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Development of the simulation thinking rubric

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ABSTRACT

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High fidelity simulation has become a widespread and costly learning strategy in nursing education because it can fill the gap left by a shortage of clinical sites. In addition, high fidelity simulation is an active learning strategy that is thought to increase higher order thinking such as clinical reasoning and judgment skills in nursing students. Nursing educators who utilize curriculum planned high fidelity simulation activities measure simulation learning outcomes with various instruments. However, few can quantify learning in nursing students due to high fidelity simulation and most are not supported by a theory of learning.

This methodological study sought to test the psychometric properties of a new instrument--the Simulation Thinking Rubric. The purpose of the rubric was to assess higher order thinking during high fidelity simulation.

A convenience sample of 22 first semester junior year and 22 fourth semester senior year Bachelor of Science in Nursing (BSN) students participated in the study. Each of the 44 BSN nursing students engaged in a high fidelity simulation research scenario to allow six trained raters to score the simulation thinking rubric.

Results for content validity were a scale content validity index average of .9764 and a scale content validity average of .92857 that provided evidence of content validity of the simulation thinking rubric. For construct validity, an exploratory factor analysis

with a principle component analysis procedure found four components that clustered together but did not represent the four cognitive stages of development of higher order thinking. In addition, the one-way analysis of variance (ANOVA) indicated first semester junior year students scored (M = 3.20, SD = 0.74) in the pre-operational stage of cognitive development of higher order thinking and fourth semester senior year BSN students scored (M = 4.11, SD = 1.12) in the concrete stage of cognitive development of higher order thinking. Although the sample size was small and the ANOVA findings were not statistically significant, the magnitude of the difference (η^2. 21) suggested that in the future, an additional ANOVA procedure with a larger sample size might be warranted. With respect to internal consistency reliability, a Cronbach's alpha of .74 provided weak evidence that the simulation thinking rubric was measuring the concept of higher order thinking. The psychometric testing of the simulation thinking rubric did not provide strong statistical evidence of construct validity and internal consistency reliability.

Knowledge gained from this study might assist other researchers in avoiding the same limitations in developing theoretically based evaluation instruments to measure learning related to high fidelity simulation. Without a strong theoretical basis that describes, defines, and explains the phenomenon of higher order thinking, the results of psychometric testing of the simulation thinking rubric score had no meaning.

The following recommendations are made for future research: (a) examine the literature for adult theories of learning, (b) conduct a concept analysis on the construct of higher order thinking, (c) sample the domain of higher order thinking based on the concept analysis, and (d) develop items for a new instrument.

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CHAPTER I

PROBLEM AND BACKGROUND

Introduction

Chapter I presents the purpose of the study, the research question, and the study aims. This is followed by an introduction to the concept of higher order thinking (HOT), the use of high fidelity simulation (HFS) in nursing education, and a brief overview of the theoretical framework for the simulation thinking rubric (STR). The chapter concludes with the significance of the study to nursing education.

Purpose of the Study

The purpose of this study was to test a theoretically based instrument (the Simulation Thinking Rubric) that might be utilized to assess the cognitive developmental stage of higher order thinking related to high fidelity simulation.

The study aims were as follows:

1. To establish content validity of the simulation thinking rubric based on consultation with the Simulation Based on Learning Language model (SIMBaLL) developers and to further query content experts for evidence of content validity,
2. To provide evidence of construct validity with a contrasted groups approach and an exploratory factor analysis,

3. To provide evidence of internal consistency reliability of the simulation thinking rubric,
4. To provide evidence of equivalence reliability with an inter-rater agreement procedure.

