith also challenged nurse faculty in Historically Black Colleges and Universities
(HBCUs) to share with the nursing community at large their wealth of knowledge on educating minority populations. Smith described the future educational system as one where we move from "picking winners", to a system of "producing winners".

**History of Minority Success in Higher Education**

Kemp (1990) posits that higher education should focus beyond retention of minority students toward graduation and social productivity. The rationale for this position was that minorities want to be educated and graduated and not simply retained. Kemp describes the status of minority students in the American university and college system as a national crisis.

Robinson (1990) assessed that minorities' persistence in college, through degree attainment, should be a higher education priority. For African Americans, a college degree is a means to cross barriers, and realize progress. Robinson concluded that thorough analysis of attrition and graduation rates is critical to understanding the gap between entry and exit of minority students in higher education.

Family income, parent's education and high school grades are factors associated with initial enrollment in college (Ballantine, 1989). Studies indicate that: (1) the average reading level of Blacks and Hispanics is four years less than White students; (2) more Black students than White students pursue higher education on a part-time basis; (3) Black students take longer than White students to complete their college degrees; and
(4) Historically Black Colleges and Universities (HBCUs) are more successful than predominately White institutions in retaining and graduating minority students (Ballantine, 1989; Fleming, 1984; Morris, 1979; Syverson & Froster, 1983; Thomas, 1981; Thomas, Mcpartland, & Gottfredson, 1981).

Overall, the performance of minority students in higher education has been considerably below the level of majority students (Ballantine, 1989; Flemings, 1985; Kemp, 1990; Hodgkinson, 1985; Nettles, 1985; Robinson, 1990). These performance indicators include progression rates, college grade point averages, and graduation rates. The performance of minority students on standardized tests has typically been below the level of White students. Schmeiser and Ferguson (1979) attributed these differences to several factors including: (1) culturally biased content, (2) technical features of the test, (3) cognitive skills measured, and (4) socio-cultural characteristics.

Minority student success in nursing education is consistent with their history of success in higher education. As was reported by the United States Public Health Service (US DHHS, 1988), the proportion of nurses from minority backgrounds has not improved. In fact the number of minorities in nursing decreased from 8.2% in 1984 to 7.2% in 1988. Despite an increase in the total number of registered nurses, the number of Black nurses stayed the same between 1984 and 1988.
The Seventh Report to Congress (US DHHS, 1990) proposed that current and complete data on the number and percentages of minority nurses is lacking. Smith (1989) addressed the importance of information and research as a vital component for future success of schools of nursing. The development of useful information systems by nursing education, according to Smith, is paramount to the survival of nursing in the future society.

Several publications on results of program evaluations conducted by nurse educators reported improved success rates for minority nursing students after academic intervention (Burris, 1987; Hussey & Wieczorek, 1991; Merritt, 1991). These educators recommended that nursing focus on empirical research that could serve as a basis for curriculum redesign to address the unique needs of a changing population.

Schools of nursing in Chicago and New York improved the pass rates of minority students from 33 to 100 percent, and 37 to 94 percent respectively (Burris, 1987; Hussey et al, 1991). These results came after schools recognized that the sudden low pass rates coincided with increased enrollment of minority students, and after educational strategies were developed to address the new population of students.

These nurse authors warned that educators must be cautious about nursing program redesign, to accommodate a changing student population, without sufficient data generated through educational research.
Recommendations included educational research that focused on college students, NCLEX, and cultural influences. The need for a comprehensive model for BSN student aptitude research was reported.

Merritt (1991) suggested that this model could serve as a framework for investigations on learning abilities of students and increase the availability of systematically acquired data on BSN student aptitude. It has even been suggested that failure by higher education institutions to provide the necessary learning strategies and support to encourage minority student achievement in high demand fields, would constitute academic fraud (Richardson, 1989).

**Nursing Licensure: NCLEX-RN**

The historical development of the nursing licensure exam can be divided into three phases: (1) State Board Test Pool Exam, or SBTPE phase from 1952 to 1982; (2) the first NCLEX exam phase from 1982 to 1988; and (3) the second NCLEX phase from 1988 to present. The first exam, SBTPE, was a 720 question, norm referenced exam consisting of five parts, that corresponded to five areas of nursing practice. The passing grade was one and a half standard deviations below the mean for each section. A person could pass one or more sub-test and fail others, but only the failed parts had to be repeated. The National Council of State Boards of Nursing (NCSBN), which represents all states and their respective boards of
nursing, was given autonomous control over the exam in 1978, by the American Nurses Association (ANA).

In 1982 the NCSBN introduced the first criterion referenced exam called the National Council Licensure Exam (NCLEX), which consisted of 400 questions. Another major change in the exam in 1982 was the move from a five part exam to a unified test and one score. This exam was used until 1988 when the NCSBN introduced the second NCLEX that reflected changes in the content focus. This 1988 revision resulted in a change in the test blueprint to reflect the new focus from human functioning to client needs. The RASCH Model (Rasch, 1980) for test development and the Ankoff standard setting models were used for the first time in developing the 1988 exam (NCSBN, 1988). The NCSBN decreased the number of questions to 300 and the passing score was changed to pass/fail in February, 1989.

The 1988-89 changes in the exam were the result of a controversial job analysis conducted without the input of nurse educators by the NCSBN (Matassarin-Jacobs, 1989). The resulting national failure rate for the 1988 NCLEX was 16.4%, the highest in the history of the NCLEX (AJN, 1988). A new job analysis was conducted in 1991 by the NCSBN, but resulted in no changes in the exam (NCSBN, 1992).
Conceptual Framework

The conceptual framework used in this study to investigate predictors of success for minority nursing students on the new NCLEX-RN incorporates two major phenomena: (1) the relationship between nursing and society; and (2) educational measurement. These two interrelated areas provide the theoretical basis for developing the research strategies and interpreting the findings.

In this section of the study the undergirding assumptions about nursing practice and nursing education, that set the stage for the discussions of nursing licensure and education of minority students, are presented. Because this study focuses on the quantification and analysis of human behavior, a discussion of the assumptions related to educational measurement and prediction are also presented.

Nursing and Society

The locus of this research study is the education and development of professional nurses to meet society’s demand for nursing services. The American Nurses Association (1980), in formulating the nature and scope of nursing practice, posits that the authority for nursing practice is derived through a social contract. The hallmark of this contractual relationship is the link between public trust and the profession’s autonomy in self-regulation. ANA describes nursing’s responsibility in this contract as: (1) establishing a code of ethics; (2) establishing standards of practice; (3)
development of nursing theory; (4) establishing educational requirements; (5) developing certification processes; and (6) other activities that foster nursing’s accountability to society.

This research study recognizes these six responsibility areas and seeks to enhance the professions’ ability to act in relation to educational standards and certification. Investigation of the association between components of the nursing education process and the national licensure exam is supportive of the bond between public trust and professional self-regulation. The social contract between the nursing profession and society is viewed as the basis for the legal authority to practice. Nursing’s autonomy in self-regulation, along with its’ legal authority to practice are operationalized through legislated nurse practice acts and licensure regulations. The nursing profession also believes that it has a responsibility to provide society a means of identifying those persons who are qualified to be nurses (ANA, 1980).

State nurse practice acts give the profession the authority to require success on the NCLEX-RN exam before persons are allowed entry into practice. The NCLEX represents one major strategy used by the profession in meeting it’s contract with society. The nursing education process is also an operation utilized by nursing to identify persons qualified for professional practice. The purpose of this study was to evaluate, through research, the relationship between these two professional strategies.
**Educational Measurement**

Measurement in education is a process used to quantify behavioral constructs in such a way as to allow for mathematical manipulation and objective discussion of human traits (Cunningham, 1986). The theoretical development of the field of educational measurement centered on a desire to investigate individual differences (Cunningham, 1986). Measurement theory has as a goal enhanced communication related to predicting and controlling human behavior, through the classification and clustering of observations. In this study the construct or behavior under investigation is "success on the NCLEX-RN". Samples of behavior or variables that are related to NCLEX-RN success, as described by the literature review and conceptualizations about nursing, are analyzed in this study. The mathematical equation is derived when a numerical value is assigned to the construct under investigation.

Predicting success entails the scientific analysis of past behavior to gain insight into future behavior. Crocker & Algina (1986) describe prediction in terms of criterion-related validation. These authors assert that predictive validity is an evaluation of the extent to which a set of scores predict future criterion performance. The criterion measure used must meet two standards: (1) be a reliable indicator of the performance studied; and (2) have a relationship to the future performance under study (Crocker & Algina, 1986).
NCLEX-RN as a Measure

The RASCH Model is the psychometric tool currently used to construct and validate the NCLEX-RN exam. According to Anthony Zara (1989), Director of Special Projects, National Council of State Boards of Nursing (NCSBN), assumptions underlying the RASCH Model must be met before NCLEX-RN can be considered a valid indicator of examinees' competence. The Rasch Model is one of a family of "latent-trait" models used to construct and analyze tests. Latent-trait theory, also called item response theory (IRT), was developed to address problems and limitations associated with traditional test procedures. Traditional methods of developing tests produce scores that are item-dependent, and, sample-dependent, whereas IRT methods do not (Hashway, 1978).

The RASCH model is based on two parameters, a difficulty for each item and an ability for each person (Rasch, 1980). These two parameters are also described as test parameters and person parameters respectively. Mastery testing, as with the NCLEX-RN licensure exam, also involves setting a cut-score or mastery level (Mckinley, 1989).

The process of test development and analysis using the RASCH model, starts with the determination of a cut-score or passing standard. The National Council utilizes the Angoff technique for standard setting. This approach to criterion referenced standard setting utilizes a panel of experts to construct a "hypothetical minimally competent person".
According to the NCSBN (1988), the seven member panel translates this hypothetical person's competence into performance on specific test items. Calculation of the cut-score is done after all items have been rated. The ratings represent the judges prediction of the probability that the hypothetical person would choose the correct answer. The cut-score or minimal competence is defined as the average of the panels ratings. The goal is to maximize decisions around the cut-score or standard. For examinees writing the NCLEX-RN the standard is used to determine pass or fail.

**Problem Under Investigation**

The shortage of nurses, especially in the southern states, along with an increasing demand for health providers to assist growing numbers of underserved populations, pose serious problems for the nursing profession and society. The changing demographics of future students create a unique challenge for higher education systems, in their quest to produce an adequate supply of qualified nurses. Additionally, nursing education has not developed a systematic framework to address the methodological issues related to predicting success on the "new NCLEX-RN exam".

The move to a pass/fail reporting scheme for graduates taking the NCLEX-RN in 1989, resulted in a lack of definitive research using the cut score reporting approach. One of the major issues raised by the educational
community in response to the National Council’s change in reporting scores, was the inability to employ usual practices in predictive research.

Numerous research studies have used pre 1988 NCLEX scores and the multiple regression analysis procedure to develop a prediction equation. Many of these studies also used the discriminant analysis procedure to determine the accuracy of classification of subjects after applying the regression equation. Adams (1990) studied minority students taking the NCLEX between 1982 and 1989 and used the multiple regression procedure to develop a prediction equation for classifying future subjects as pass or fail.

Carolyn Yocom, Director of Research Services, National Council State Boards of Nursing, reported that use of the multiple regression procedure to develop a prediction equation and the pass/fail score as the criterion variable, is inappropriate (1987). This author presented the discriminant analysis procedure as the appropriate tool for developing a prediction equation for a linear combination of variables when the criterion is not continuously scored. The use of regression analysis in this situation violates basic assumptions of the model and could result in false findings (Huberty, 1975, 1984; Kichigan, 1986; Klecka, 1980; Norusis/SPSS Inc., 1990; Pedhazur, 1982; Yocom, 1987).
Variable and Sample Selection

Predictive research studies on NCLEX success showed that numerous variables are associated with student performance. Nurse educators have utilized admissions data, demographic data, prior success, qualitative data, teacher-made tests, clinical evaluations, standardized tests, and other cognitive and non-cognitive variables to measure success in education. Other variables that have been found to be associated with NCLEX success include: the timing of indicators; reading ability for Black-American students; and research on critical thinking ability. The abundance of variables identified from previous research and the incongruence in findings among studies, supports the need to examine variable selection techniques.

Other areas that were found to be important in prediction research include: (1) validity and reliability of measures; (2) missing data analysis; (3) prediction decision accuracy; and (4) generalizability in discriminant analysis. The majority of the studies on NCLEX success to date have examined individual schools and did not attempt to cross validate their studies across curricula with other schools of nursing. The preponderance of studies are representative of the western, mid eastern and eastern United States. There is a lack of recent studies that support generalizability across schools.
The need for a comprehensive model for investigating BSN student aptitude and success, using the "new NCLEX-RN exam" is evident. The availability of current data to assist nurse educators to predict success of minority students, enrolled in nursing education in Louisiana and Mississippi, is lacking.

**Purpose of this Study**

The purpose of this study was to determine which factors, best forecast success on the post 1988 versions of NCLEX-RN, for minority, baccalaureate nursing students enrolled in higher education institutions in the south. A second purpose was to develop a methodological framework for predicting success on the "new" NCLEX-RN, that addresses; (1) stability and generalizability across curricula and schools, and (2) variable selection to minimize misclassification of failures.

This study seeks to address the void in the availability of recent empirical research that focuses on minority student success on the "new version" of the licensure exam. Investigating NCLEX success using multiple nursing programs, and samples representing the southern states, is a unique feature of this study. The methodological model for prediction, using dichotomous variables, and a four part variable selection process used to enhance stability of the prediction equation, also serve to fill a void in research in nursing education.
This study addresses criterion-related validity and validation, or how effective several predictor variables are in predicting the pass or fail classification of students. The predictor variables will be analyzed to determine the best combination of variables that can be used to discriminate between the two groups. Once the best combination of predictor variables are identified, a mathematical equation will be derived to classify future students into a potentially pass or potentially fail group. The discriminating variables are selected from the list of variables that have been found to be significant predictors in previous research, and or variables associated with minority student success.

The Research Questions

(1) What is the relationship between academic variables and performance on the "new NCLEX-RN" for minority BSN students residing in the southern region and attending different nursing programs?

(2) Which academic variables are useful in predicting success on the "new" NCLEX-RN for minority BSN students residing in the southern region and attending different nursing programs?

(3) How might these academic variables be combined into a mathematical equation to predict performance on the "new" NCLEX-RN?

(4) What is the accuracy rate and stability for the equation derived?
Significance of the Study

Within the conceptual context of nursing's contract with society, (to maintain self-regulation by assuring appropriate nursing services for society), this study can be viewed as an investigation that contributes to the determination of the effectiveness of the profession in self-regulation. This research study recognizes the responsibility of the profession to society and seeks to enhance nursing's ability to act in relation to educational standards and certification. Investigation of the association between components of the nursing education process and the national licensure exam is supportive of the bond between public trust and professional self-regulation.

This study represents a model for BSN student aptitude research that focuses on college students, NCLEX, and cultural influences, and could serve as a methodological framework for predicting success on the "New NCLEX-RN". Additionally, this research increases the availability of systematically acquired data on the education of minority health professionals. The results of this study could be used to address the unique needs of the future population, and to adjust educational systems to avoid the negative effects that would result from thrusting non-traditional students into traditional settings. The findings from this study should make a significant contribution to improved retention and graduation of minority nursing students.
The methodological design provides a model that addresses several issues, including: prediction research when the criterion variables are dichotomous, maximizing variable selection, addressing assumptions of discriminant analysis, evaluating discriminant functions, and cross validation of classification rules in discriminant analysis. This project provides some insight into the predictive validity of several cognitive and non-cognitive student variables, and nursing curricula components.

The ultimate goal of this educational research project, is to provide a methodological framework for improving the success of minority students on the "new" NCLEX-RN exam. This project addresses retention and graduation of minority students, and success of nursing students in the south. The significance of this project is it’s potential to make a positive contribution on the supply of nurses, and to the health condition of underserved populations in the southern region.

**Definition of Terms**

**Academic Variables** - variables that have been used to predict academic success and are related to educational achievement include; ACT scores, Nelson Denny reading scores, prior nursing experience, participation in remedial education, NLN achievement test scores (Basics I,II,III; Pharmacology; Health & Illness I,II; Maternal Child; Psychosocial; Community; BSN Comprehensive), Mosby Assessment, School Comprehensive Exam, high school GPA, freshman GPA, natural science
course GPAs (Biology, Microbiology, Chemistry), social course GPAs (Psychology, Philosophy, English, Sociology), math GPA, admission to nursing GPAs, nursing course GPAs (levels 1, 2 and 3, and cumulative), cognate courses GPA.

**Baccalaureate Nursing Education (BSN)** - refers to programs located in higher education institutions that prepare students for entry into nursing practice. BSN students are enrolled in four year nursing programs and are eligible to take the NCLEX exam after graduation.

**Demographic Background** - student characteristics that include; age, income levels, parish residency, sex, part-time or full-time student status, and employment status while in school.

**Minority** - refers to persons enrolled in higher education who represent one of the following ethnic groups: African-Americans (Blacks); American Indians; Asian-Americans; and/or Hispanics.

**NCLEX-RN** - a criterion referenced, multiple choice test designed to measure minimal competencies required to practice as a registered nurse. The examination is taken by graduates of nursing education programs and the results are reported as pass/fail.

**Southern Region** - a geographical area of the United States that includes one or more of the states that comprise the South Central Region. As defined for this study, this region includes eight states; Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas.
Stages of Academic Performance - five stages are defined for this study to represent academic activity from high school to end of college, including; pre-college, freshman-sophomore years, admit to nursing criteria, junior year college, and senior year college. These five stages represent this researchers' conceptualization of academic activity.
CHAPTER 2
REVIEW OF LITERATURE

The purpose of this review of the literature was to explore current relevant research on predicting success of nursing students. The goal was to survey and analyze the research on nursing education success to identify: (1) academic variables studied and their relationship to current educational practice; (2) populations studied and their generalizability across educational programs, and to minority students; and (3) statistical models applied and their usability in predicting success on the "new" NCLEX exam. This literature review established that methodologically sound, empirical research studies, that addressed minority nursing students and the "new" NCLEX exam was still lacking.

The review showed that numerous studies have been published on success of nursing students over the years. This abundance of research is indicative of the emphasis placed on program evaluation and educational success by the nursing profession, and the social ramifications of NCLEX failure. This emphasis on forecasting success is also linked to the profession’s desire to maintain self-regulation through fulfillment of its obligation to produce sufficient numbers of qualified nurses to meet society’s demand.

Grant (1986) reviewed over 20 studies, published before 1979, related to predicting success of nursing students. A synopsis of Grant’s
findings are provided as a means to summarize research on the topic up to 1979. An additional 45 studies, on predicting nursing student success, were examined for inclusion in this review of literature. Several of these studies are presented in depth, to establish the overall state-of-the-art in predicting NCLEX success.

The studies are divided into three major categories; methodological issues, variable selection, and minority success. Several published studies, examined for this research project, were not included in the review (they were included in the reference list) because they provide no additional information. Collectively, the studies reviewed provide the background needed to address variable selection, population and samples, and methodological issues related to the "new" NCLEX-RN exam.

A tabular summary, of the research studies used to establish the state-of-the-art in predicting NCLEX success, is provided in Table 2.1. The table presents an overview of the trends in the selection of predictor variables for NCLEX-RN performance, and depicts the types of methodologies currently used in predictive studies. The third column in Table 2.1 gives the version (by year) of NCLEX-RN used in the particular study. This column gives the reader a picture of the number of published, empirical research studies \( (n = 2) \) that used the post 1988 version of the NCLEX exam.
### TABLE 2.1

**SUMMARY OF RESEARCH ON PREDICTING SUCCESS OF NURSING STUDENTS ON NCLEX-RN**

<table>
<thead>
<tr>
<th>RESEARCHER</th>
<th>METHOD</th>
<th>NCLEX VERSION</th>
<th>SIGNIFICANT VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams, B. 1990</td>
<td>Multiple Regression</td>
<td>1982-89</td>
<td>ACT, Cognate &amp; Cum. GPAs</td>
</tr>
<tr>
<td>Allen et al 1988</td>
<td>t Test Chi Square</td>
<td>(D grade)</td>
<td>Pre Admit GPA Prerequisite GPA</td>
</tr>
<tr>
<td>Ashley et al 1991</td>
<td>t Test Chi Square</td>
<td>1989 July</td>
<td>Test Coaching</td>
</tr>
<tr>
<td>Bauwens et al 1987</td>
<td>Multiple Regression</td>
<td>1987</td>
<td>Non-significant Critical-thinking</td>
</tr>
<tr>
<td>Breyer, F. 1984</td>
<td>Multiple Regression</td>
<td>1982-83</td>
<td>NLN Comprehensive Achieve Test</td>
</tr>
<tr>
<td>Dell &amp; Halpin 1984</td>
<td>Discriminant Analysis</td>
<td>1970-74</td>
<td>High Sch GPA NLN PreNsg</td>
</tr>
<tr>
<td>Ellison et al 1985</td>
<td>Discriminant Analysis</td>
<td>Admit process</td>
<td>Admission data</td>
</tr>
</tbody>
</table>

*Table continues*
<table>
<thead>
<tr>
<th>RESEARCHER</th>
<th>METHOD</th>
<th>NCLEX</th>
<th>SIGNIFICANT VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felts, J. 1986</td>
<td>Discriminant Analysis</td>
<td>1982-84</td>
<td>College courses; sciences &amp; humanities</td>
</tr>
<tr>
<td>Glick et al 1986</td>
<td>Multiple Regression</td>
<td>1982</td>
<td>None Significant Nsg III &quot;best&quot;</td>
</tr>
<tr>
<td>Horns et al 1991</td>
<td>Multiple Regression</td>
<td>1985-86</td>
<td>Admit GPA Race</td>
</tr>
<tr>
<td>Jenks et al 1989</td>
<td>Discriminant Analysis</td>
<td>1984-87</td>
<td>Nursing Course Mosby Assess</td>
</tr>
<tr>
<td>McKinney et al 1988</td>
<td>Multiple Regression</td>
<td>1983-85</td>
<td>GPA, Pre/exam Mosby Assess Courses repeated</td>
</tr>
<tr>
<td>Quick et al 1985</td>
<td>Discriminant Analysis</td>
<td>1982</td>
<td>Freshman GPA SAT Verbal</td>
</tr>
</tbody>
</table>

(table continues)
<table>
<thead>
<tr>
<th>RESEARCHER</th>
<th>METHOD</th>
<th>NCLEX VERSION</th>
<th>SIGNIFICANT VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payne &amp; Duffey 1986</td>
<td>Multiple Regression</td>
<td>1983-84</td>
<td>Nursing GPA</td>
</tr>
<tr>
<td>Poorman, et al 1991</td>
<td>Multiple Regression</td>
<td>?</td>
<td>Self-reported grades &amp; scores</td>
</tr>
<tr>
<td>Sharp, T. 1984</td>
<td>Discriminant Analysis</td>
<td>1974-79</td>
<td>HSch. GPA, Math &amp; Natural Science</td>
</tr>
<tr>
<td>Woodham, et al 1986</td>
<td>Multiple Regression</td>
<td>1982-83</td>
<td>Nursing Course Grades</td>
</tr>
<tr>
<td>Yang, et al 1987</td>
<td>Multiple Regression</td>
<td>?</td>
<td>ACT soc science</td>
</tr>
</tbody>
</table>

**Pre-1980 Research on Nursing Success**

The 20 plus studies reviewed by Grant (1986) were conducted before 1979 and used the SBTPE rather than the NCLEX. Grant concluded that the most widely accepted criteria for predicting success in nursing are the most traditional (GPA, ACT, SAT and GRE). Three other conclusions
were presented by this author; (1) the best predictor of future success is past success, (2) National League Achievement test were found to be predictive of success on the licensure exam, and (3) college cumulative GPA and reading ability were found to be predictive of success for black students.

Grant provided four major recommendations; (1) continued effort needs to be put into multivariate approaches in research to answer the prediction questions, (2) nursing programs should develop and validate prediction equations to assist nurses in preparing for the licensure exam, (3) with the revisions in the licensure exam, replication of studies is warranted, and (4) research efforts should focus on the relationship between curricula and teaching/learning processes and nursing practice. This research study addresses the first three recommendations by Grant, in relation to the new licensure exam (post-1988), and should provide some insight into predictors across curricula.

**Predicting Success: Methodological Issues**

Several studies are presented that address methodological issues related to prediction. These studies generally applied regression analysis to develop a prediction equation, using interval level licensure scores as the criterion variable. All NCLEX-RN scores reported between 1982 and February 1989 were presented as numerical (interval level) scores that
ranged from 200 to 3,200, with a pass score set at 1,600. Discriminant Analysis was used only to evaluate the prediction accuracy of the equation in many of these regression studies.

A number of investigations (seven) used Discriminant Analysis and the pass/fail status of graduates to develop the prediction equation and to test the accuracy of prediction. Factor analysis was used in one study to evaluate and combine predictor variables. Overall, the studies provided valuable information on methodology.

Clearly, some conflicting results were found (e.g., SAT math scores were predictors and non-predictors). Researchers found that predictors of success on the nursing licensure exam for minority students were different from predictors for Caucasians. The regression studies addressed issues related to; errors of estimate, multicollinearity, tolerance levels, "shrinkage", and the use of cross-validation to estimate the degree of shrinkage. Issues related to variable selection-deletion were found to be important in prediction research including; (1) Validity and reliability of measures, (2) missing data analysis, (3) prediction decision accuracy. Methods that addressed effective ways to reduce the number of variables used in a study were not found among research on NCLEX success.

The majority of the studies looked at individual schools and did not attempt to cross validate their studies with other schools of nursing. Studies examined in this review were predominantly representative of the
western, mid eastern and eastern United States. Therefore, the results presented in this review are generalizable to the regions studied.

**Use of Multiple Regression to Analyze Predictors**

Nine studies examined in this section of the literature review used a multiple regression procedure to predict success on the national nursing licensure exam. These studies used a pre-1988 version of the exam as the criterion variable. One study (Melcolm et al, 1981) used the pre-1982 norm referenced, State Board Test Pool Exam (SBTPE) as the criterion variable. The other studies in this section used the criterion referenced NCLEX-RN exam.

The purpose of a study by Breyer (1984) was to validate the reliability of the National League for Nursing (NLN) Comprehensive Achievement Test (Form 39-3013) in predicting success on NCLEX-RN. Breyer used the July 1982 version of the licensure exam as the criterion variable and the five sub-scores of the comprehensive exam as the predictor variables. The research purposes were; (1) to determine the ability of the NLN Comprehensive test sub-scores, to predict scores on the NCLEX-RN, and (2) to develop an equation that could be used to predict the NCLEX scores of future students who would take both the NLN comprehensive exam and the NCLEX. Two population samples were used, a validation sample and a group used to equate two versions on the NLN test. The sample used as a validation group consisted of 2,496 graduates.
of diploma and associate degree nursing programs who wrote the NCLEX-RN (version 782) in July 1982. The equating group, consisting of 861 subjects, was used by Breyer to equate the 1983 version of the NLN test with the 1982 version.

The multiple regression procedure used by Breyer produced five standardized Beta coefficients that corresponded to the five sub-scores of the NLN test used as predictor variables (Med, .17; Surg, .18; Peds, .23; OBs, .25; Psych, .23). These Beta weights were used as indicators of the relative importance of each sub-score in predicting success on NCLEX. The Beta coefficients were used to develop a prediction equation to be used to predict future NCLEX test scores from the scores obtained on the 1982 NLN Comprehensive exam. A standard error of estimate was developed to provide a measure of how far the predicted NCLEX scores could deviate from the actual score. The validation sample had a mean score on NCLEX-RN (version 782) of 2043.68, and a standard deviation of 278.05. The standard error of estimate for the predicted scores was 187.85. Breyer concluded that the NLN test can predict success on NCLEX-RN within a reasonable margin of error.

The Breyer’s study supports the inclusion of NLN test scores in future prediction studies. The large sample used, along with the follow-through to determination of errors of estimate, strengthens the usability of the model. This study used the regression analysis procedure to test the
hypotheses, when the criterion and predictor variables were all interval level numerical variables. The replication of this study using post-1988 NCLEX results, where the scores are reported as dichotomous (pass/fail) indices, would necessitate some modification in the procedures used to determine correlations and Beta coefficients.

A study by Glick, McClelland, & Yang (1986) used three separate regression analysis procedures to answer three research questions. The question related to NCLEX success was; what is the extent to which achievement in clinical nursing courses predicted performance on NCLEX-RN? These authors used a total of 55 different variables to answer the three research questions. The sample consisted of 51 graduates of a large mid-west BSN program.

Glick et al, evaluated the extent to which five clinical nursing course grades predicted success on NCLEX. The findings were that none of the five variables were significant predictors of success. All variables (except for NSG V) were found to be significantly correlated with performance on NCLEX success, but none were significant predictors of performance on NCLEX. The authors noted that the results of this study contradicted previous research that showed clinical courses as significant predictors of NCLEX success.

Several areas of this study warrant further investigation. First, the study used five predictor variables, when the sample used consisted of 51
subjects. This provides a 1 to 10 ratio between predictor variables and subjects. Pedhazur (1982) recommends a 1 to 30 ratio between predictor variables and number of subjects, when using regression analysis. According to Keppel & Zedeck (1989) a ratio of 40 subjects per variable is recommended.

A second issue concerns the five course grades (descriptive statistics were not provided) which represent the students performance on progressive courses in an integrated curriculum. This implies that each course builds on the previous course, and competencies measured at the end of the courses incorporate previous competencies measured in previous courses. In other words the scores on the five predictor variables could be intercorrelated. The term used to describe this type problem is multicollinearity. Pedhazur (1982) defines multicollinearity as the absence of orthogonality among the predictor variables. High multicollinearity could lead to distortions in the magnitudes of regression coefficients and could even reverse the direction of the effects found (Pedhazur, 1982). In one example presented by Pedhazur the Beta weights were 50% less when two predictor variables, in hypothetical data, were changed from a correlation of .1 to a correlation .85.

The Glick et al study found a negative Beta weight for one variable (Nsg. 5). The correlation matrix showing the intercorrelations between the five courses was not provided. This data, along with tolerance levels,
would have been useful in further analyzing the issue of collinearity in this study. The tolerance of a variable \((1 - R^2)\), is used to detect collinearity (high correlation between independent variables). A small tolerance signifies a linear combination, between variables (Norusis/SPSS, 1990).

Glick et al did find that only one course, the third course (Nsg III) in the five course sequence, made a significant contribution to the NCLEX scores \((p < .001)\). All others were not significant predictors of NCLEX. This study also found that virtually no contribution \((R^2\) for change, when Nsg IV and V were each entered last in the stepwise analysis was 0.00) was made by the fourth and fifth level courses.

Senior clinical course grades obtained in a BSN program were also used as predictors in a recent study by Horns, O’Sullivan & Goodman (1991). The major focus was on timing of indicators of NCLEX success. This study examined the contribution of variables, selected from student performance during pre-admission, and years 2, 3, and 4 of a baccalaureate program, as predictors of success. The study used a sample of 408 BSN students attending school in Alabama. The subjects were divided into two groups, where 208 were used in the screening study and 186 used for cross validation. Fifteen percent of the population were minority, and the group had an 88% pass rate on the 1985 NCLEX-RN. The pre-admission variables included; age, sex, race, and admission GPA. Predictor variables for years two and three included numerical grades for the first five clinical
courses. Year four variables included senior level clinical course grades, percentile rank on NLN Comprehensive exam, and GPA at graduation. The results of the regression analysis by Horns et al showed that years one and two. Race and admission GPA accounted for 33% of the variance, and the second beginning level course (NUR 246) accounted for an additional 10% of the change. Senior level variables accounted for only 9% of the variance in NCLEX scores.

Horns et al used a forward regression analyses procedure and entered the variables in a hierarchial manner coinciding with the students progression from level one to final year. This study also used a cross-validation process to determine the correlation between the predicted pass/fail scores on NCLEX and the actual pass/fail scores. These authors computed a final regression analysis, this time using only the variables that were significant contributors at the time they were initially entered into the analysis (Admission GPA, Race, NUR 246, Adult Health, NUR 457, NLN). This grouping accounted for 67% of the variation in NCLEX scores, and race represented 26% of the variation. In interpreting the results of their study, Horn et al warned that, a conclusion that Caucasian students are more likely to succeed on NCLEX-RN, is misleading. The authors saw the race variable as a "proxy" variable that incorporated other skills including reading ability.
This study gives us some insight into two methodological concerns related to predictive studies. One, it provides a concrete example of how to address the issue of "shrinkage" and the use of cross-validation to estimate the degree of shrinkage. The issue of shrinkage as used here refers to the phenomenon that occurs when the beta weights derived from one sample are applied to the predicted scores of another sample. The result is a "shrinkage" in $R$ obtained in this situation, as compared to the $R$ obtained in the experimental group (Pedhazur, 1982). The use of the cross-validation procedures allow the researcher to estimate the degree of shrinkage. In this study the results of the cross-validation indicated that $R^2$ for the second group was .54, which represented a shrinkage of 13%.

A second methodological concern that is revealed in the Horn et al (1991) study is the issue of interpreting the effects of predictive research. According the Pedhazur (1982), the results of regression analysis conducted in non-experimental conditions, do not necessarily reflect a cause-effect relationship between variables. The generally accepted interpretation of non-experimental (ex-post-facto) prediction studies, like the Horn et al study, is that a significant relationship between predictor and criterion variable, reflects an "average relationship" (Pedhazur, 1982). When this interpretation of the effects of prediction is applied to the results of the Horn et al study, we conclude that race and NCLEX success have an
"average" or shared, rather than a cause/effect relationship and therefore any interpretation beyond this point must be empirically tested.

The predictor variables for a study by McKinney, Small, O'Dell and Coonrod (1988) were determined after their literature review revealed three categories of variables that predicted success on the nursing licensure exam. The three groups corresponded to; (1) pre-admission predictors, (2) variables associated with matriculation in the nursing program, and (3) non-cognitive variables. A total of twelve predictor variables were used including: Group (1) SAT total score, SAT verbal, SAT math, prenursing GPA; Group (2) cumulative GPA, nursing theory course GPA, nursing clinical course GPA, number of repeat support courses, cumulative nursing GPA, cumulative college GPA, Mosby Assess Test; Group (3) age, and Type A personality.

The purpose of the study was to identify "at risk" students, whose academic patterns suggest potential difficulty with the nursing program and the NCLEX-RN exam. A convenience sample of 136 BSN students who graduated from a Virginia liberal arts college, in 1983 to 1985, was used. McKinney et al (1988) cited continued failure of nursing graduates on the NCLEX as justification for the study.

McKinney et al used a simple regression procedure to determine model fit, or, if each of the 12 predictor variables was linearly related to NCLEX. After the model fit was determined to be positive, the multiple
correlation procedure was used to answer the three research questions. All predictors, except the repeat courses variable, was found to be positively correlated with NCLEX success. The multiple regression procedure was then used to determine the best predictors of NCLEX scores and to develop a prediction equation. The best predictors were; college GPA, SAT verbal, Mosby Assess Test, and nursing theory course GPA (p > .001).

These authors concluded that two separate predictive equations, generated by their study, could be used to assist students at risk for failure. One formula, using the Beta weights for college GPA, and SAT verbal and SAT total, could be used to identify "at risk" students as early as the end of the freshman year. The second equation would be used to identify students at risk for NCLEX failure. The Beta coefficients that would be used in this equation are associated with the following variables; nursing theory GPA, nursing GPA, and college GPA.

This study exemplifies how the review of empirical research can be used to select and group predictor variables. Information, that was not provided by these researchers, on the relative importance of the variables would provide additional insight on variable selection for future studies. The information that would have been useful includes Beta (b’s and $\hat{b}$’s), and how the variables were entered into the regression analysis. These statistics could assist to select the smallest number of variables that; (1) is
necessary to account for as much of the variance as possible, and (2) maximizes $R^2$, at the least cost.

A 1981 study by Malcolm, Venn, & Bausell used a stepwise selection, multiple regression procedure, and found that eight NLN Achievement Test accounted for 82% of the predicted variation on the NCLEX exam. The purpose of the study was to determine the reliability of previous predictive studies across different curriculum orientations (defined as different schools). This study used 539 BSN graduates (1976 and 1977) of the University of Maryland. The criterion variable, therefore was the pre-1982 (norm referenced) version of the licensure exam. This version of the exam reported five sub-scores, that were used to divide the study into five different regression analyses.

Three sets of predictor variables were used; (1) NLN Achievement Test, (2) grade point average, and (3) individual grades from selected nursing courses. A total of 18 predictor variables were used including 8 NLN test scores, 2 GPA variables, and 8 nursing course variables. The correlation coefficients showed that 77 of the 80 variable combinations were significant at .05 level. The five multiple regressions, corresponding to the five sub-scores of the licensure exam, ranged from .71 to .75. The conclusions were that the NLN Tests were significant predictors of exam success and therefore stable across curricula.
These researchers' choice of the regression model, including the variable selection procedure, for this study, enhanced the interpretation of the results. For example, these authors first clustered the 18 variables into three categories or sets that described the theoretical contribution of the variables (NLN tests, GPAs, and nursing courses). This allows the researcher to interpret the effects of the data manipulation in broader terms. Even when one of several variables, with in a category, is eliminated from the equation because of a lack of contribution, conclusions can still be drawn based on the contribution of the category. Also, theoretical clustering avoids having to draw theoretical conclusions from each significant variable, and in this study 40 conclusions (8 test variables times 5 sub-scores) could possibly exist.

The stepwise procedure, Melcolm et al chose for variable selection, combines the backward and forward elimination selection methods. This selection method eliminates variables that do not meet both a predetermined $E$ ratio to enter ($PIN$) and an $E$ to be removed ($FOUT$) from the equation. The probability of the $E$ to enter ($PIN$) for this study was set at .01, when the SPSS default $PIN$ is set at .05. The authors justified this $PIN$ level because of the fear of pooled error associated with five separate analyses.

The Payne and Duffey (1986) study, also used stepwise regression to answer their research questions. Additionally, the methodology for this
study included clustering of predictor variables, and cross-validation procedures. Two other issues related to prediction studies are addressed by the Payne and Duffey study. First, these authors provide an example of how to deal with missing data. Second, procedures to evaluate decision rules are included in the final phases of this study. A list of all procedures in order of occurrence includes; (1) Validity and reliability of measures, (2) missing data analysis, (3) descriptive statistics, (4) multiple correlations, (5) stepwise regression, (6) cross-validation, (7) prediction decision accuracy.

According to the author's conclusions, the major purpose of this study was to present and describe procedures for predicting nursing student success on the licensure exam. The sample consisted of 144, 1983 graduates, and 139, 1984 graduates of the University of North Carolina School of Nursing. Independent variables were clustered according to the timing of predictors made during a student's baccalaureate program. This grouping consisted of five categories; entrance to school, mid-junior year, end-junior year, mid-senior year, and graduation. Nine predictor variables were grouped under these categories. The study found that the best prediction points were mid-junior, end-junior, and mid-senior years. The nursing GPAs were also strong predictors of success and entrance GPA and SAT scores were found to be fair to poor predictors.
In this study by Payne & Duffey (1986), a decision was made to include subjects who had missing SAT scores. The authors found that no SAT scores were available on 12.5% and 11.5% of the 1983 and 1984 graduates respectively. With a total sample of 283, the decision to eliminate subjects with missing data would have resulted in a change in the ratio of subjects to variables (for effect of variables on graduation) to approximately 20 to one. These authors chose to include the subjects, and substitute the mean SAT for the missing data. A test of the effect (inclusion or exclusion) of the missing data revealed a minimal change in the prediction coefficients.

Noursis/SPSS (1990) suggest that in cases of missing data, a summary review of the data to determine if there is a relationship between other characteristics of these subjects and the missing data, should be undertaken. Another strategy proposed by this author was to divide the group into two subsets (those with missing data and those without), and examine the differences between the two groups on other variables using the $t$-Test. A detection of non randomness would indicate that the researcher must proceed with caution.

Two cross-validation procedures were used by Payne & Duffey. The first was the "shrinkage" test, described earlier in the Horn et al study review. Payne & Duffey used the 1984 graduates as the screening sample and the 1983 group as the calibration sample. The second, test used by
these authors, for cross-validation, compared the predicted scores of the 1984 group (determined by using the 1983 regression coefficients) with the actual licensure exam scores. This process revealed a decision accuracy of 75%.

Poorman and Martin (1991) evaluated the effects of nonacademic variables on graduates’ scores on the 1988 version of the NCLEX-RN (the new version). The results of this version of the NCLEX were reported as numerical scores with a mean of 2000 and a pass score of 1600. This study used 102 senior level BSN students attending school in Pennsylvania. A stepwise multiple regression model revealed that two nonacademic variables were significant predictors of the 1988 NCLEX-RN, self-perceived student-grades, and self-predicted NCLEX scores. Nonacademic variables that were not significant predictors of this 1988 version of NCLEX were; anxiety, academic aptitude, biggest worry, concentration, worry, visual appraisal, physical symptoms, and test anxiety. The following prediction equation was developed from the results of this study:

\[
108.64 \text{ (student-reported self-perceived grades)} + 0.21 \text{ (predicted NCLEX score)} + 1195.79 = \text{NCLEX Score}
\]

\( (F = 14.94, \text{ with } p < .0001) \).

Woodham and Taube’s (1986) correlational study investigated the relationship between admission criteria, nursing course grades and NCLEX-
RN performance for 104 graduates. They also used multivariate regression to develop a prediction equation for NCLEX scores. While age at graduation, high school class rank and SAT math scores were not significant indicators of academic success, the predicted scores for NCLEX correlated strongly with the actual scores on NCLEX.

Pearsons' product moment correlation and stepwise multiple regression were used to examine the relationship between predictor and criterion variables in a study by Yang, Glick and McCelland (1987). The purpose was to determine the relationship between admission selection variables (high school rank, Act sub-test and composite scores, and cumulative GPAs for chemistry, biological sciences, social sciences and prenursing courses) and success on NCLEX. A sample of students ($n = 210$) attending a mid-western university were used in the study. The investigators concluded that ACT social science sub-score ($r = .48$) was the best predictor of success on NCLEX. High school rank, ACT composite, Chemistry GPA, and prenursing GPA were also predictors of success.

**Studies Using Discriminant Analysis for Prediction**

The discriminant analysis (DA) procedure is preferred over multiple regression and partial correlation, when the criterion variable is discrete categorical (as with the "new" NCLEX), rather than continuously scored (Crocker & Algina, 1986; Huberty, 1975, 1984; Klecka, 1980; Norusis/SPSS, 1990; Pedhazar, 1982). This procedure uses a linear
combination of variables, called the discriminant function, to classify subjects into groups. Studies are presented that utilized the discriminant analysis procedure to separate predictor variables according to the criterion variable, NCLEX, and to classify subjects. These studies provided insight into methodological issues related to prediction, and identified independent variables that were found to predict NCLEX success.

Of the seven studies presented in this review, that used DA to develop the prediction equation: (1) all used the older versions (1970-1987) of NCLEX as the criterion; (2) six of the seven used BSN students as the population; (3) four used samples from the southern region but none from Louisiana or Mississippi; (4) one used minority students and the 1970-74 SBTPE, normed referenced examination (Dell & Halpin, 1984); and (5) only one examined students across curricula to multiple schools (Felts studied five associate degree programs using the 1982-84 NCLEX). The Dell & Halpin (1984) study is presented in the section of this review on minority student success, along with a recent investigation report that used a minority population from Louisiana and regression analysis.

Since the "new" NCLEX (post 1988) is a criterion referenced exam, based on pass/fail scoring and a new test plan and passing standard, the results of these DA studies are limited in their generalizability to current students. These studies did provide insight into DA methodologies, but
research that focuses on minorities, and BSN students from multiple programs, writing the "new" NCLEX was still lacking.

The purpose of a DA study by Quick, Kupra, & Whitley (1985) was to predict performance on the NCLEX-RN using data collected at the admission stage of students matriculation through BSN education. This retrospective study used 138 (non-transfer) graduates of 1982, 1983, and 1984. This sample was divided into two groups; the pass group ($n = 121$), and the fail group ($n = 17$). Discriminant analysis was used to; (1) determine if 10 predictor variables could be used to interpret differences between the pass and fail groups, and (2) provide an equation to classify future students as pass or fail. The predictor variables used were; SAT verbal and math scores, freshman GPA, and GPAs in general chemistry, biochemistry, anatomy and physiology, and college algebra. A review of the mean scores for each group, on each predictor variable, revealed that the pass group was higher on all variables except for chemistry and biochemistry.

The second step, undertaken by these authors to determine group differences, was the examination of the Wilks' lambda statistic. The results indicated that Wilks’s lambda (a measure of residual discrimination) was significant ($\lambda > .0001$) using chi-square as the test of significance ($\lambda = 0.753, \chi^2 = 37.23$). According to Klecka, (1980), the Wilks’s lambda is an
intermediate statistic, used to determine the discrimination power of the predictor variables. The lambda has a maximum value of 1.0, which indicates no group differences (or group centroids are equal). When lambda values are closer to 0.0, the group centroids are different in relation to the amount of dispersion within the groups. The chi-square statistic test the significance of the difference in dispersion between groups. The Wilks’s lambda statistic for the Quick et al study indicates that a chi-square (.0001) this large would occur only one time in ten thousand samples, if the centroids were actually equal. This finding, that the predictor variables significantly discriminated between the two groups, allowed the researchers to move to the next step in answering their question.

In the third step, these authors analyzed the canonical correlation. This statistic is also used to evaluate the usefulness of the discriminant function. Low canonical correlations indicate that the two groups are not very different on the predictor variables. The canonical correlation is always positive, and ranges from 0.0 to 1.0, with a 0.0 indicating no association between groups (Klecka, 1980). The canonical correlation coefficient for the study by Quick et al was 0.497. These authors concluded from this statistic that the discriminant function was useful in discriminating between the pass and fail groups.

Quick et al (1985) displayed both the standardized and unstandardized discriminant coefficients, (also referred to as canonical
discriminant function coefficients) in their study. Their evaluation of these statistics revealed that the greatest contribution to predicting success on NCLEX was the GPA at the end of the freshman year (std. coefficient = .6752). Standardized coefficients for the remaining variables were: chemistry lab. = -.5919; SAT verbal = .5910; chemistry lec. = -0.4595; biochemistry lec. = -0.2695; anatomy and physiology lec. = 0.2540.

The authors expressed some surprise at finding the negative contribution of chemistry and biochemistry to predicting success on the NCLEX. They attributed this finding to the fact that the chemistry content may not be reflected on the NCLEX-RN exam. Other possible contributing factors to this finding, cited by the authors were; (1) multicollinearity, (2) small sample size, and (3) disparity in the size of the two groups (pass = 121, fail = 17).

Drawing conclusions about individual, variable contribution to group differences in discriminant analysis was discussed by Huberty (1975). He concluded that no proposals have been developed to measure the "importance" of a single variable. Huberty felt that variables in discriminant analysis act as a group, and their individual effect cannot be separated. The standardized coefficient was offered, by Huberty, as the statistic that measures the "relative contribution" of an individual variable, in concert with all other variables. Substantive interpretation of an individual variable, according to Huberty, is a waste of time and effort.
If Huberty’s explanations are accepted, we could conclude that Quick et al need not try to substantively interpret the contribution of the chemistry courses to NCLEX performance. Rather, their interpretation of the standardized coefficients would suffice.

The last step in the analysis by Quick et al, was the determination of the efficiency of classification. The results of their classification procedures indicated that 83.3 percent of the students in the pass group were correctly classified, and 16.7 percent were incorrectly classified. The classification rates for the group who actually failed were 84.2 percent correct and 15.8 percent incorrect. The authors did not describe the rules used to classify subjects. Three probability statistics that can be used to evaluate the efficiency of classification are; (1) prior probability, (2) conditional probability, and (3) posterior probability (Huberty, 1975; Klecka, 1980; Norusis/SPSS, 1990). The prior probability estimate used by SPSS, (1990), for example, can take into account the disproportion in group size, between the pass and fail groups used in this study. Klecka (1980) offers a formula for calculating the magnitude of the percentage correctly classified for known cases (pp 51). Using this formula the Quick et al study’s correct classification rate of 83.43% made 16% fewer errors than would be expected by random assignment.

Another study that used the discriminant analysis procedure to predict success on NCLEX was conducted by Felts (1986). This study used
five midwestern, associate degree nursing programs, and focused on the relationship between cognitive variables and success on NCLEX scores from 1982-1984. With a sample consisting of 297 graduates, these researchers found that; (1) ACT composite, support courses GPA and microbiology were the best predictors of success in nursing courses, (2) performance in college courses was a better predictor of success on NCLEX than performance in high school, (3) grades in prenursing cognates differentiated between students who passed and those who failed NCLEX, (4) nursing course grades were not predictive of success on NCLEX, and (5) age and experience as a Licensed Practical nurse were not predictors of success.

Three different discriminant analyses were used in this study to answer three questions. The first of these, evaluated the ability of admission criteria (high school GPA, ACT english, ACT math, ACT social science, ACT natural science, ACT composite) to predict NCLEX success from a sample of 99 students (pass \(n=84\), fail \(n=15\)) writing the exam in 1982 and 1984. Only two of these predictor variables made a significant contribution to the discrimination between groups, high school GPA and ACT social science. The canonical correlation coefficient was .403, and the authors interpreted this as an indication that the discriminant function can be explained by group membership. The correct classification for this study was 69.7%.
The second part of the study conducted by Felts (1986), used 121 subjects to evaluate eight college course grades including: anatomy and physiology, chemistry, microbiology, general psychology, English I, English II, sociology, and child psychology. All mean values were higher for the pass group (pass $n = 102$, fail $n = 19$). Five variables were found to contribute to the discrimination between the two groups (microbiology, anatomy/physiology, sociology, child psychology and english). The authors noted that the first analysis done on college course grades produced no variables that met the criteria for inclusion in the equation. The original list contained three variables that were not available for two of the five schools used in the study. These three variables were eliminated and a second analysis was done. The canonical correlation was .541, and the equation generated, classified subjects correctly 73.26% of the time.

The primary purpose of Krupa, Quick and Whitley's (1988) study (the second study presented in this review, by these authors, see Quick et al) was to investigate the effectiveness of nursing course grades as predictors of success on the NCLEX-RN exam. A second purpose of the study was to test a method for predicting the performance of students as they entered the nursing program later in their nursing careers. The previous (1985) study, by these authors focused on admissions criteria as a predictor of NCLEX-RN.
The 1988 study by Kupra et al, consisted of 384 baccalaureate nursing students attending a school in North Carolina. They found that grades in nursing courses can be used to predict NCLEX-RN success. The authors concluded that grades in introductory nursing courses, taken during the sophomore year, and a medical-surgical course, taken during the junior year, were substantially related to success on the NCLEX-RN exam. Krupa, Quick and Whitley also found that practicum courses were relatively poor predictors of NCLEX performance.

The methodology for this 1988 study also used discriminant analysis to select a linear combination of variables that could be used to predict success on NCLEX. This study provides several useful examples of statistical procedures that enhance the interpretation of results obtained from discriminant analysis. These examples include (1) procedures to test assumptions of discriminant analysis, and (2) variable selection in discrimination.

Kupra et al (1988) used the Box’s $M$ statistic to examine the tenability of the homogeneity of variance assumption. According to Klecka, (1980) the homogeneity assumption is one of several assumptions related to DA. These assumptions, as described by Klecka, are: (1) discriminating variables must be at the interval or ratio level of measurement, to allow for calculation of means and variances, (2) The total number of subjects used, must exceed the number of variables by at least two, (3) no independent
variable should be a linear combination of other discriminating variables, (4) for each group, the population covariance matrices are equal, (5) each group represents a sample drawn from a population that has a multivariate normal distribution.

The violation of two important assumptions (multivariate normality, and equal covariance matrices) in DA could result in decreased efficiency and accuracy, and increases in misclassifications (Klecka, 1980). Norusis/Spss (1990) recommends the examination of the distributions of each variable individually, to test the normality assumption. The Box's $M$ statistic, used by Kupra et al, evaluates the equality of covariances, and is also sensitive to violations of the multivariate normality assumption (Norusis/SPSS, 1990). The failure to reject the null hypotheses, that the covariances are equal, using the Box's $M$ test, would indicate that the assumption of equal covariances is not violated. The probability of significance of the $M$ is based on an $F$. For the Kupra et al study, the $F$ had a probability of .146. These authors concluded that the equal covariance assumption was met, and according to Norusis/SPSS, this $F$ would also indicate that the normality assumption was met.

Variable selection for the Kupra et al study, also provides insight into methodological concerns related to prediction research. The selection procedure used by these authors was the forced entry method. This method allows all variables to be simultaneously entered into the
discriminant analysis. The only criteria for inclusion of a variable, in the forced entry method, is that the variable satisfy the tolerance criteria. Kupra et al entered all 15 of their independent variables simultaneously, and rank ordered the variables, using the within group structure coefficients. The result was a correct classification rate of 74.9 %. The cross-validation procedure, where the unstandardized discriminant function coefficients of the 1982 through 1985 graduates, were used to classify the 213 graduates of 1986 through 1987 on the NCLEX, generated a correct classification rate of 63.6 % with a shrinkage of 11.3 %.

According to Norusis/SPSS (1990), the inclusion of all independent variables in an equation could increase the standard error of estimate, and is usually not a good idea. The alternatives to the forced entry procedure for selecting variables to include in the prediction equation include; (1) forward selection, (2) backward selection, and (3) stepwise selection. The stepwise procedure incorporates both the forward and backward procedures, and examines each variable’s contribution to group separation, in conjunction with the contribution of all other variables. Variable selection in the stepwise procedure is the most commonly used procedure and is based on several criteria including; (1) $F$ to enter, (2) $F$ to remove, and (3) tolerance (collinearity). The stepwise procedure could have advantages over the forced entry selection procedure used by Kupra et al. Mainly, the stepwise procedure would have eliminated variables that did
not contribute to the separation. It is even possible that the use of the stepwise procedure, would have increased or decreased the contribution made by some variables and/or improved the classification rate.

Variable selection for a study by Ellison, Scherubel and Yocom (1985) included the grouping of independent variables into categories corresponding to cognitive and non-cognitive admission data. This study did not use NCLEX as the criterion variable. The study found that the Applicant Evaluation Process used in an Illinois, Baccalaureate (BSN) nursing program was not a significant predictor of success in nursing theory and practice courses. The Applicant Evaluation Form (AEF) was found to be predictive of overall success during the sophomore year of study ($F = 7.11; p = 0.013; df = 1,133$).

Discriminant function analysis was used to identify AEF items that discriminated between students encountering academic problems and students who did not have problems. The predictor variables consisted of the two sub-scores and the total scores obtained from the applicant review process. The sub-scores for the 135 subjects in this study represented; (1) a cognitive component representing 70 percent of the total admission score, and (2) a non-cognitive component representing 30 percent of the score. The cognitive score was based on cumulative grade point average (GPA), science GPA, credit hours earned, and requisite course grades. The non cognitive score was based on communication skills, extracurricular
activities, recommendations, residency, ethnicity, gender, and prior experience in health care. These authors concluded that the AEF provided an applicant review process that allows for review of large numbers of students and is predictive of success in nursing.

Sharp (1984) used a combination of stepwise discriminant analysis and stepwise multiple regression to answer questions related to success of nursing students on the SBTPE exams (1974-1979). These licensure exams reported results for each subject as five, interval level sub-scores. For the discriminant analysis study the criterion variable was pass or fail on the SBTPE, and independent variables were; high school GPA, prior to graduation GPA, ACT English, ACT math, ACT social science, ACT natural science. The multiple regression study used the five sub-scores, of the licensure exam, to represent the dependent variables in five different studies, each using the same seven independent variables (high school GPA, GPA prior to graduation, ACT English, ACT social science, ACT natural science, ACT math, ACT composite).

The four, variable selection steps, in the discriminant analysis study, by Sharp, showed that F values increased from 10.43 (with all six variables) to 20.10 ($p < .0001$) with three variables (GPA prior to graduation, ACT math, ACT natural science). The five multiple regression studies selected four variables (GPA, ACT English, ACT social science, ACT natural science) that predicted success on each of the five sub-test. As a
result Sharp recommended that the study be replicated and include additional variables.

Jenks, Selekman, Bross and Paquet (1989) also studied cognitive variables and their relationship to pre 1988 NCLEX success. Additionally, these researchers examined the timing of interventions. Pearson correlation, regression and discriminant analysis were used in the study. The findings were; (1) Mosby Assess Test was most predictive of success on NCLEX, (2) theory courses in nursing were also predictive of NCLEX success, (3) prenursing data (cumulative, prenursing and science GPAs, sex, and type of university attended (2 or 4 year) for prenursing) was not predictive of success on NCLEX, and (4) end of senior year was the optimal time to identify students at risk for NCLEX failure.

Jenks et al (1989) recommended that because the Mosby Assess Test is a standardized instrument, it should be used to predict success of students on NCLEX. These investigators also recommended that further research is needed to determine the most effective interventions for improving the performance of high-risk students. This study used 407 graduates of a Pennsylvania BSN nursing program.

Jenks et al warned that the results of their study were not generalizable beyond the curriculum used in the study. This raises the issue of generalizability in discriminant analysis. According to Huberty (1975), generalization in discriminant analysis has two dimensions. The first
dimension relates to inferences made from a sample to a population, and the second relates to the stability of the results. This author recommends a cross-validation process to determine the stability of the results, using a random sample of one-third of the sample used, that was withheld from the study.

Cross-validation measures the misclassification rate associated with the discriminant function. Norusis/SPSS (1990) also felt that the misclassification rate was an indication of the effectiveness of the discriminant function. The evaluation of the discrimination functions could then provide insight into the stability of discriminant results and the generalizability of the study findings. SPSS (1990) produces two statistics that might be used to evaluate the quality of the discriminant function. These two statistics are based on an ANOVA using the discriminant scores as the dependent variables and the group as the independent variable. Conclusions about the stability and generalizability of the discriminant study can be interpreted from the results of this ANOVA, along with examination of; (1) eigenvalues (large eigenvalues are associated with a good function), and (2) the canonical correlation (measure of the degree of association between discriminant scores and the groups) (Norusis/SPSS, 1990).
Variable Selection and Nursing Education Success

Several additional studies are included in this review because of their contribution to variable selection. One study used factor analysis to reduce the number of variables to a smaller and more manageable set (Haney et al, 1976). Variables used included traditional cognitive measures and critical thinking, and type of curriculum. One study is presented to provide an example of studies that attempt to control for effect of treatment, in prediction research.

A non-randomized, post-test only, control group-treatment group design was used by Ashley and O’Neil (1991) to study NCLEX success for high-risk students. The fourteen students who received the treatment had a 92.9 percent pass rate on NCLEX-RN, and the control group (n = 16) had a 50 percent pass rate. The intervention was 20 hours of test-coaching, conducted over five months, during the final semester of the subject’s senior year. High-risk was defined as; nursing GPA < 2.4, rank on Mosby Assessstest < 20th percentile, and a diagnosed learning disability. The Fisher’s Exact Test was substituted for Pearson’s chi square (because of small marginal totals) to test the association between membership in the treatment group and NCLEX-RN success. The findings were that there was a significant relationship between membership in the "at-risk" treatment group and success on NCLEX (p < .01).
Ashley & O’Neil concluded that test-coaching can assist "at-risk" students to succeed on the NCLEX-RN. These authors recommended that future research efforts should concentrate on understanding factors that promote success on NCLEX. The study also recommended that nurse educators take a proactive role in assuring the success of their graduates on NCLEX.

Allen, Higgs & Holloway (1988) found that pre-admission cumulative (GPA) and pre-requisite GPA were predictors of four student outcome variables: cumulative nursing GPA, completion of the program, receipt of a D in a nursing course, and receipt of an F in a nursing course. These authors studied 296 generic baccalaureate nursing students attending a school located in Spokane, Washington. Their purpose was to identify factors that might discriminate between those students who could succeed in nursing and those who could not succeed. Forty potential predictive variables were studied including demographic, personal and sociological variables. Factors that were unrelated to success included age, marital status and previous experience as a nurse’s aide or as a licensed practical nurse.

Allen et al, (1988) made several recommendations from their study. They suggested that schools should determine those factors which contribute to success in their individual programs. A second recommendation was that programs identify and utilize predictor variables
to effectively promote student retention. These authors also recommended that considering the current nursing shortage, retention of students benefits the community.

Kroll (1990) used a sample of registered nurse students to study the relationship between nursing GPA and success in nursing. A second purpose was to examine background variables common to students who do not complete their program. This study was a replication of Allen et al (1988). Eighty-one registered nurse students enrolled in an integrated program located in the northwest were the subjects. This researcher found that GPA on previous college course work was most predictive of success in the program. A second finding was that Challenge exam results were the only variables predictive of program completion. Kroll recommended that future studies evaluate the relationship between credit by examination and nursing GPA.

The purpose of a study by Bauwens and Gerhard (1987) was to determine the relationship between critical thinking as measured by the Watson-Glaser Critical Thinking Appraisal Test, and success in nursing education as measured by NCLEX. The researchers found that scores for 145 BSN students on Watson-Glaser were not valid indicators of success in nursing. The critical thinking scores along with GPAs accounted for only 15 percent of the variance in NCLEX scores (p < .001).
The purpose of a study by Pardue (1979) was to determine the difference between blocked and integrated nursing curricula on critical thinking ability and state board pass rate. The random sample of schools representing 4 integrated and 4 blocked curricula was taken from a volunteer sample of 74 integrated programs and 10 blocked programs. The findings from this study were; (1) there was no significant difference between program types in critical thinking ability, and (2) blocked curricula students scored significantly higher on state board exams.

Kaufman (1987) evaluated the effectiveness of a decision-making process in preparing students for the NCLEX exam. The subjects for this study were 185 students enrolled in a test taking study course. Student surveys were used to collect the data immediately after the course and three months after the course. The findings indicated that the process facilitated identification of strengths and weaknesses and facilitated confidence building.

Whitley and Chadwick (1986) studied the causes of success on the NCLEX. The subjects for this study consisted of 176 students who attended a private Northwestern liberal arts college in which the school of nursing was 50 years old. Correlations for this study were computed using 23 predictor variables. The results indicated that several predictor variables had a high correlation with success on the NCLEX: SAT verbal and math scores, entry science GPAs, nursing major test scores, exit GPAs and
number of academic warnings. The authors recommended that the school under study should focus more on admission requirements of students.

Factorial analysis was used by Haney et al (1976) as a means to reduce the number of variables used in their study of nursing student success. This procedure reduced 28 predictor variables, for a sample of Black students, to four distinct factors, including: (1) course achievement; (2) NLN exam achievement; (3) reading comprehension, vocabulary, and study skills proficiency; and (4) mathematical or quantitative thinking. These factors were different for white students, using the same 28 variables. For white students the first two factors defined for Black students were identified as one dimension. The Haney et al study is presented in more detail in the next section of this review.

According to Kachigan (1986), the factor analysis procedure is useful in reducing the redundancy in a set of correlated variables. The procedure also serves to systematically summarize large numbers of variables and render them more manageable. Factor scores, which represent a combination of variables, are used as predictor variables rather than the actual variable scores.

Populations Studied and Minority Student Success

A major issue in the stability and/or generalizability of the results of a study relates to the sample size and population characteristics. A summary of the populations used in empirical studies reviewed in this section is
presented in Table 2.2. The summary indicates that the majority of studies examined samples representing single schools. The average study presented in Table 2.2 had a sample size between 100 and 300 subjects.

Three empirical studies focused on minority students (Adams, 1990; Dell & Halpin, 1984; Haney et al, 1976, 1977), and are presented in this section to illustrate several points related to sampling. These three studies used samples from Louisiana, Alabama and California respectively. Regression analysis was used to evaluate variables in two of these studies and Dell & Halpin used discriminant analysis. The pre-1982 SBTPE licensure exams were used in two of these studies, and the Adams study used the 1982 to 1989 results.

An analysis of the literature revealed several evaluation studies (non-empirical) that addressed academic success related to minority student populations. These studies presented recommendations to address success of minority nursing students. These evaluation results provide insight into the need for research in this area.
TABLE 2.2

SUMMARY OF POPULATIONS STUDIED IN NCLEX SUCCESS RESEARCH:
PROGRAM TYPE AND GEOGRAPHICAL REGION

<table>
<thead>
<tr>
<th>RESEARCHER</th>
<th>REGION</th>
<th>PROGRAM TYPE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
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<td>Adams, B.</td>
<td>Louisiana</td>
<td>Baccalaureate</td>
<td>1 program, 180</td>
</tr>
<tr>
<td>1990</td>
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<tr>
<td>Ashley et al</td>
<td>Mass</td>
<td>Baccalaureate</td>
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</tr>
<tr>
<td>1991</td>
<td></td>
<td></td>
<td>students</td>
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<tr>
<td>Breyer F.</td>
<td>National</td>
<td>Associate Degree Diploma</td>
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<td>1984</td>
<td></td>
<td></td>
<td>black students</td>
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<td>Felts, J.</td>
<td>Mid-west</td>
<td>Associate Degree</td>
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<td>Jenks et al 1989</td>
<td>Pennsylvania</td>
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<td>Krupa et al 1988</td>
<td>Nth Carolina</td>
<td>Baccalaureate</td>
<td>1 program, 384 students</td>
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<td>McKinney et al 1988</td>
<td>Wst Virginia</td>
<td>Baccalaureate</td>
<td>1 program, 136 students</td>
</tr>
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<td>Melcolm et al 1981</td>
<td>Maryland</td>
<td>Baccalaureate</td>
<td>1 program, 539 students</td>
</tr>
<tr>
<td>Quick et al 1985</td>
<td>Nth Carolina</td>
<td>Baccalaureate</td>
<td>1 program, 182 students</td>
</tr>
<tr>
<td>Payne &amp; Duffey 1986</td>
<td>Nth Carolina</td>
<td>Baccalaureate</td>
<td>1 program, 283 students</td>
</tr>
<tr>
<td>Poorman et al 1991</td>
<td>Pennsylvania</td>
<td>Baccalaureate</td>
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</tr>
</tbody>
</table>

*table continues*
### RESEARCHER REGION PROGRAM TYPE NUMBER OF PROGRAMS

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<th>PROGRAM TYPE</th>
<th>NUMBER OF PROGRAMS</th>
</tr>
</thead>
<tbody>
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<td>1 program, 322 students</td>
</tr>
<tr>
<td>Whitley et al 1986</td>
<td>North West</td>
<td>Baccalaureate</td>
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<tr>
<td>Whoodham et al 1986</td>
<td>Indiana</td>
<td>Baccalaureate</td>
<td>1 program, 107 students</td>
</tr>
<tr>
<td>Yang et al 1987</td>
<td>Mid-west</td>
<td>Baccalaureate</td>
<td>1 program, 210 students</td>
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</table>

**Empirical Studies on Minority Success**

One purpose of the study by Dell and Halpin (1984) was to determine if cognitive variables (SAT verbal, SAT quantitative, high school GPA, NLN pre-nursing exam) significantly differentiated between students who graduated and students who did not. These researchers used 180 Black students enrolled in a BSN program who wrote the exam between 1970 and 1974. The findings were that the four variables plus cumulative
GPA significantly differentiated between those students who passed the state board exam and those who did not ($p < .001$).

A second purpose of the Dell & Halpin study was to determine if the predictors of success of black students were different from predictors for white students, as reported in the literature. These researchers concluded that the predictors for black students were also predictors for other ethnic groups. Dell and Halpin recommended that further studies involving other black students be conducted to establish more definitive conclusions. The authors fell short of generalizing their findings to black students in general.

The sample in this study was restricted to black students in one Historically Black Institution (HBCU). According to the second purpose of this study, the authors' intent was to generalize to all predominately black colleges. This interpretation of the results, does provide some insight into sampling and generalizability. The sample in this study might be described in several ways; (1) a convenience sample, (2) a purposive sample, (3) a non-randomized sample, and (4) an intact group sample. The target population appeared to be black students enrolled in predominately black colleges.

The key issue, related to the sample used in this study, and practically all other studies presented in this review, is that they are non-probability samples. This property indicates that the principle of randomization (distinguishing characteristics of the target population are
equally represented in the sample) can not be automatically applied to the sample. Kerlinger (1973) warns that these non-probability samples are sometimes necessary and many times they cannot be avoided. This author recommends that the weaknesses in these samples can be overcome by circumspection in analysis and interpretation of the research findings.

Additionally, one of the assumptions related to discriminant analysis, is that each group is drawn from a multivariate normal population. Klecka (1980) recommends that the multivariate normal distribution assumption be tested and if the assumption is violated, appropriate procedures be undertaken to avoid a unnecessary decreases in efficiency and accuracy.

Haney, Martois, & Micheal (1976, 1977) published two studies that focused on ethnicity and nursing student success. The first study (1976), examined the relationship of 15 predictor variables (high school GPAs, age, and 10 scores from basic skills achievement tests) on 13 criterion variables (NLN achievement test scores; college, and nursing course grades). The subjects were three samples, each representing a different ethnic group (Caucasians, Black-Americans, and Mexican-Americans). The researchers found that reading vocabulary was the best predictor for all three ethnic groups.

Multiple regression analysis was used, in the Haney et al (1976) study, to determine the four best predictors of nursing student success. A principal components factor analysis using varimax rotation was also used.
to evaluate data on each ethnic group. The authors found that Caucasian’s \((n = 223)\) mean scores on all variables were higher than for the Black-Americans \((n = 67)\), or Mexican-Americans \((n = 73)\). The results indicated that the four best predictors of total nursing GPA was different for each ethnic group. The best predictors for Black-Americans were; the California Achievement Tests Reading Vocabulary and Math Computation, BBS study skills information test, and pharmacology math test. For Caucasians the four best predictors included; California Achievement Tests, Reading Vocabulary, BBS study skills information test, high school GPA, and number of units in college.

Haney et al concluded that most of the variables were significant predictors of success for Caucasians, but relatively few were significant for Mexican-Americans, and especially for Black-Americans. A second conclusion was that reading vocabulary as measured by the California Achievement Test was the best predictor for all three ethnic groups.

The 1977 study by Haney et al was an extension of the first study, and added the nurse licensure exam as a criterion variable. The results of this study indicated that the course providing the highest relationship with success on the licensure exam was; (1) nursing 102 for Caucasians, (2) pharmacology for Mexican-Americans, and (3) nursing 101 and microbiology for Black-Americans. The authors recommended that future research concentrate on composites of variables and cross-validation.
Adams (1990) studied causes of NCLEX success for Black students

\( n = 141 \), who graduated from a BSN program located in a private liberal arts college in Louisiana. The subjects took the NCLEX exam between 1982 and 1989. The results of the stepwise regression procedure indicated that ACT, cognate GPA, and cumulative course GPA were the best predictors of success on NCLEX for these minority students. These three predictor variables accounted for 33% of the variation in NCLEX scores, and the variables were reported to be significant predictors \( F = 6.25, p < .01 \). The accuracy of classification for the study by Adams was tested using discriminant analysis. The result was a 51% accuracy rate of classification.

A second purpose of the study by Adams was to determine if internal locus of control and achievement motivation were significant factors in NCLEX success. A two-way ANOVA procedure revealed no significant differences between groups on these variables \( F_{1,37} = 0.35, p < .05 \). The results of a regression analysis performed to evaluate the relationship between these variables revealed that external locus of control accounted for 14% of the variation in these scores. A sample of 23 students was used to evaluate the second purpose. The number of variables used in the stepwise procedure for this portion of the study is unclear. It is clear that variables, other than locus of control and motivation, were used. ACT scores were reported to account for 11% of
the variation in the investigation of NCLEX success and locus of control and achievement motivation. A correct classification rate of 78% was calculated for the second part of the study.

Adams concluded that locus of control and achievement motivation were not significant predictors of success for minority BSN students in Louisiana. Prior academic success (ACT, cumulative course GPA, cognate GPA) was found to be predictive of future NCLEX success. These findings warrant a critique of several methodological issues including; (1) appropriateness of statistical procedures used, (2) ratio of variables to subjects, and (3) interpretation of findings related to variance explained and accuracy rates.

This researcher used ANOVA and multiple regression to forecast success on the 1982 through the 1989 versions of NCLEX. The appropriateness of these procedures should be viewed in relation to the following: (1) The 1988-1989 NCLEX exams were based on a different test plan and description of nursing practice from the 1982-87 exams, which could indicate that two different constructs were measured; (2) the ANOVA and regression procedures are not recommended as the procedure of choice for predicting success on the dichotomously scored 1989 version of the NCLEX; (3) the study did not address multicollinearity, tolerance, and missing data analysis; (4) standardized versus non-standardized beta coefficients were not distinguished.
This study by Adams (1990) used samples numbering less than 20 subjects along with two to six predictor variables in several instances, which is contrary to the recommended 1 to 30 ratio. The lack of significant results could be affected by the ratio of variables to subjects used in this study. Additionally, correlations between the criterion variable and the eight predictor variables ranged from a low of .15 to a high of .35. There were no correlations at the .50 level or above between the criterion variable and the predictors.

Non-empirical Studies on Minorities

Burris (1987) studied 125 black students enrolled in an Illinois, BSN program. This investigator found that a faculty facilitated support system designed for disadvantaged students was successful in improving reading levels up to 2 to 4 grades. The evaluation also revealed that the attrition rate for "at risk" students, decreased from 45 percent to 37 percent, and then to 13 percent after three years of intervention. NCLEX pass rates increased from 33 percent to 100 percent after three years. The support program used in this study consisted of tutorial directed toward; (1) reading comprehension, (2) study skills, and (3) nursing vocabulary. Students were evaluated using course grades, scores on standardized test, pre and post course vocabulary test, Nelson Denny reading scores, and NCLEX scores.

Hudepohl and Reed (1984) proposed that faculty attitudes toward high-risk students was a factor in academic success. They conducted a
survey of faculty attitudes, before the implementation of an advisory program for high-risk students. The survey revealed that 70 percent of the faculty felt that faculty needed preparation before implementing an advisory program.

Faculty's prejudicial social attitudes (defined as empathy) and their relationship to non-white student withdrawal from a BSN program was the focus of a study by Burgess (1975). The premise of the study was the self-fulfilling prophecy phenomenon which links teacher expectation to student achievement. The subjects included 632 nursing faculty who responded to a survey. These faculty represented 74 respondents that were non-white, and of these, 50 percent represented predominately Black schools. Ex-students who responded to the student survey equaled 299 and of these 28 were non-white. The data was obtained from a 35 question, true-false survey. Faculty and students were asked to respond to the same questions. Faculty empathy was defined as faculty's estimation of ex-student's actual response to the questionnaire. Burgess found that the "self-fulfilling prophecy was at work" in the programs represented. The researcher concluded that withdrawal rate of non-white students was associated with low faculty empathy, while "like ethnicity" and social class were associated with high empathy toward non-white ex-students.

Johnston (1989) studied causes of success for "non-primary" speakers of English. The subjects were BSN students in New York state.
The investigator found that language had a greater effect on success in nursing education than did grades or scores on standardized tests, for linguistically diverse students. Johnston concluded that the findings have implications for recruitment and retention, and enhances the ability of schools to graduate this population of students.

The purpose of Linares' (1989) study was to determine the difference between generic and RN baccalaureate students on three constructs; (1) self-directed learning, (2) learning style preference, and (3) locus of control. The subjects were 190 RN and 184 generic student volunteers attending a South Texas BSN program. The findings indicated that there was no significant difference between the two groups on the three constructs. Linares did find that ethnicity was a factor in differentiating between students on the three constructs. The sample represented 84.9 percent Whites, 9.9 percent Blacks, and 5.2 percent Hispanics. The findings were that; (1) Hispanic and Black students indicated greater preference for concrete learning style than white students, (2) Hispanic students scored lower than Black and White students on self-directed learning readiness, and (3) White students were more internal on locus of control orientation than both Black and Hispanic students.

Richardson (1989) provided eight strategies that lead to academic success for first generation college students. This author concluded that
"Institutions are guilty of fraud if they do not provide the assessment, academic support, and learning strategies necessary to encourage minority achievement in mainstream high demand academic fields" (The Chronicle of Higher Education, January, 1989).

Hussey Wolahan & Wieczorek (1991) reported that enrichment education was effective in increasing the NCLEX pass rate of minority and disadvantaged students from 37% in 1989 to 94% in 1990. The problem of NCLEX success, identified by these authors, resulted after the BSN school, located in New York, experienced an increase in minority enrollment from 13% in 1980 to 89% in 1990. The authors recommended that future educational research focus on college students and NCLEX and include, among other areas, cultural influences.

A similar recommendation is presented by Merritt (1991). This author adds a warning, that educators must be cautious about nursing program redesign, without sufficient student aptitude data. The need to recognize nursing education research as an important concern of the nursing profession, was also a recommendation of this author. The problem addressed by Merritt was the decline in the aptitude of baccalaureate nursing students. This author suggested that a comprehensive model for investigating BSN student aptitude characteristics would also serve as a framework for examining the learning abilities of students. One conclusion given was that, the availability of systematically acquired data on BSN
student aptitude is lacking. This author also concluded that this data must be available to be used by nursing faculty as a basis for planning and designing educational programs.

Summary of Literature Review

The purpose of this review of the literature, related to nursing student success, was to examine: (1) trends and patterns in selecting variables to predict success on the NCLEX-RN examination, (2) statistical methodologies used to answer research questions, and (3) research on minority student success in nursing education. The review provides some insight into what has and what has not been studied related to predicting success on NCLEX.

The review revealed that increases in minority student populations could result in increased failure on NCLEX, unless strategic planning is undertaken to address the unique needs of this population. Additionally, the inclusion of findings from educational research was suggested as a necessary first step in designing educational programs that meet the needs of tomorrow’s nursing students. The presentation of studies on minority success in nursing education indicated that predictors for minorities may be different from predictors for majority students.

Predictors that were found to be significant included; past success, National League Achievement test, and other cognitive and non-cognitive variables. The timing of indicators of NCLEX success was viewed as a
necessary consideration in prediction. Reading ability appeared to be a consistent predictor of success for Black-American students. Research studies have indicated that cumulative GPAs, SAT scores, introductory nursing courses and medical-surgical courses, biological sciences, philosophy, math and psychology grades, age at graduation, SAT math scores and high school class rank were all highly correlated with academic performance. Empirical evidence to date suggest that age, marital status, previous nursing experience, and practicums (clinical courses), were poor predictors of academic success for nursing students. In addition, the junior, end of junior and mid-senior year may be the best times for prediction of academic success.

One study used factor analysis to reduce the redundancy in a large set (28) of correlated predictor variables. The procedure also served to systematically summarize the variables and render them more manageable. Factor scores, which represented a combination of variables, were used as predictor variables rather than the actual variable scores.

Researchers, in this review, concluded that there is a need for continued research on critical thinking ability as a predictor of nursing student success. It was also suggested that the revisions in the NCLEX-RN exam warrants replication of previous studies on success.

Several methodological issues related to prediction studies were presented. The regression studies addressed issues related to: errors of
estimate, multicollinearity, tolerance levels, "shrinkage", and the use of cross-validation to estimate the degree of shrinkage. Issues concerned with interpreting the effects of predictive research were explored. The generally accepted interpretation of non-experimental (ex-post-facto) prediction studies is that a significant relationship between predictor and criterion variable, reflects an average relationship.

Prediction studies should address model fit, or, if the predictor variables are linearly related to the criterion variable. The relative importance of the variables and information on Beta coefficients (b’s and β’s), were determined to be useful in variable selection. The stepwise variable selection procedure was found to have advantages over the backward and forward procedures but the need to address external validity of predictors was not adequately addressed.

Other issues related to variable selection that were found to be important in prediction research included: (1) Validity and reliability of measures, (2) missing data analysis, (3) descriptive statistics, (4) multiple correlations, and (5) prediction decision accuracy.

Many of the predictor variables were found to be predictive in one study and non-significant in another. Few empirically sound variable reduction techniques were used. The stability of results across schools was therefore poor or the issue was not evaluated. Current research studies had classification accuracy rates that ranged from 51% to 84%, indicating a
need for techniques to identify the best subset of variables.

Discriminant analysis was used most often when the researchers examined
the relationship between predictor variables and pass/fail on NCLEX. The
examination of several statistics were shown to contribute to the
interpretation of discriminant analysis results. These included the Wilks’s
lambda statistic (a measure of residual discrimination), and the canonical
correlation. The latter statistic is used to evaluate the usefulness of the
discriminant function.

Drawing conclusions about individual, variable contribution to group
differences in discriminant analysis was also discussed. This literature
review concluded that variables in discriminant analysis act as a group, and
their individual effect cannot be separated. The standardized coefficient
was offered as the statistic that measures the "relative contribution" of an
individual variable, in concert with all other variables. Substantive
interpretation of an individual variable was determined to be questionable.

The majority of the studies looked at individual schools and did not
attempt to cross validate their studies with other schools of nursing.
Studies examined in this review were predominantly representative of the
western, mid eastern and eastern United States. Therefore, the results
presented in this review are only generalizable to the regions studied.

The findings of this literature review indicate that educators are
cconcerned about success of nursing students. The number of studies
conducted on predicting NCLEX success is an indication of the value placed on educational attainment by the nursing profession. A major concern of the profession after the NCLEX scoring was changed to pass/fail was the availability of methodologies to predict success using the categorical variables.

Few studies are available that address the current needs of minority nursing students. One predictive study used the post-1989 version of the NCLEX as a criterion variable. The statistical model used in this study of minority students from Louisiana, raises several methodological concerns that should be addressed in future research. Variable selection-elimination techniques used to study NCLEX success, that were designed to maximize stability and external validity, were absent from current research. Several studies violated model assumptions related to number of subjects to variables ratios.

This review found that studies that use appropriate multivariate techniques for variable selection and analysis, and subjects representing regional populations and the southern United States, to predict success on the "new" NCLEX are still needed.
CHAPTER 3
METHODOLOGY

The purpose of this study was to determine which academic variables, best forecast success on the post 1988 versions of NCLEX-RN, for minority, baccalaureate nursing students enrolled in higher education institutions in the south. A second purpose was to develop a methodological framework for predicting success on the "new" NCLEX-RN, that addressed (1) stability and generalizability across curricula and schools, and (2) variable selection to minimize misclassification of failures.

The study design was non-experimental, ex post facto, predictive research, where the causes of success on NCLEX-RN had already exerted their effect. Data submitted by BSN programs were divided into an analysis sample, and a hold-out sample to test the accuracy and stability of the equation derived. Discriminant analysis and factor analysis were used, along with Pearson’s correlation and one-way ANOVA to cluster and manipulate 24 predictor variables.

This chapter describes the population and sample, the limitations of the study, and the design and procedures related to the following research questions; (1) what is the relationship between academic variables and the "new" NCLEX, (2) which subset of predictors is useful in predicting success, (3) what is the best mathematical equation for success, and (4) what is the accuracy and stability of the equation derived.
Population and Sample

The target population was minority nursing students enrolled in baccalaureate programs in the southern region of the United States. The Southern Region, as defined for this study, includes eight states (Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas) described by the US DHHS (1990) as the East and West South Central area. In 1988 these states admitted 6,119 students into BSN programs and graduated 3,706. The number of BSN programs in this region is 88 and 9 are in Historically Black Colleges and Universities (HBCUs).

The eight states in this population graduated 489 Black students in 1986 when the total number for the United States was 1,452. Louisiana graduated the largest number of Black students (127) among states in the target population. Kentucky had the least number of Black students or 13 and Alabama and Texas had 109 and 115 students respectively to graduate in 1986 (NLN, 1987). Louisiana is one of three states in the Nation, and the only state in the Southern region, that is predicted to have more than a 20% decrease in RN supply between 1990 and 2020 (US DHHS, 1990).

The sample for this investigation was purposive, deliberate, and non-randomized and includes graduates of three BSN programs located in Louisiana. Four HBCUs located in Louisiana and Mississippi were invited to participate in this study. One school in Mississippi agreed to participate but
did not submit the required data. The three schools making up this sample include two public open admissions universities, and one private liberal arts college. The percentage of minority graduates in all three schools was over 80 percent and included a representative number of pass and fail students. Tables 3.1, 3.2, and 3.3 present comparisons of the three schools and Louisiana on several variables.

The sample for this study includes 255 Black, BSN students who graduated from one of three HBCUs located in Louisiana and wrote the NCLEX between 1988 and 1991. The subjects represent products of three different BSN curricula. All three programs were nationally accredited by the National League for Nursing and each school provided students with a four year, upper division major leading to the BSN degree. Graduates of each program were eligible to take the NCLEX-RN exam after graduating. All students who graduated from the four programs after May 1988, and who were described as minorities were included in the study.

Data Collection

The four BSN programs located in Louisiana and Mississippi were contacted and asked to participate in the study. A letter sent to the Dean of each program, described the purpose of the project and listed the information needed on each graduate. The Deans were assured of confidentiality and anonymity of student and school information submitted for inclusion in the study. The request to participate also addressed
benefits and the option to request assistance in data collection. A data information sheet, describing information needed, was sent to each school and follow-up telephone calls were made to answer questions and monitor progress in data collection.

Information submitted by each school included values for each person who graduated between July 1988 and July 1991. Other information requested included date NCLEX was taken, and names and series of NLN test used. The data were compiled in a DBase IV file and transferred to SPSS/PC 4.0 for cleaning and analysis. The data set was divided into a variable analysis group, and a hold-out sample, representing 2/3 and 1/3 of the total cases respectively. Each of these study groups were subdivided into a pass and a fail group based on known group membership.
### TABLE 3.1

NUMBER OF FACULTY, STUDENTS AND GRADUATES FOR THE THREE BSN PROGRAMS IN SAMPLE FOR 1989 AND 1990

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th># FACULTY</th>
<th># NEW STUDENTS</th>
<th># GRADS</th>
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</thead>
<tbody>
<tr>
<td>ALPHA</td>
<td>16</td>
<td>32</td>
<td>46</td>
</tr>
<tr>
<td>BETA</td>
<td>16</td>
<td>51</td>
<td>24</td>
</tr>
<tr>
<td>GAMMA</td>
<td>15</td>
<td>35</td>
<td>21</td>
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TABLE 3.2

COMPARISON OF THREE BSN PROGRAMS IN SAMPLE AND LOUISIANA ON ENROLLMENT OF BLACK STUDENTS IN 1991

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th># STUDENTS</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
</tr>
<tr>
<td>ALPHA</td>
<td>125</td>
<td>98</td>
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<tr>
<td>BETA</td>
<td>305</td>
<td>85</td>
</tr>
<tr>
<td>GAMMA</td>
<td>437</td>
<td>95</td>
</tr>
<tr>
<td>LOUISIANA</td>
<td>1,627</td>
<td>29</td>
</tr>
</tbody>
</table>

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**TABLE 3.3**  
COMPARISON OF THREE BSN PROGRAMS IN SAMPLE AND LOUISIANA ON NCLEX PASS RATES FOR 1988-1991

<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>ALPHA</td>
<td>53</td>
<td>72</td>
<td>93</td>
<td>94</td>
</tr>
<tr>
<td>BETA</td>
<td>75</td>
<td>77</td>
<td>93</td>
<td>76</td>
</tr>
<tr>
<td>GAMMA</td>
<td>50</td>
<td>60</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td>LOUISIANA</td>
<td>91</td>
<td>92</td>
<td>95</td>
<td>94</td>
</tr>
</tbody>
</table>
Limitations of the Study

The limitations associated with this study are primarily related to the non-randomness of the sample used and the resulting generalizability issues raised. The subjects represented a purposive, non-probability sample. Although cross-validation steps were taken to evaluate the effect of this limitation on the results of the research, inferences made from this study must be considered cautiously. Additionally, this study addresses prediction research and therefore cause and effect relationships between predictor and criterion variables cannot be inferred.

Design and Procedures

The concept, prediction was defined in this study as the process of determining values on a criterion variable, when the values on the predictor variables are known. Since the criterion variable for this study was dichotomous in nature, the DA procedure was deemed more appropriate than multiple regression analysis for use in deriving the prediction equation (Huberty, 1975, 1984; Kichigan, 1986; Klecka, 1980; Pedhazur, 1982; Norusis/SPSS Inc., 1990).

Variable Selection

A major component of this study was concerned with variable selection and minimizing errors in classification. The review of the literature revealed that the stepwise procedure was most often used for variable selection, and as many as 40 variables per study were used to predict...
NCLEX success. Variable selection procedures, for studies on nursing student success, resulted in correct classification rates that ranged from 51% in the Adams (1990) study to 83% for Quick et al (1985). The cross-validation studies had correct classifications that ranged from 54% to 75%.

According to Huberty (1984) over reliance on stepwise variable selection methods will not necessarily produce the most effective predictor subset. Stepwise variable selection is based on the index of variable entry, which is dependent on variable importance to separation, within the context of variables already in the model. This dependency on the variables in the model was cited as problematic by Huberty. The recommended method of selection was a process that yielded the subset of predictors (of all possible subsets) with; (1) the smallest lambda value, and (2) the lowest misclassification rates. To overcome the limitations of the stepwise procedure Huberty recommended a process of selection and deletion of variables (to form subsets) before and after the stepwise procedure and the use of classification accuracy as the stopping point.

Several methods have been recommended for identifying subsets of variables before applying the stepwise procedure, including selection based on; (1) findings of previous research and theoretical formulations, (2) variables meeting model assumptions, (3) variables associated with the criterion within a univariate sense, (4) uncorrelated variables, (5) factor
scores, (6) variables with high correlations with the linear discriminant function, and (7) variables common across several selection techniques (Huberty, 1975, 1984; Klecka, 1980; Norusis/SPSS, 1990; Pedhazur, 1982).

A variable selection process that incorporated the methods described by these researchers was used in this study. The process used four selection deletion techniques designed to identify predictor subsets before variables were entered into a stepwise procedure. The four techniques were labeled as follows: (1) All Variables, DA #1; (2) Uncorrelated Variables, DA #2; (3) Factor Scores, DA #3; (4) Common Variables, DA #4. The subsets resulting from the four techniques were evaluated to identify the "best" predictor set. Wilks' lambda values, canonical correlations, univariate F significance, and classification misrates, were used to evaluate and compare the four variable sets.

**DA #1, All Variables**

The first variable selection technique used all variables found to be predictors of success in previous research, that met the DA assumption of interval level data. The use of this total variable set avoids the hazard of deleting variables that contain significant information related to separation and classification.
DA #2. Uncorrelated Variables

The uncorrelated technique attempts to eliminate redundancy in variable contribution to separation before entry into the stepwise procedure. This technique maximizes discriminating power of the resulting subset, by selecting variables that have unique contributions to separation.

DA #3. Factor Scores

Selection based on factor scores, derived from the total variable set, was used as the third technique. The scores represented clusters of variables that were linked because of commonality. The resulting group of factors represent the shared contribution of the total predictor set.

DA #4. Common Variables

The fourth selection technique was based on the premise that variables that are significantly related to NCLEX within a univariate sense should also be associated in a multivariate sense. This technique selects variables that were commonly identified by two of three association methods including; significant $F$ from one-way ANOVA, uncorrelated with other predictors, and/or factor varimax loadings greater than .40.

The variable subsets resulting from the four selection techniques were examined, and reanalyzed (using stepwise procedure) to allow for reordering of variable entry when one or more variables were eliminated. In this reanalyzing process, the lowest ranked variable was eliminated until a subset was isolated and there was no further improvement in classification.
rate. The "best" subset was described as the one having the lowest classification misrates.

After the best combination of predictor variables were identified, a mathematical equation was derived to classify students into a pass or fail group. A cross-validation study using a hold-out sample was used to evaluate the stability of the equation.

**Discriminant Analysis Assumptions**

The following discriminant analysis assumptions were validated to assure proper interpretation of results; (1) discriminating variables must be at the interval or ratio level of measurement, to allow for calculation of means and variances, (2) The total number of subjects used, must exceed the number of variables by at least two, (3) no independent variable should be a linear combination of other discriminating variables, (4) for each group, the population covariance matrices are equal, (5) each group represents a sample drawn from a population that has a multivariate normal distribution.

The assumption related to collinearity between independent variables was examined, and controlled through use of the stepwise procedure (tolerance set at .001), factor analysis and selection based on the correlation matrix. The Box’s $M$ statistic was used to evaluate the equality of covariances. This statistic is also sensitive to violations of the multivariate normality assumption (Norusis/SPSS, 1990). The failure to reject the hypotheses, (significance < .01) that the covariances are equal,
would indicate that both the equal covariance and multivariate normality assumptions were not violated.

The DA assumptions of interval level data and subject to variable ratios were evaluated after all data were coded, compiled and cleaned. The variable to subject ratio was assessed at all stages of the DA process to assure adherence and enhance interpretation of the results. Data that did not meet the interval level criteria were excluded from the analysis.

Variables

The criterion variable used in this study was the pass/fail status on the July 1988 to July 1991 versions of the NCLEX-RN. The original set of 24 academic variables were selected from a list of predictors associated with success on the nursing licensure exam, as provided in the review of literature. Several variables were selected because of their association with academic success of minority students (reading level measured by Nelson Denny). The variables represented academic performance from high school to senior year college. The 24 variables used in the study (listed in Table 3.4) represented five stages of academic performance including; pre-college, freshman-sophomore year, admission into nursing, junior year, and senior year.

A variables selection-deletion process was used to identify the smallest possible subset of variables that could be used to effectively classify subjects as pass or fail. To enhance interpretation of results, the
operational definitions, validity and reliability values, and data coding information for all variables are presented.

**Operational Definitions and Validity Values**

**NCLEX-RN**

The criterion variable to be used in this study is the subjects' pass or fail score on the 1988 through 1991 versions of the NCLEX-RN exam. These tests represent the new version of the exam that was developed and validated using the Rasch methods. The standard setting procedure was Angoff. The *KR-20* reliabilities for these tests range from .87 to .89, with a mean standard error of .13 for all versions used in this study. The range of the national pass rates for these exams was 83.6% in 1988 to 91.9% in 1990. Values for each subject was taken from official reports, provided to each school, by the NCSBN. The pass subject were coded as 1, and fail 0.

**Demographic Variables**

The demographic variable, age was coded according to the numeric equivalent. The data was taken from official transcripts, using birth date. Age represented status at graduation for all subjects.

**ACT Scores**

The American College Testing Program (ACT) composite, for each subject, was used in this study. The ACT composite score range from 1 to 36, and is a measure of educational development four cognitive areas. The composite score has an estimated reliability of .90 and an internal-
consistency reliability of about .90 for the four parts. The numeric equivalent was used for each subject. Scores were taken from official school data files.

**Nelson Denny Reading Test**

The Nelson Denny has two major purposes. The test is used for screening students to identify advanced or "at risk" students. The second purpose is diagnostic, and used as a survey tool. The test measures reading abilities in three levels; vocabulary, comprehension, and reading rates. The scores are reported as three sub-scores or a total score. The total score (a percentile rank score) has a mean of 89.48 and a standard deviation of 29.52. This mean Nelson Denny score is equivalent to an ACT of 16.67. The alternate forms reliability for the total score is .91.

**NLN Achievement Tests**

The NLN tests are norm referenced test, designed to be used after the student has completed courses related to the content being tested. The purpose of the NLN achievement test series is to assist nursing education programs to evaluate student attainment in a specific nursing content area. A second purpose is to allow the school to compare their students' performance with the performance of a national sample of baccalaureate nursing students. Percent correct scores for each subject on each test will be used in this study.
Mosby Assesstest

The Assesstest measures the student’s attainment of the minimal competencies described for entry into nursing practice. The test is a simulation of the NCLEX-RN and the overall correlation between the two is .81. The reliability coefficient for the secured version was (KR-20) .934.

The Mosby assesstest measures the students’ knowledge of: nursing behaviors (described as the nursing process); locus of decision making; specific clinical area content; and the students’ attainment in four cognitive levels. The percent-correct score taken from official school files were used.

Comprehensive Exams

The student’s score on the schools comprehensive exit exam (percent correct) were used. These tests measure the students’ attainment of competencies defined by the individual school as essential for completion of the baccalaureate program. Each exam represents a teacher made test, designed by the faculty to evaluate the student at the end of the program of study. The comprehensive exams used in this study were not validated at the time of data collection.

Schools reported that exams were developed from items and content covered in each required nursing course and content measured by NCLEX-RN. The objectives measured by each exam included the following: (1) synthesizes theoretical and empirical knowledge from the humanities, physical and behavioral sciences with nursing theory and practice; (2)
functions as a nurse generalists in assisting individuals, families, and groups to maximize their health potential, (3) evaluates nursing actions using the nursing process, critical thinking and professional judgement.

Each exam was multiple choice, and used a format consistent with NCLEX and Mosby Assessment, where a description of a nurse-client situation is presented and several questions with 4 or 5 possible answers follow. Each school used in the study required that students pass the comprehensive exam before graduation.

Grade Point Averages

Sixteen grade point averages were used as predictor variables to evaluate success on the NCLEX. These GPAs represent cumulative grades at five levels; pre-college, freshman-sophomore year, admission into upper division nursing, junior year (level II), and senior year (level III).

Predictors related to the subjects' knowledge of specific content included the following categories; math, biology, chemistry, microbiology, sociology, psychology, high school, freshman, cognate, admit to nursing, nursing cumulative, college cumulative, level 1 nursing, level 2 nursing, and level 3 nursing.

The grades were taken from official transcripts and converted to numeric values based on a four point grading scale. The levels 1, 2 and 3 nursing GPAs represented the average of the 200, 300 and 400 level nursing grades respectively. The nursing cumulative GPA represented the
average of the three nursing level values. Cognate GPA was the average of the grades for the humanities, social and biological science courses, required as pre-nursing. Admit to nursing represented the cumulative GPA for all courses taken prior to entry into upper-division nursing and cumulative college GPA was the average of all courses taken prior to BS degree attainment.
TABLE 3.4

LIST OF ALL VARIABLES BY CATEGORY

<table>
<thead>
<tr>
<th>PRE-COLLEGE</th>
<th>FRESH-SOPH YEARS</th>
<th>ADMIT CRITERIA</th>
<th>JUNIOR YEAR</th>
<th>SENIOR YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>GPA FRESHMAN</td>
<td>COGNATE GPA</td>
<td>LEV1 NU GPA</td>
<td>NURS CUM GPA</td>
</tr>
<tr>
<td>ACT SCORE</td>
<td>GPA BIOLOGY</td>
<td>ADMIT GPA</td>
<td>LEV2 NU GPA</td>
<td>CUM GPA</td>
</tr>
<tr>
<td>HIGH SCH GPA</td>
<td>GPA CHEMISTRY</td>
<td>PRE-NLN TEST</td>
<td>NLN TEST</td>
<td>LEV3 NU GPA</td>
</tr>
<tr>
<td></td>
<td>GPA ENGLISH</td>
<td></td>
<td></td>
<td>SCHOOL COMP</td>
</tr>
<tr>
<td></td>
<td>GPA MATH</td>
<td></td>
<td></td>
<td>MOSBY</td>
</tr>
<tr>
<td></td>
<td>GPA MICROBIO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GPA PSYCHOLOGY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GPA SOCIOLOGY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NELSON DENNY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>REMEDIAL EDU</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Research Questions

(1) What is the relationship between academic variables and performance on the "new NCLEX-RN" for minority BSN students residing in the southern region and enrolled in different nursing programs?

An analysis of the 24 predictor variables using univariate and multivariate descriptive statistics and the factor analysis procedure was undertaken. Variable analysis also generated means, standard deviations, and a correlation matrix. Univariate $F$ ratios were also computed to determine the significance of a relationship between each predictor variable (or factor score) and the criterion variable. These univariate test provided the data needed to answer the first research question.

The variable analysis process included: (1) evaluation of the 24 predictor variables for adherence to statistical model assumptions and review of cases with missing values; (2) univariate and multivariate analysis of variables remaining in the model after stage one using means, standard deviations, correlations, one-way ANOVA, and factor analysis.

(2) Which academic variables are useful in predicting success on the "new NCLEX-RN" for minority BSN students residing in the southern region enrolled in different nursing programs?

The variable selection process used to answer the second research question employed a combination of four selection techniques. Univariate and multivariate techniques were used before and after the stepwise
procedure to select the subset of variables that yielded the smallest Wilks' Lambda value and were correlated with the Canonical Discriminant Function (CDF). Classification accuracy rates were used as the stopping point for variable selection. The stepwise selection method, based on Wilks' lambda was used because it takes into consideration both the differences between groups and group cohesiveness (Klecka, 1980).

According to Norusis/SPSS (1990), the inclusion of all independent variables in an equation could increase the standard error of estimate, and is usually not a good idea. To minimize error rates, several variable selection and deletion methods were used to identify the best set of predictors. The initial 24 discriminating variables are selected from the list of variables that have been found to be significant predictors in previous research, and or variables associated with minority student success. These variables are listed in Table 3.4 and represent five stages of academic performance; (1) pre-college, (2) freshman-sophomore college, (3) admit to nursing criteria, (4) junior year and (5) senior year.

The four variable selection techniques used to answer the second research question were labeled: (1) All Variables, DA #1; (2) Uncorrelated Variables, DA #2; (3) Factor Scores, DA #3; (4) Common Variables, DA #4. The subsets resulting from the four techniques were evaluated to identify the "best" predictor set. Wilks' lambda values, canonical
correlations, univariate $F$ significance, and classification misrates, were used to evaluate and compare the four variable sets.

The factor analysis, with varimax rotation procedure was used as one method to cluster the large number of variables. New variables were created by clustering the 24 predictors into sets or factors that best represented homogeneous clusters. These factors were used as predictor variables and their classification accuracy rates were compared to other selection methods. Other purposes for using factor analysis were; (1) to attempt to decrease the number of variables to subjects ratio, (2) to examine association between variables to gain insight into student learning characteristics, and (3) to address multicollinearity.

(3) How might these academic variables be combined into a mathematical equation to predict performance on the "new NCLEX-RN"?

The canonical discriminant function coefficients was generated and analyzed to answer the third research question. The standardized and unstandardized coefficients were examined. Discriminant scores were generated from the coefficients, for each subject. Classification of each subject into the pass or fail group was computed using SPSS 4.0. The classification results were examined and conclusions drawn.

The discriminant function coefficients, one for each predictor variable, provided the estimated weights (per variable) to maximize
separation between groups. The weighted combination of the predictor variables or the discriminant function \( L \) can be expressed as:

\[
L = b_1x_1 + b_2x_2 + \ldots + b_kx_k
\]

where \( x \) represents values on the predictor variables and \( b \) represents a weight associated with a linear combination of the predictor variables. This weighted index is a function produced using SPSS 4.0 that provides for the best separation between subjects who passed NCLEX-RN and those who failed. These \( b \) values were used to develop discriminant scores for graduates to predict success on NCLEX-RN.

The standardized canonical coefficients represent discriminant properties that have been adjusted for unequal means. The result is a set of coefficients, representing each predictor variable, that have a mean of 0 and a standard deviation of 1. These standardized coefficients can be used to evaluate the relative importance of each variable in discriminating between the pass and fail group.

Two additional statistics were used to evaluate the discriminant scores. Group centroids, or the average score for each group, were used to evaluate the differences between the groups. The second statistic evaluated, was the pooled within group correlations between the discriminating variable and canonical discrimination function.

Evaluation of the usefulness of the discriminant function was accomplished through the examination of two statistics, canonical
correlations and residual discrimination or Wilks Lambda. According to Klecka, (1980), the Wilks’ Lambda is an intermediate statistic, used to determine the discrimination power of the predictor variables. The Lambda has a maximum value of 1.0, which indicates no group differences (or group centroids are equal). When lambda values are closer to 0.0, the group centroids are different in relation to the amount of dispersion within the groups. The Chi-Square statistic tests the significance of the difference in dispersion between groups. The canonical correlation was also used to evaluate the usefulness of the discriminant function. Low canonical correlations indicate that the two groups are not very different on the predictor variables. The canonical correlations are always positive, and range from 0.0 to 1.0, with a 0.0 indicating no association between groups (Klecka, 1980).

(4) What is the accuracy rate for the equation derived for the sample and among the?

To answer the fourth research question a classification output table was generated using the probabilities of group membership. The accuracy of classification was evaluated using the confusion matrix generated by the analysis and hold-out samples. The prior probability of group membership was set to equal actual group size to account for the disproportion in cases, between the pass and fail groups used in this study.
The statistical significance and accuracy of the LDF were evaluated first using the Chi Square test of differences between groups. The empirical and hold-out sample methods were used to evaluate the stability and generalizability of the LDF across schools. These methods were deemed more appropriate than other methods used to evaluate external validity and replicability, because the study focused on generalizability to schools not included in the analysis. Other methods used to evaluate classification error, or sample specificity have been recommended (Taylor, 1991; Daniel, 1989; Fish, 1986; Huberty, 1984). The advantage of the hold-out procedure was the ability to minimize bias through the use of one sample to develop the prediction equation and a different one for cross-validation. The classification rates for both samples (internal and external) were compared to determine stability across schools. The Jackknife approach to invariance assessment uses an "averaged out" estimate of random subsets of the sample to decrease bias (Daniel, 1989). This method of evaluating stability and generalizability addresses bias due to outliers and/or atypical samples. According to Taylor (1991), this method has advantages when the sample is too small to split into an internal and a hold-out group.

The assessment of the effect of sampling on stability was one purpose of this study. The intent was to determine if an LDF based on two schools was externally valid. In other words, if the N for this study was sufficient (at least 2 cases per variable), merging of the samples (as in the
Jackknife procedure) would not provide additional information on generalizability across schools. The hold-out method was also simpler and less costly in computer time.

Conclusions about the stability and generalizability of the discriminant study were derived from examination of; (1) eigenvalues (large eigenvalues are associated with a good function), (2) the canonical correlation, (3) Chi Square statistic and resulting significance, and (4) classification miss rates for internal and hold-out samples.

This study also addressed the issue of "shrinkage" and the use of cross-validation to estimate the degree of shrinkage. The issue of shrinkage as used here refers to the phenomenon that occurs when the weights derived from one sample are applied to predict scores of another sample. The result is a "shrinkage" in $R$ obtained in this situation, as compared to the $R$ obtained in the experimental group (Pedhazur, 1982). The use of the cross-validation procedures allow the researcher to estimate the degree of shrinkage.

The accuracy of the prediction equation was also evaluated, using a standard measure of improvement over chance, proposed by Klecka (1980) and Huberty (1984). This statistic (Tau) uses the total cases, number accurately classified, and prior probabilities to determine the proportional chance criterion (a percentage). Tau is a measure of the percent improvement in classification over chance assignment. Using internal and
external samples, the Tau statistic was used to evaluate invariance in the sample, replicability and generalizability.
CHAPTER 4

DATA ANALYSIS AND FINDINGS

The factor analysis and discriminant analysis procedures were used to examine predictor variables and establish rules that could effectively classify future nursing students as pass or fail on the national licensure exam. A preliminary analysis was done using descriptive and univariate statistics to assess data quality and address missing value problems. Statistical procedures were then applied to the data set to answer the four research questions. The predictors, which represent academic performance from high school to senior year in college, and the criterion were assessed to determine degree of association between and among variables. A variable selection-elimination process that incorporated four techniques was used to ascertain the smallest set of variables that could accurately predict NCLEX outcomes. Classification results from the most effective predictor set were analyzed and a hold-out sample, representing a school not included in the variable selection process, was used to test the accuracy and stability of the prediction equation.

The variable analysis process included: (1) evaluation of the 24 predictor variables for adherence to statistical model assumptions and review of cases with missing values; (2) univariate and multivariate analysis of variables remaining in the model after stage one using means, standard deviations, correlations, one-way ANOVA, and factor analysis; (3)
examination of the contribution of the remaining predictors to group separation using factor analysis (eigenvalues, variance explained, rotation matrix), and DA (Wilks’ Lambda, canonical correlations, and classification miss rates).

The four variable selection-elimination techniques were used prior to a stepwise method based on Wilks’ Lambda values, to determine the best set of predictors. The four resulting variable subsets were evaluated according to their misclassification rates. Variable sets used in the four stages were; (1) DA #1, all predictors included in the data set after cleaning, (2) DA #2, uncorrelated variables using the intercorrelation matrix to eliminate all but one predictor in interrelated clusters, (3 DA #3, factor scores derived from the total variable set, and (4) DA #4, predictors common across two of three association methods (uncorrelated, factor scores, significant univariate F).

Analysis of Sample

Data submitted by three BSN schools located in Louisiana were coded and compiled in a DBASE IV file. The data set contained 255 subjects before cleaning and 216 cases met the criteria for inclusion in the study. The thirty-nine cases not included in the study were removed after examination found that values for key variables, including NCLEX responses, were missing. Group means were substituted for listwise missing values for 13 subjects, during the classification process.
All cases included in the study (n = 216) represented minority (Black-American) students who wrote the NCLEX-RN first time, between July 1988 and July 1991. Two schools, including a private liberal arts college and a state supported school, were represented among cases used in the variable analysis procedures. Cases from these two schools represented two-thirds of the total sample and included the 13 cases that were included in the classification process but were eliminated using listwise deletion from the variable analysis process.

Characteristics and number of subjects by school attended are presented in Tables 4.1 and 4.2. Students representing the two schools included in the variable selection process (alpha, beta) were similar on percentage of females and number of students enrolled in remedial courses during their college years. A larger number of students from school Alpha were enrolled as part-time (less than 12 credit hour load) students during their senior year.
TABLE 4.1
CHARACTERISTICS OF SUBJECTS INCLUDED IN THE STUDY BY SCHOOL ATTENDED

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>PERCENTAGE OF STUDENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ALPHA</td>
</tr>
<tr>
<td>FEMALE</td>
<td>94%</td>
</tr>
<tr>
<td>ENROLLED PART-TIME</td>
<td>28%</td>
</tr>
<tr>
<td>REMEDIAL COURSE TAKEN</td>
<td>30%</td>
</tr>
</tbody>
</table>

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TABLE 4.2

NUMBER OF SUBJECTS INCLUDED IN VARIABLE ANALYSIS, CLASSIFICATION AND CROSS-VALIDATION PROCEDURES BY SCHOOL

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>VARIABLE ANALYSIS</th>
<th>CLASS</th>
<th>CROSS VALIDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAIL</td>
<td>PASS</td>
<td>TOTAL</td>
</tr>
<tr>
<td>ALPHA</td>
<td>26</td>
<td>44</td>
<td>72</td>
</tr>
<tr>
<td>BETA</td>
<td>15</td>
<td>47</td>
<td>73</td>
</tr>
<tr>
<td>GAMMA</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTALS</td>
<td>41</td>
<td>91</td>
<td>145</td>
</tr>
</tbody>
</table>

* Not a Row sum, represents grand total.
The cross-validation sample includes 71 subjects from the BSN program coded Gamma. This school was one of the two state supported programs included in the data set and had a representative number of cases for pass and fail groups (closest to national pass rates). A comparison of subjects used in the factor analysis and discriminant analysis tests, with the cross-validation sample is presented in Table 4.3. The cases used for cross-validation represent 32.8% of the total sample and includes minority students who were predominately female (n = 63 females; n = 8 males) and took the NCLEX-RN, first time, between July 1988 and July 1991.

The proportion of subjects for the pass and fail groups used in the variable analysis group (Table 4.4) was consistent with the national rates for all persons on the NCLEX-RN first writing. The National Council of State Boards of Nursing do not currently publish (or make available) success rates for minority students on NCLEX. The national rates used in Table 4.4 include students educated outside of the United States. The proportion of pass and fail subjects used in this study for variable analysis and cross-validation is consistent with the rates for minority graduates from the three schools in the sample.
### TABLE 4.3

NUMBER OF CASES IN FAIL AND PASS GROUPS, AGE AND ACT TEST
SCORES FOR VARIABLE ANALYSIS AND CROSS-VALIDATION SAMPLES

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>TOTAL</th>
<th>FAIL</th>
<th>PASS</th>
<th>AGE</th>
<th>ACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANALY SAMP</td>
<td>145</td>
<td>42</td>
<td>103</td>
<td>29.57</td>
<td>14.11</td>
</tr>
<tr>
<td>CROSS-VAL</td>
<td>71</td>
<td>13</td>
<td>58</td>
<td>27.34</td>
<td>14.17</td>
</tr>
<tr>
<td>TOTAL</td>
<td>216</td>
<td>55</td>
<td>161</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### TABLE 4.4

**PROPORTION OF SUBJECTS IN FAIL AND PASS GROUPS FOR THE THREE SAMPLE SCHOOLS, LOUISIANA AND THE NATION**

<table>
<thead>
<tr>
<th>POPULATIONS</th>
<th>RANGE OF PERCENTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAIL</td>
</tr>
<tr>
<td><strong>SCHOOLS IN STUDY</strong></td>
<td>0-50</td>
</tr>
<tr>
<td><strong>NATIONAL</strong></td>
<td>14-37</td>
</tr>
<tr>
<td><strong>STATE</strong></td>
<td>05-09</td>
</tr>
<tr>
<td><strong>SAMPLE</strong></td>
<td></td>
</tr>
<tr>
<td>VAR ANALYSIS</td>
<td>29%</td>
</tr>
<tr>
<td>CROSS-VAL</td>
<td>18%</td>
</tr>
</tbody>
</table>
Findings Pertinent to Each Research Question

(1) What is the relationship between academic variables and performance on the "new" NCLEX-RN for minority BSN students residing in the southern region enrolled in different nursing programs?

The relationship between predictor variables and NCLEX for minority graduates of two Louisiana BSN programs was examined using univariate and multivariate statistical procedures. A preliminary review of the data set was conducted to evaluate adherence to the multivariate assumption of interval level values, and determine the adequacy of the available information pertaining to each variable. The association between NCLEX and predictors was assessed, first, using means and standard deviations. Pearson intercorrelations, Univariate F tests, and Factor Loadings were computed to examine the relationship between the criterion, and academic variables, and answer the first research question.

The original list of 24 variables was derived from findings of previous research on NCLEX and minority student success. These variables were grouped into five categories representing academic performance from high school to end of senior year in college. An initial review of missing values and statistical model assumptions resulted in deletion of seven variables from the study. Table 4.5 provides a list of the variables and the causes for deletion. The Nelson Denny reading test was not included because data was available on cases from only one of the three schools. All NLN test
variables were deleted. NLN test used by the three schools were varied in content and series, and resulted in few commonalities that could be grouped. The number of valid cases for NLN test ranged from 14 to 73 non-missing of 216 subjects.

The seventeen predictor variables retained in the study included 13 GPAs, two national test scores (ACT & Mosby), the schools’ comprehensive exams and one demographic variable (age). These variables represent all five levels of academic performance, from high school to end of senior year in college. Table 4.6 provides means and standard deviations for the 17 predictors for fail, pass and total groups used in the variable analysis.

When the pass and fail groups were compared on variable mean values, 4 variables (GPA high school, GPA freshman, GPA Level 1, GPA Level 3) showed very little difference (.05 or less). The GPA variables with the largest standard deviations for the total group represented prenursing courses taken during freshman and sophomore years in college (English, math, microbiology, psychology, sociology).
### TABLE 4.5

**LIST OF ALL VARIABLES BY CATEGORY (INCLUDED AND ELIMINATED) AND CAUSES FOR DELETION**

<table>
<thead>
<tr>
<th>Pre-college</th>
<th>Fresh-soph Years</th>
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* Deleted-interval level data not available  ** Deleted-data unavailable for majority of cases
TABLE 4.6
DESCRIPTIVE DATA FOR PASS, FAIL AND TOTAL GROUP SAMPLES FOR SEVENTEEN PREDICTORS

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<th>FAIL MEAN</th>
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The correlation matrix for intercorrelations between all predictor variables presented in Table 4.7 showed that four predictors (GPA cognate, GPA english, GPA nursing, GPA cum) were significantly correlated with more than ten of the seventeen variables. The academic variables showing the least number of significant intercorrelations were; age, GPA high school, GPA microbiology, GPA math and the schools' comprehensive exit exams. Four predictors could be isolated when all but one variable in intercorrelated clusters were eliminated (age, ACT comp, MOSBY, GPA microbiology).
### TABLE 4.7

CORRELATION MATRIX FOR SEVENTEEN PREDICTOR VARIABLES USED IN DA

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Results of the univariate $F$ test, using one-way ANOVA to examine
the difference between pass and fail groups on the seventeen predictors,
are displayed in Table 4.8. Four predictors had significance levels of greater
than .50, indicating that the difference between groups, on these variables,
had greater than a 50% chance of occurring through random assignment.
The pass and fail groups had the least significant differences on; age,
freshman year GPA, and level 1 and level 3 nursing course GPAs. Variables
that had significantly different values for the pass and fail groups ($p < .05$)
represented; freshman-sophomore years (GPA microbiology, English,
psychology, ), admit criteria (GPA cognate), and senior year (nursing
cumulative GPA, cumulative college GPA, Mosby, school comprehensive).
Four of the predictors with significant univariate $F$ values represented
college senior level variables.

Variable clusters extracted from the 17 predictors, using the factor
analysis procedure, were evaluated for association with NCLEX. The
principal components extraction produced four factors that explained 57%
of the variance in the predictors. Results of the extraction, orthogonal
rotation using varimax method, and univariate $F$ for pass and fail groups are
presented in Tables 4.9.
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FAC2 and FAC3 were significantly associated with NCLEX at .05 level (univariate F for one-way ANOVA) and accounted for 22.4% of the variance in scores not accounted for by FAC1. The factor loadings presented in Table 4.10 reveal underlying dimensions derived from associations between predictors and factors. The variables representing the factor with the largest F value (FAC2) are related to national testing and could represent "test taking ability". ACT and Mosby are both standardized instruments, and each requires proficiency in english for success.

The underlying dimension found in the second factor (FAC3) could be described as "critical thinking-evaluation versus memory-recall". The concept represents the levels of learning associated with success in the two areas measured by the variables. The negative relationship between GPA microbiology and this dimension could indicate that subjects with higher GPAs were predominant to memory-recall learning style and had less skill in evaluation and application. This interpretation of the dimension could explain the negative relationship between GPA microbiology and NCLEX and the commonality between the predictor and the School comprehensive, which is positively related to licensure success.

FAC2 reveals a strong relationship between GPAs and could represent a dimension called "academic achievement". Since FAC4 is represented by only one variable meeting the cut-off level of .04, (age) labeling is simplified. Using these interpretations of the four factor
dimensions, the univariate F test of association between NCLEX and factors (difference between group means), would indicate that "test-taking ability" and "critical thinking-application versus knowledge-recall" skills are significantly associated with NCLEX.

At least twelve of the seventeen academic variables included in this study were associated with NCLEX, using the findings of all statistical methods. A summary of the results in Table 4.11 indicates that Mosby AssessTest and microbiology grade point averages were consistently associated with the licensure exam. High school, college freshman, and math GPAs were not found to be significantly associated with the criterion. Nursing GPAs for level 1 and 3 were not associated with NCLEX.
### TABLE 4.11

VARIABLES ASSOCIATED WITH NCLEX BY STATISTICAL TECHNIQUE USED

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<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>ACT COMP</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>CUM GPA</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>GPA ADMIT</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>GPA COGN</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>GPA ENGL</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>GPA MICR</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>GPA PSYC</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>GPA SOCI</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>MOSBY</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>NURS GPA</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>SCH COMP</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>
(2) Which academic variables are useful in predicting success on the "new" NCLEX-RN for minority BSN students residing in the southern region and enrolled in different nursing programs?

The variable selection process used to answer the second research question employed a combination of techniques. Univariate and multivariate techniques were used before and after the stepwise procedure to select the subset of variables that yielded the smallest Wilks' Lambda value and were correlated with the Canonical Discriminant Function (CDF). Classification accuracy rates were used as the stopping point for variable selection.

Four Discriminant analysis stepwise procedures (DA #1; DA #2; DA #3; DA #4) were used to select variable subsets. These variable subsets were derived from the following: (1) all seventeen variables meeting interval level data assumptions; (2) four predictors remaining after all but one of the intercorrelated variables were eliminated; (3) four factor scores derived from factor analysis; (4) twelve variables commonly selected using univariate F test, uncorrelated variables, and greater than .40 on rotated factor loadings. The variable subset with the smallest misclassification rate was selected as the most useful predictors.

DA #1, All variables

The subset of variables selected when all seventeen variables were used in the stepwise procedure (DA #1) contained ten predictors. The order of entry into the selection process, as recorded in Table 4.12, was based
on Wilks’ Lambda. Mosby, school comprehensive, and GPA freshman had
the smallest, before entry, Lambda statistics and were the first three
variables to enter the stepwise procedure. The last three variables to enter
and remain in the subset were age, GPA math and GPA english. Seven
variables including nursing cumulative, high school and level three nursing
GPAs, did not exhibit sufficient separation power, considering predictors
already in the model, to be included in the subset.

The Wilks’ Lambda showed that the first three variables entering the
model in DA #1, along with cumulative college GPA, cognate GPA,
psychology GPA, and GPA microbiology exhibited the largest difference
between pass and fail group means (smallest lambda statistic). Two
variables that were not selected by the stepwise method were among the
smallest seven Lambda values (GPA cognate, GPA psychology). The ratio
of within group to total group variability for these two variables
individually, was less than the ratios computed when all variables in the
stepwise model were considered.

The pooled-within-groups correlations for the set of seventeen
predictors were generated after the correlations for the pass and fail groups
were combined into one (Table 4.12). The larger values indicate greater
association with the canonical discriminant function (CDF). Six of the seven
predictors selected by smallest lambda, also had the highest CDF
correlation coefficients. The two uncommon variables were GPA level 3 for
correlations, and GPA freshman for lambda. The three predictors with the largest correlations with CDF were all senior level variables. Negative CDF correlations were found, which indicate that smaller values on these variables are associated with the pass group (coded 1). Age and GPA microbiology had the largest negative correlations.

**DA #2, Uncorrelated Variables**

The second pre-stepwise selection technique (DA #2) used the intercorrelations between the seventeen predictors, to select sets of independent variables for enter into the stepwise process. The results of these DA test are recorded in Table 4.13.

The absence of shared association between variables was used as selection criteria for DA #2. Using the matrix presented in Table 4.7, all but one variable of interrelated clusters was isolated. This process produced a group of four predictors including; age, ACT composite, MOSBY, and GPA microbiology. The stepwise process using Wilks’ Lambda method produced a subset containing three predictors (ACT was not included). MOSBY recorded the smallest, before entry, Lambda value for DA #2, followed by GPA microbiology. The F values that measured differences between means, for the remaining two variables were not significant ($p < .05$). The variable age, was included in the subset after stepwise selection, but had the smallest CDF correlation.
In this variable subset, Mosby had a pooled-within-groups CDF correlation (.8657) that was double the next largest value (-.3648 for GPA microbiology). Consistent with the DA #1 variable subset, low values for GPA microbiology were associated with the pass group.
**TABLE 4.12**

SEVENTEEN PREDICTORS, WILKS’ LAMBDA STATISTIC, AND CDF CORRELATION, AFTER DA #1 STEPWISE PROCESS

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>STEP</th>
<th>WILKS' LAMBDA</th>
<th>CORR CDF #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>8</td>
<td>.9851</td>
<td>-.1288</td>
</tr>
<tr>
<td>ACT COMP</td>
<td>4</td>
<td>.9978</td>
<td>-.0495</td>
</tr>
<tr>
<td>GPA HIGH SCH</td>
<td>13</td>
<td>.9980</td>
<td>-.0159</td>
</tr>
<tr>
<td>GPA FRESHMAN</td>
<td>3</td>
<td>.9769</td>
<td>.1612</td>
</tr>
<tr>
<td>GPA COGNATE</td>
<td>17</td>
<td>.9632</td>
<td>.1962</td>
</tr>
<tr>
<td>GPA ADMIT</td>
<td>14</td>
<td>.9845</td>
<td>-.0159</td>
</tr>
<tr>
<td>GPA ENGLISH</td>
<td>10</td>
<td>.9948</td>
<td>.0755</td>
</tr>
<tr>
<td>GPA MATH</td>
<td>9</td>
<td>.9936</td>
<td>.0844</td>
</tr>
<tr>
<td>GPA MICRO</td>
<td>5</td>
<td>.9664</td>
<td>-.1954</td>
</tr>
<tr>
<td>GPA PSYCH</td>
<td>15</td>
<td>.9368*</td>
<td>.2019</td>
</tr>
<tr>
<td>GPA SOCIOL</td>
<td>16</td>
<td>.9936</td>
<td>.0326</td>
</tr>
<tr>
<td>GPA LEVEL1</td>
<td>6</td>
<td>.9985</td>
<td>-.0411</td>
</tr>
<tr>
<td>GPA LEVEL3</td>
<td>12</td>
<td>.9950</td>
<td>.2047</td>
</tr>
<tr>
<td>NURS CUM GPA</td>
<td>11</td>
<td>.9991</td>
<td>.0796</td>
</tr>
<tr>
<td>CUM GPA</td>
<td>7</td>
<td>.9427*</td>
<td>.2582</td>
</tr>
<tr>
<td>MOSBY</td>
<td>1</td>
<td>.8160*</td>
<td>.4975</td>
</tr>
<tr>
<td>SCHOOL COMP</td>
<td>2</td>
<td>.8831*</td>
<td>.3812</td>
</tr>
</tbody>
</table>

*Significance $p < .05*
TABLE 4.13
WILKS’ LAMBDA STATISTIC, AND CDF CORRELATIONS FOR DA #2
(UNCORRELATED VARIABLES) AND DA #3 (FACTOR SCORES)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>IN/OUT</th>
<th>WILKS’ LAMBDA</th>
<th>F</th>
<th>CDF CORR</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA #2 (UNCORRELATED VARIABLES)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGE</td>
<td>IN</td>
<td>.9989</td>
<td>.15</td>
<td>.0349</td>
</tr>
<tr>
<td>ACT COMP</td>
<td>OUT</td>
<td>.9897</td>
<td>1.47</td>
<td>.1837</td>
</tr>
<tr>
<td>MOSBY</td>
<td>IN</td>
<td>.6074</td>
<td>91.80*</td>
<td>.8657</td>
</tr>
<tr>
<td>GPA MICRO</td>
<td>IN</td>
<td>.8970</td>
<td>16.30*</td>
<td>-.3648</td>
</tr>
<tr>
<td>DA #3 (FACTOR SCORES)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FACTOR1</td>
<td>IN</td>
<td>.9866</td>
<td>1.33</td>
<td>.2480</td>
</tr>
<tr>
<td>(ACADEM ACHIEV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FACTOR2</td>
<td>IN</td>
<td>.9324</td>
<td>7.10*</td>
<td>.5726</td>
</tr>
<tr>
<td>(TEST ABILITY)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FACTOR3</td>
<td>IN</td>
<td>.9440</td>
<td>5.81*</td>
<td>.5182</td>
</tr>
<tr>
<td>(EVAL VS RECALL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FACTOR4</td>
<td>IN</td>
<td>.9937</td>
<td>.62</td>
<td>.1696</td>
</tr>
<tr>
<td>(AGE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significance p < .05

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**DA #3, Factor Scores**

The four factor scores used in DA #3 and recorded in Table 4.13, were all selected for inclusion in the variable subset by the stepwise procedure. Factor2, representing "test-taking ability", had the smallest before entry Lambda value (significant @ .05) and the largest CDF correlation. The only other significant Lambda value was for Factor3 representing the dimension "evaluation vs recall". Differences between group means, or Lambda for Factor1 and Factor4, ("academic achievement" and "age") were not significant. Age represented the smallest CDF correlation value indicating little association between Factor4 and the discriminant function.

**Comparisons between DA #1, DA #2, and DA #3**

Variable subsets resulting from the first three DA procedures were compared on their ability to correctly classify subjects as pass or fail on NCLEX. Findings from this analysis are presented in Table 4.14. The canonical correlation in this table is a measure of the association between the discriminant scores (derived from the discriminant coefficients and subjects values on the variable subsets) and pass and fail groups. The square of this correlation is equivalent to \( \eta^2 \) and represents variance associated with differences between groups. The Lambda values presented in Table 4.14 were significant (\( p < .001 \)) for all three variable groups, and
represent unexplained variance or the ratio of within group variance to total group differences.

The Factor scores used in DA #3 recorded the largest Lambda value and the smallest association between discriminant scores and group membership. The predictor subset (DA #1) with the largest number of variables (10) had the smallest Lambda and a canonical correlation of 69%. The resulting misclassification rate for DA #1 was approximately 66% less than the misrate for the variable subset based on factor scores (DA #3). The number of misclassified failures for DA #2 was less than the number of failures misclassified by DA #1 and DA #3.

DA #4. Common Variables

The fourth variable selection technique used 12 predictors that were common among three statistical techniques (uncorrelated = 4, significant univariate $F = 8$, and greater than .40 rotated factor loading = 12). Each of the twelve variables was common to at least two of the three methods (Table 4.11). The stepwise procedure based on Wilks’ Lambda yielded a subset of seven predictors for this fourth selection technique. These seven predictors were then re-entered in a stepwise selection process and the results are recorded in Tables 4.14 through 4.19. To determine if the smallest possible set of predictors had been identified, an additional stepwise procedure was conducted using only the first six of the seven variables in the subset selected in DA #4.
TABLE 4.14

CANONICAL CORRELATIONS, WILKS’ LAMBDA, AND CLASSIFICATION MIRSATES FOR FIRST THREE VARIABLE SELECTION METHODS (DA #1, DA #2, DA #3)

<table>
<thead>
<tr>
<th># VARS IN</th>
<th>CANON</th>
<th>WILKS’</th>
<th>MISS RATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA CLASSFI</td>
<td>CORR</td>
<td>LAMBDA</td>
<td>FAIL</td>
</tr>
<tr>
<td>DA1 10</td>
<td>.6904</td>
<td>.5234*</td>
<td>9 (21%)</td>
</tr>
<tr>
<td>DA2 3</td>
<td>.6806</td>
<td>.5368*</td>
<td>7 (17%)</td>
</tr>
<tr>
<td>DA3 4</td>
<td>.4254</td>
<td>.8190*</td>
<td>39 (94%)</td>
</tr>
</tbody>
</table>

*Significance p < .001
<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>STEP</th>
<th>IN</th>
<th>WILKS' LAMBDA</th>
<th>CORR</th>
<th>WILKS' LAMBDA</th>
<th>CORR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>7</td>
<td></td>
<td>.9851</td>
<td>-.0933</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACT COMP</td>
<td>6</td>
<td></td>
<td>.9978</td>
<td>-.0343</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPA COGNATE</td>
<td>12</td>
<td></td>
<td>.9632</td>
<td>.1799</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPA ADMIT</td>
<td>9</td>
<td></td>
<td>.9845</td>
<td>-.1313</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPA ENGLISH</td>
<td>8</td>
<td></td>
<td>.9948</td>
<td>.2771</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPA MICRO</td>
<td>5</td>
<td></td>
<td>.9664</td>
<td>-.2007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPA PSYCH</td>
<td>10</td>
<td></td>
<td>.9368*</td>
<td>.2107</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPA SOCIOL</td>
<td>11</td>
<td></td>
<td>.9936</td>
<td>.0059</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NURS CUM GPA</td>
<td>4</td>
<td></td>
<td>.9991</td>
<td>.0410</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUM GPA</td>
<td>3</td>
<td></td>
<td>.9427*</td>
<td>.3318</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOSBY</td>
<td>1</td>
<td></td>
<td>.8160*</td>
<td>.5716</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCHOOL COMP</td>
<td>2</td>
<td></td>
<td>.8831*</td>
<td>.4078</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significance p < .05
TABLE 4.16

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS (LDF) FOR SEVEN VARIABLES SELECTED IN DA #4

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>STANDARDIZED COEFFICIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOSBY</td>
<td>.88325</td>
</tr>
<tr>
<td>SCH COMP</td>
<td>.59150</td>
</tr>
<tr>
<td>CUM GPA</td>
<td>.46834</td>
</tr>
<tr>
<td>NURSING GPA</td>
<td>-.19435</td>
</tr>
<tr>
<td>GPA MICRO</td>
<td>-.32415</td>
</tr>
<tr>
<td>ACT COMPOS</td>
<td>-.18495</td>
</tr>
<tr>
<td>AGE</td>
<td>-.13295</td>
</tr>
</tbody>
</table>
Four of the twelve predictor variables used in DA #4 had pre-entry Lambda values that were significant at .04 level (Table 4.15). Three of the significant variables were retained in the subset of seven predictors after the stepwise procedure. This fourth variable analysis process also included MOSBY, school comprehensive, and cumulative GPA as variables contributing to group separation. Age, ACT and GPA microbiology were also included in the subset and each had negative correlations with the fourth discriminant function. Four predictors that were among the subset DA #1 (derived from all seventeen variables), were excluded in this fourth subset. These four variables represented three freshman-sophomore GPAs and level 1 nursing GPA.

The seven variable subset produced by DA #4 includes variables representing three levels of academic performance; four from senior year, one freshman-sophomore level, and two from the pre-college group. All pre-senior level predictors for this subset (age, ACT, GPA microbiology) were negatively correlated with the fourth canonical discriminant function.

Standardized canonical discriminant functions for the DA #4 variable subset are presented in Table 4.16. These coefficients were standardized to adjust for unequal means and represent individual variable contribution to group separation. Three senior level variables had the largest standardized CDF coefficients. The remaining four variables (including one
senior level) had negative coefficients. The negative values indicate that low values on nursing cumulative GPA, microbiology GPA, ACT, and age are associated with larger values on the criterion or with the pass group.

The variable combination produced by DA #4 includes representation from each of the four dimensions generated from the Factor analysis procedure. The first three factors are each represented by two variables in the DA #4 subset (FAC1-cum GPA, nursing GPA; FAC2-Mosby, ACT; FAC3-GPA Micro, School Comp) and FAC4 is represented by age. In each of these two variable combinations associated with factors, one variable has a negative standardized coefficient, and one a positive value.

The discriminant function statistics for the DA #4 variable subset are presented in Table 4.17. The results in this table represent both the seven and six variable (age deleted before entry in stepwise procedure) subsets. The eigenvalues, canonical correlations and Wilks' Lambda values for the two subsets are similar. These data values represent the ratios of between, within, and total variance associated with the particular discriminant function. For the variable subsets, the large eigenvalues (1.46, 1.50) indicate that the between-groups variability is larger compared to within-group. The results of the squared canonical correlations indicate that about 60% of the samples' variance can be attributed to differences between the pass and fail group. The Lambda value indicates that 40% of the variance
is not attributed to group difference. The Chi Square test of the difference between group means on discriminant scores (derived from discriminant function DA #4) was significant at .0001 level. The resulting misclassification rates are recorded in Table 4.18.
### TABLE 4.17

CANONICAL DISCRIMINANT FUNCTION STATISTICS FOR SIX AND SEVEN VARIABLE SUBSETS FROM DA #4

<table>
<thead>
<tr>
<th>SUB SET</th>
<th>EIGEN VALUE</th>
<th>CANONICAL CORR</th>
<th>WILKS' LAMBDA</th>
<th>$\chi^2$</th>
<th>SIG</th>
</tr>
</thead>
<tbody>
<tr>
<td>VARS 7</td>
<td>1.5037</td>
<td>.7750</td>
<td>.3994</td>
<td>116.098</td>
<td>.0000</td>
</tr>
<tr>
<td>VARS 6</td>
<td>1.4795</td>
<td>.7725</td>
<td>.4033</td>
<td>115.322</td>
<td>.0000</td>
</tr>
</tbody>
</table>

### TABLE 4.18

CLASSIFICATION MISRATES FOR DA #1 AND DA #4

<table>
<thead>
<tr>
<th>DA VARS</th>
<th># CASES</th>
<th>MISS RATES</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAIL</td>
<td>PASS</td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>10</td>
<td>42</td>
<td>103</td>
</tr>
<tr>
<td>#4</td>
<td>7</td>
<td>42</td>
<td>103</td>
</tr>
<tr>
<td>#6</td>
<td>6</td>
<td>42</td>
<td>103</td>
</tr>
</tbody>
</table>
### TABLE 4.19

**PREDICTOR VARIABLES AND RESULTING MISRATES**

*(NUMBER/PERCENT) USING FOUR DIFFERENT SELECTION TECHNIQUES*

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>ALL/VARS</th>
<th>UNCORR</th>
<th>FACTORS</th>
<th>COMMON/METH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(13/09%)</td>
<td>(17/12%)</td>
<td>(41/28%)</td>
<td>(06/04%)</td>
</tr>
<tr>
<td>MOSBY</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>SCH COMP</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>CUM GPA</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>GPA MICRO</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>NURS GPA</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>ACT COMP</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>AGE</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>GPA FRESH</td>
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<td></td>
</tr>
<tr>
<td>GPA LEV1</td>
<td>*</td>
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<td></td>
</tr>
<tr>
<td>GPA MATH</td>
<td>*</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>GPA ENGLISH</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>
Comparisons between Four Variable Selection Techniques

Misclassification rates for the DA #4 variable subset is compared to rates for the DA #1 group in Table 4.18. The number and percent of misclassified failures improved with the fourth variable subset. The deletion of the lowest ranking variable from the DA #4, seven predictor subset did not increase nor decrease the misclassification rates. All three variable subsets presented in Table 4.18 with 10, 7 and 6 variables respectively recorded the same misrates for the pass group. The seven variable subset had a better total classification rate than did the ten variable subset.

A listing of variables for each of the four DA selection techniques used to answer the second research question is recorded in Table 2.19 along with their misclassification rates. Several variables were consistently selected as discriminators (Mosby, GPA microbiology, ACT, and age). The Factor scores recorded the highest misclassification rates and the seven variable method selected from common associations with NCLEX had the lowest misrates. The variable subset with the largest number of variables retained in the model had the second lowest number of misclassified cases.
(3) How might these academic variables be combined into a mathematical equation to predict performance on the "new" NCLEX-RN?

The variable subset with the lowest misclassification rate (DA #4) was used to form the mathematical equation, and to answer the third research question. The linear discriminant function coefficients were derived, and examined for usability in classifying cases with known group membership, into the pass or fail group. These findings along with the test of equal covariance matrices (using Box's $M$), and classification results are presented to examine the efficiency of the prediction equation.

The multivariate normality and equal covariance assumptions were tested and the results are presented in Table 4.20. Validation of these assumptions are essential to interpretation of misclassification rates of the linear discriminant function. The $F$ values for the seven and six variable subsets (DA #4) listed in Table 4.20, indicate that the covariance matrices are not significantly different ($p < .001$). Since Box's $M$ is sensitive to multivariate normality, the failure to reject the hypotheses that matrices are equal for the pass and fail groups, means that the assumptions were not violated. The test of unequal matrices for the six variable subset (ACT, Mosby, Cumulative GPA, Nursing GPA, School comprehensive, GPA microbiology) was rejected at $p < .05$, indicating that this subset was more similar than the seven variable subset (includes age).
TABLE 4.20

TEST OF EQUALITY OF GROUP COVARIANCE MATRICES USING BOX’S M FOR SEVEN AND SIX VARIABLE SUBSETS FROM DA #4

<table>
<thead>
<tr>
<th>SUBSET</th>
<th>Box’s M</th>
<th>F value</th>
<th>Degrees of Freedom</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>VARS 7</td>
<td>56.285</td>
<td>1.8673</td>
<td>28, 22680.1</td>
<td>.0036</td>
</tr>
<tr>
<td>VARS 6</td>
<td>32.189</td>
<td>1.4391</td>
<td>21, 23743.4</td>
<td>.0877</td>
</tr>
</tbody>
</table>

The Fisher’s Linear Discriminant Function Coefficients (Table 4.21), and the standardized canonical coefficients (Table 4.22) represent the weights assigned each variable in the equation to maximize separation. The standardized coefficients which are adjusted for differences in means and standard deviations, provide information on relative importance of the variables in maximizing group separation. Mosby, school comprehensive and cumulative course GPA contribute the most to group separation. The remaining three variables less to discrimination and have negative coefficients. The negative function values are associated with failure and the positive with passing. Therefore the larger the student’s score on GPA microbiology, nursing cumulative GPA and ACT the more the student is
associated with failure. The opposite would be true for the three variables with positive function values.

Unlike the standardized coefficients, the magnitudes of the classification coefficients are not indicators of relative importance of the variables. These values represent the weights assigned each variable to determine which group a particular subject belongs. For the first three variables, the values are larger for the pass group, and the last three variables have larger values for the fail group. The unstandardized coefficients can be used to calculate a subject's discriminant score. Group centroids recorded in Table 4.23 represent the mean discriminant function score for each group. These values indicate that the average score for subjects who failed was a negative 1.7983 and the function mean for the pass group was .81023. The resulting prediction equation follows:

\[
\text{Discriminant Score} = .14927(Mosby) + .71546(Sch_{comp}) + 2.8594(Cum\ GPA) - .5424(GPA_{Micro}) - .7905(Nurs\ GPA) - .42336(ACT)
\]
TABLE 4.21

LINEAR DISCRIMINANT FUNCTION COEFFICIENTS (CLASSIFICATION FUNCTION COEFFICIENTS (LCF))

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>GROUP</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAIL</td>
<td></td>
<td>PASS</td>
</tr>
<tr>
<td>MOSBY</td>
<td>2.1718</td>
<td></td>
<td>2.5612</td>
</tr>
<tr>
<td>SCH COMP</td>
<td>1.2361</td>
<td></td>
<td>1.4228</td>
</tr>
<tr>
<td>CUM GPA</td>
<td>95.8966</td>
<td></td>
<td>103.3557</td>
</tr>
<tr>
<td>NURSING GPA</td>
<td>-9.4510</td>
<td></td>
<td>-11.5132</td>
</tr>
<tr>
<td>GPA MICRO</td>
<td>6.2668</td>
<td></td>
<td>4.8519</td>
</tr>
<tr>
<td>ACT COMPOS</td>
<td>-0.6114</td>
<td></td>
<td>-0.7219</td>
</tr>
<tr>
<td>(CONSTANT)</td>
<td>-220.0231</td>
<td></td>
<td>-265.6930</td>
</tr>
</tbody>
</table>

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### TABLE 4.22

**STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS (LDF) FOR SIX VARIABLES SUBSET**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>STANDARDIZED</th>
<th>UNSTANDARDIZED</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOSBY</td>
<td>.85855</td>
<td>.14927</td>
</tr>
<tr>
<td>SCH COMP</td>
<td>.59840</td>
<td>.71546</td>
</tr>
<tr>
<td>CUM GPA</td>
<td>.48114</td>
<td>2.85948</td>
</tr>
<tr>
<td>NURSING GPA</td>
<td>-.22035</td>
<td>-.79054</td>
</tr>
<tr>
<td>GPA MICRO</td>
<td>-.32985</td>
<td>-.54242</td>
</tr>
<tr>
<td>ACT COMPOS</td>
<td>-.17205</td>
<td>-.42336</td>
</tr>
</tbody>
</table>

### TABLE 4.23

**CANONICAL DISCRIMINANT FUNCTION AT GROUP MEANS (GROUP CENTROIDS)**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>FUNCTION MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAIL</td>
<td>-1.7983</td>
</tr>
<tr>
<td>PASS</td>
<td>.8102</td>
</tr>
</tbody>
</table>
Classification of subjects was based on Baye's rule and prior probability for group membership was specified according to the proportion of cases analyzed that fell into each group. The values presented in Table 4.24 indicates that 31% of cases used in this study failed the NCLEX and 69% passed. The prior probabilities for group membership used to classify subjects was set at .311 and .689 for the fail and pass group. The numbers of subjects in these groups was consistent with the population studied. Numbers of subjects in each group, recorded in Table 4.24 also indicates that the recommended ratio of variables to subjects (1/2) was met.

The classification results, using the mathematical equation derived from the six variable combination (ACT, GPA microbiology, cumulative course GPA, nursing course GPA, Mosby, school comprehensive), are recorded in Table 4.25. The fail group had a 95.2% correct classification rate and the pass group was correctly classified 96.1% of the time. The overall correct classification rate was 95.86% and 6 of 145 subjects were misclassified.
**TABLE 4.24**

NUMBER OF CASES USED IN DISCRIMINANT ANALYSIS AND CLASSIFICATION, AND PRIOR PROBABILITIES BY NCLEX RESPONSE

<table>
<thead>
<tr>
<th>NCLEX RESPONSE</th>
<th>DA</th>
<th>CLASSIFICATION</th>
<th>PRIORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAIL GROUP</td>
<td>41</td>
<td>42</td>
<td>.311</td>
</tr>
<tr>
<td>PASS GROUP</td>
<td>91</td>
<td>103</td>
<td>.689</td>
</tr>
<tr>
<td>TOTAL</td>
<td>132</td>
<td>145</td>
<td>1.000</td>
</tr>
</tbody>
</table>
TABLE 4.25
CLASSIFICATION RESULTS FROM DISCRIMINANT PROCEDURE

<table>
<thead>
<tr>
<th>ACTUAL GROUP</th>
<th>NO. OF CASES</th>
<th>PREDICTED GROUP MEMBERSHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAIL</td>
<td>PASS</td>
</tr>
<tr>
<td>FAIL</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95.2%</td>
<td>4.8%</td>
</tr>
<tr>
<td>PASS</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.9%</td>
<td>96.1%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>145</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CORRECT CLASSIFICATION RATE: 95.86%</td>
<td></td>
</tr>
</tbody>
</table>
(4) What is the accuracy rate and stability for the equation derived?

The utility of the Discriminant Function was examined using a hold-out sample of 71 subjects. The cases represented graduates of one of the three schools used in the study (Gamma) and these subjects were not included in the variable analysis nor the development of the equation. Results of the cross-validation are recorded in Table 4.26. The correct classification rate provides information on the stability of the prediction equation and the degree of shrinkage. The correct classification rate of 76.06% for the hold-out sample indicates that the shrinkage over schools would equal 19.80%. The number of failures misclassified was 46% compared to 5% for the sample used to develop the equation.
**TABLE 4.26**

CLASSIFICATION RESULTS FROM DISCRIMINANT PROCEDURE FOR HOLD-OUT SAMPLE

<table>
<thead>
<tr>
<th>ACTUAL GROUP</th>
<th>NO. OF CASES</th>
<th>PREDICTED GROUP MEMBERSHIP</th>
<th>FAIL</th>
<th>PASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAIL</td>
<td>13</td>
<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>53.8%</td>
<td>46.2%</td>
<td></td>
</tr>
<tr>
<td>PASS</td>
<td>58</td>
<td>11</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>19.0%</td>
<td>81.0%</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CORRECT CLASSIFICATION RATE: 76.06%
CHAPTER 5

SUMMARY AND CONCLUSIONS

Purpose

The purpose of this study was to identify academic variables that could be used to forecast success on the "New" nursing licensure exam for minority, baccalaureate students enrolled in higher education in the south. A second purpose was to develop a methodological framework for predicting success on the post-1988 versions of the NCLEX-RN, that addressed: (1) stability and generalizability across curricula and schools, and (2) variable selection to minimize misclassification of failures.

Problem

This research study addressed three major areas related to success of nursing students, including the need; (1) to develop a framework for predicting success using the new dichotomous NCLEX-RN score as criterion; (2) to address the unique needs of growing numbers of minority nursing students; and (3) to investigate methodologies that enhance stability of prediction results across schools and curricula.

Design

The study design was non-experimental, ex post facto, predictive research. Discriminant analysis, factor analysis and cross-validation, using a hold-out sample (representing graduates of a school not included in the
variable analysis) were used to analyze predictor variables and classify subjects into a pass or fail group. Four variable selection-elimination techniques were used, prior to a stepwise procedure, to identify the most effective subset of predictors. The sample was purposive, deliberate, non-randomized and included 216 minority graduates of three BSN programs located in Louisiana.

**Research Questions and Findings**

**(1) What is the relationship between academic variables and performance on the "new NCLEX-RN" for minority BSN students residing in the southern region and enrolled in different nursing programs?**

Twelve predictor variables were found to be associated with NCLEX success for minority nursing students, enrolled in BSN programs located in Louisiana, including: ACT composite score, age, Mosby assessment, school comprehensive exams, and eight grade point averages (cumulative college, admit to nursing, cognate courses, English, microbiology, psychology, sociology, cumulative nursing course). The GPA in microbiology, along with college cumulative and nursing course GPAs, Mosby, and the school comprehensive exam showed the largest significant differences between the pass and fail groups (univariate F values with significance < .0001).

Two clusters of variables were significantly associated with NCLEX success (p < .05) including; (1) Mosby, ACT score, GPA English, GPA
psychology, and (2) school comprehensive and GPA microbiology. These clusters, resulting from factor loadings, could indicate that dimensions labeled "test-taking skill" and "application vs memory recall abilities" are related to success of minority nursing students. The factors revealed a common association between high scores on the school comprehensive and low scores on GPA microbiology.

The Mosby assessment score and the GPA in microbiology were consistently (associated across three methods) related to success. Academic variables that were not found to be associated with NCLEX success represented early stages of college academic performance. The GPAs from high school, freshman-year college, math in college, and GPAs for Level 1 and Level 3 nursing courses were not associated with NCLEX for students used in this study.

(2) Which academic variables are useful in predicting success on the "new" NCLEX-RN for minority BSN students residing in the southern region enrolled in different nursing programs?

The four variable selection-elimination techniques produced a six variable subset of the 17 predictors (Mosby, school comprehensive exams, cumulative college GPA, nursing course cumulative GPA, microbiology GPA, ACT composite) that was found to be most effective in predicting success of minority nursing students. The Mosby assessment and the school
comprehensive made the largest contribution to separation of the pass and fail groups, among the six variable subset.

More senior level variables (four) were predictive of NCLEX performance, than other academic stages. ACT and GPA microbiology were the only non-senior level variables included among the six variables found to be most predictive of NCLEX success. Both of these pre-nursing variables had negative standardized coefficients.

The findings related to the contribution of ACT composite score and microbiology GPA to group separation provided some insight into predictors for minority students. This study found that higher ACT scores were not necessarily associated with passing NCLEX (LCF was negative .42336). Among the six variable combination, ACT made the least individual contribution to predicting success.

Like the ACT score, higher GPAs in microbiology were associated with failure and lower values with the pass group. Of the six variables, GPA microbiology was ranked fourth on relative importance to group separation. The importance of these variables to group separation was examined within the context of all six variables, and therefore conclusions are related to partialed out contributions. For the six variable set, subjects who scored high on Mosby and school comprehensive and low on ACT and microbiology were associated with the pass group. Likewise, cases with
low scores on Mosby and school comprehensive and high scores on ACT and microbiology were members of the fail group.

The DA mathematical requirements for subject to variable ratio and interval level predictors, were met. The six variable subset resulted in a subject to predictor ratio of 7:1 for the fail group (n = 42) and 17:1 for the pass group (n = 103). The total variable analysis sample included 145 subjects and values for six predictors.

(3) **How might these academic variables be combined into a mathematical equation to predict performance on the "new" NCLEX-RN?**

The Fisher's discriminant function derived in this study was effective in separating subjects into two significantly different groups. The linear discriminant function coefficients associated with each of the six predictors were used to develop the mathematical equation for deriving discriminant scores. The mean function score for subjects who failed was a negative 1.7983, and the mean for the pass group was 0.81023. The resulting prediction equation follows:

\[
\text{Discriminant Score} = 0.14927(\text{Mosby}) + 0.71546(\text{Sch_comp}) + 2.8594(\text{Cum GPA}) - 0.5424(\text{GPA_Micro}) - 0.7905(\text{Nurs GPA}) - 0.42336(\text{ACT})
\]

The squared canonical correlation for the discriminant function showed that 60% of the variance in the discriminant scores can be
attributed to differences between the pass and fail group. The Lambda value indicated that only 40% of the variance was not explained by group difference. The discriminant function for this study produced predictor scores that were significantly different for the pass and fail groups ($X^2 = 115.322$, df 6, $p = .0000$). Box’s M test showed that cases and values for the six variable subset represented a multivariate normal population and the covariance matrices for both the pass and fail groups were equal (df 21, 23743.4, rejected at $p = .0877$).

(4) What is the accuracy rate and stability for the equation derived?

The six variable subset selected in this study produced a prediction equation that resulted in correct classification rates that were higher than rates expected from assignment by chance alone. The equation resulted in correct classification of 95% of the subjects who failed NCLEX, and 96% of those who passed. The predictive equation had a 96% accuracy rate for the total internal sample. When the accuracy of the equation was evaluated, using proportional chance criterion, the rate for the internal sample resulted in a 90% improvement over rates expected by chance. The standard rate of improvement in accuracy of classification for the sample used to develop the equation was 1 versus 61 errors expected by chance.

The prediction equation derived in this study was also found to be stable across schools and curricula. When the LDF was used to classify
subjects representing a school not included in the variable analysis, the classification rate was 76%. The hold-out, cross-validation sample, showed 26% fewer errors in classification than was expected by chance assignment. This sample recorded a ratio of 1:27 for the actual and expected by chance errors. The shrinkage of only 19.80% across schools indicated that the equation derived could be replicated in future studies. The results of the proportional chance criterion evaluation, and the cross-validation process indicated that the statistical results were externally valid and generalizable to the larger population of minority nurses residing in the south.

Discussion

The methodological framework used to select and analyze predictors of success for minority nursing students on the "New" NCLEX was effective in addressing the statistical significance of the study. The stability of research findings were enhanced when appropriate statistical procedures were used to analyze dichotomous level criterion variables, and when model assumptions were met. The use of variable selection-elimination techniques before the DA stepwise process, demonstrated the importance of identifying the best predictor subset. The four stage variable selection process, that isolated six predictors from a set of 17, produced a mathematical equation that accurately identified subjects who would most probably fail the "New" NCLEX exam.
The results of a hold-out sample and the proportional chance criterion used to evaluate accuracy and stability, showed that the equation derived was not sample specific, but could be stable across schools. The study demonstrated the utility of these procedures, in interpreting research findings.

The research showed that senior level variables are predictive of success for minority nursing students. These predictors combined with microbiology and ACT scores can be used to identify students at risk for NCLEX failure. Admission level variables were not predictive of success for minority students. The Mosby assessment score and the schools comprehensive exams made the largest individual contribution to predicting success.

Commonalities among variables resulting from factor analysis and discriminant analysis indicated that for minority nursing students, low scores on the ACT are associated with high scores on Mosby. Additionally, low GPAs in microbiology were associated with high scores on the school comprehensive exam. The patterns presented by these findings could give some insight into learning ability of students. These results could indicate that for minority students, low academic abilities, as measured by ACT, are not good predictors of NCLEX failure. Further, the association between success on senior level variables and low abilities at these early levels could
indicate that, for minority students who persist to graduation, low ACT scores and pre-nursing GPAs are not associated with college failure.

Integration With Literature Review

The findings of this study support the results of previous research on minority student success on the licensure exam. Additionally, some conflicting results were found related to the stages of academic performance that were predictive of NCLEX success. Classification accuracy for this study was higher than rates for previous research.

Several previous studies support the finding that senior level academic variables are predictive of NCLEX success (Adams, 1990; Dell & Halpin, 1984; Jenks et al, 1989; McKinney, 1988). Jenks et al (1989) and Haney et al (1977) also found that GPA microbiology was a good indicator of licensure exam performance. Horns et al (1991) found that senior level variables were the least important among a set of variables that included race as a predictor.

The finding that Mosby AssessTest, cumulative GPA, microbiology GPA and ACT were indicators for minority students were also supported (Adams, 1990; Dell & Halpin, 1984; Haney et al, 1977). Haney et al found that of several combinations of 28 variables, microbiology was always selected for Blacks but not for other groups. Data on the direction of the relationship between microbiology and success was not available for the
minority students used in the Haney study, but research on white students conducted by Jenks et al showed a positive significant relationship with this predictor.

Of the several studies that used classification to measure accuracy of prediction, the correct rates ranged from 51% to 84%. These studies used one staged techniques to isolate variables before entry into a selection process (forward, backward, forced, or stepwise). The study by Payne & Duffey (1986) used a hold-out sample representing students from the same school and recorded a cross-validation accuracy rate of 75%. Results related to extension of the cross-validation process across curricula, and accuracy rates of 95% for failures were not supported by the literature review.

Integration with Prediction Framework

The results of this study should be considered within the context of prediction research. Findings generated by these investigations are restricted in their ability to detect cause-effect relationships. Significant relationships between predictors and criterion presented in this study are not presented as explanations of phenomena. In other words, the significant predictors should not be viewed as causes of NCLEX success or visa versa, these selected variables are simply predictors of future performance.
A second area that should be considered in interpretation of prediction results relates to the problem with restriction in range of values used in this study. The criterion and predictor scores represented graduates of the three BSN programs. Scores representing students who did not succeed to completion of the BSN degree, were not included in the study, and therefore variance on these values was confined. This explicit selection and restriction in range could cause underestimation of the validity of the predictive data.

Conclusions and Recommendations

The findings indicated that the best predictors of success for minority BSN nursing students were the Mosby Assessstest, school comprehensive exit exams, GPA microbiology, the college cumulative GPA, nursing course cumulative GPA, and ACT composite. The design used in this study generated a mathematical equation (derived from the six academic variables) that had a correct classification rate of 96% for students used in the study. Only two of forty-two subjects (4.8%), known to belong to the fail group, were misclassified. The cross-validation, correct classification rate for BSN graduates of a different school was 76% (shrinkage equaled 19.80%).

A methodological design that incorporated discriminant analysis, factor analysis and a four stage variable selection process, employed prior to a stepwise procedure, produced a prediction equation that was
externally valid and stable across schools. The prediction equation was found to be generalizable to the larger population of minority nursing students.

A set of predictors that were common across three association techniques (Uncorrelated, factor scores, univariate F), produced a subset of academic variables that was effective in forecasting success on NCLEX for minority students. This study also found that senior level academic variables were more often predictive of success than freshman level indicators. Also, larger values on ACT composite score and microbiology GPA were associated with the failure group, and ACT was the least important contributor to group separation.

The results of this study support the inclusion of multi-stage variable selection techniques in predicting success on NCLEX. This study showed that classification accuracy could be improved when a multi-stage process was used. Additionally, the use of methods to evaluate external validity, and generalizability of research findings enhances the replicability of research. The continued interest in research on NCLEX success, supports the need to use methodological designs, like the one employed in this study, to generate findings that are not sample specific.

Minority student success in nursing education could be enhanced if educators used predictors to identify potential NCLEX failures. The Mosby Assessstest and school comprehensive exams have been validated as
predictors of success on the "new" NCLEX-RN, for minority students. These exams should be used to select students who are in need of additional help in succeeding on the licensure exam. The equation presented could be used to predict minority student success with some degree of accuracy. The results of this study provide empirical data that could be used by educators to improve the success rate of minority students.

The ACT and pre-admit GPAs should be used cautiously in eliminating minority students from nursing education. The findings of this study indicate that high ACT scores are not necessarily predictive of NCLEX success. The implications of the findings from this study and previous research, on the role of microbiology content in forecasting success for minority students should be further investigated. Insight into negative associations between ACT and Mosby, and school comprehensive exams and microbiology, could enhance our understanding of learning characteristics of minority students.
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VITA

Janet Simmons Rami received a bachelor of science in nursing degree from Dillard University, New Orleans, Louisiana, in 1970, and a masters degree in cross-cultural mental health nursing from the University of Southern Mississippi, Hattiesberg, Mississippi, (1979). Her professional career as a nurse began in 1970 at Earl K. Long Hospital in Baton Rouge, Louisiana. She spent 14 years in the State Hospital System, including eight years as Director of Nurse Staff Education. In 1983 she coordinated nurse staff education programs for the Louisiana State Office of Hospitals.

She was appointed Dean of the School of Nursing, at Southern University, Baton Rouge, Louisiana in 1986 and guided the program through the acquisition and move into the new state-of-the-art building, and to national accreditation of the baccalaureate program. Through her leadership the SU School of Nursing has become nationally recognized for its success in educating minority nursing students. The students at Southern had two consecutive 100% pass rates on the National Licensure Exam in 1990 and a 95% pass rate in 1991.

Janet Rami is currently a consultant to the US Public Health Service, Division of Nursing, located in Rockville Maryland, and serves as a peer reviewer for its 20 million dollar grants program. She has secured over 1.2 Million dollars in federal grant funds for disadvantaged nursing students at Southern. She has written numerous manuscripts, and a publication related...
to predicting success of minority students on the national licensure exam. She was recognized as "Outstanding Nurse Educator of the Year" by the Baton Rouge District Nurses Association in 1990. Additionally she; has served on the Board of Directors for the Louisiana State Nurses Association, was appointed to a Louisiana Governors Commission by former Governor Dave Treen, and served on the state's Council of Administrators of Nursing Education (CANE) task force, designed to solicit additional funding for state supported nursing education programs.

Janet Simmons Rami, a native of Washington, Louisiana (near Opelousas), has three adult children, ages 18 through 23, and resides in Zachary, La. She is the third of four daughters, born to Mr. Joseph Simmons, and Lydia Lawson Simmons. Janet's mother is a retired, high school math teacher, from St. Landry Parish.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Janet S. Ramí
Major Field: Education
Title of Dissertation: Predicting Success of Minority Nursing Students on the "New" NCLEX-RN

Date of Examination: July 6, 1992

Approved:

[Signatures]

Major Professor and Chairman
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

July 6, 1992