Higher Order Thinking

The Essentials of Baccalaureate Education for Professional Nursing Practice (American Association of Colleges of Nursing [AACN], 2008) states that a liberal arts education is the foundation for the acquisition of higher order thinking (HOT) in college students. A broad- based education in the sciences and humanities and higher-order cognitive and practical skills prepare students to transition from a liberal arts background into the complexities of a nursing education (AACN, 2008). However, college learners struggle with HOT, which is required for conceptual thinking and understanding (Arwood & Kaakinen, 2009; Ben-Chaim, Sait, & Zoller, 2000; Burns, O'Donnell, & Artman, 2010; Del Bueno, 2005; Gruberman, 2005; McGovern & Valiga, 1997; McKinnon & Renner, 1971; Quellmalz, 1985; Schwebel, 1975; Sheldon, 2005; Thornton & Fuller, 1981; Young, 2007). Educators from nursing and other healthcare professions are concerned that critical thinking, a higher order reasoning skill, might not be established when students graduate from their program of study (Del Bueno, 1985; Facione & Facione, 1996; Lapkin, Levett-Jones, Bellchambers, & Fernandez, 2010; McGovern & Valiga, 1997). The literature suggests that HOT skills such as expert reasoning and critical thinking can develop using HFS as a learning methodology (Bremner, Aduddell, Bennett & VanGeest, 2006; Burns et al., 2010; Friedrich, 2002). In baccalaureate nursing education, the inability to graduate nursing students with professional HOT skills prepares entry-level nurses who are less able to provide safe and effective patient care (Del Bueno, 1985; Facione & Facione, 1996; Lapkin et al., 2010; O'Connor, 2006).

High Fidelity Simulation in Nursing Education

High fidelity simulation is a widespread pedagogical modality utilized in institutions of higher education (Damasi & Sitko, 2006) and is considered an innovative and active student-centered learning strategy in nursing education (AACN, 2008; National League for Nursing [NLN], 2003; Nehring & Lashley, 2010). Nursing leaders and nursing organizations support the incorporation of HFS into nursing curricula (AACN, 2008; National Council of State Boards of Nursing [NCSBN], 2005) because it is complementary to traditional clinical education. High fidelity simulation is complementary to clinical education because it is an active learning strategy that allows nursing students to not only demonstrate procedural skills but also HOT abilities such as clinical decision-making, problem solving, and critical thinking (AACN, 2008; Nehring, 2008; NLN, 2003, 2005). Critical thinking, problem solving, and critical reasoning skills are the basis for the provision of safe and effective nursing care in an increasingly acute and complex clinical environment (Del Bueno, 2005; Forbes & Hickey, 2009; Ironside & McNellis, 2011; Lapkin et al., 2010; Nehring, 2008; Sherwood & Drenkard, 2007; Tanner, 2006b).

Although the use of high fidelity simulation in nursing and other health care professions is a widely accepted practice (Alinier, Hunt, Gordon, & Harwood, 2006; Bradley, 2006; Cant & Cooper, 2009; Harder, 2010; Issenberg, McGaghie, Petrusa, Gordon, & Scalese, 2005; Kardong-Edgren, Adamson, & Fitzgerald, 2010; Kautz, Kuiper, Pesut, Knight-Brown, & Daneker, 2005; Kneebone, Scott, Darzi, & Horrocks, 2004; Murin & Stollenwerk, 2010; Okuda et al., 2009; Shinnick, Woo, & Mantes, 2011; Waxman, 2010), the discipline of nursing has embraced this innovative educational strategy without significant research that can quantify the role of HFS in clinical education and in the development of HOT skills such as critical thinking, clinical judgment, or clinical decision-making skills (Alinier et al., 2006; Cant & Cooper, 2009; Harder, 2010; Kardong-Edgren et al., 2010; Kautz et al., 2005; Shinnick et al., 2011; Waxman, 2010; Weaver, 2011). The *Future of Nursing* report (Institute of Medicine [IOM], 2010) pointed out that nurse educators are augmenting clinical time with HFS without data to define what portion of time in clinical experience HFS can replace. The discipline of medicine agrees that there is no scientific evidence that can establish a direct link between gains in cognition and the use of HFS as a learning strategy (Bradley, 2006; Issenberg et al., 2005; Murin & Stollenwerk, 2010).

The use of high fidelity simulation as an instructional activity will not reach its potential effect in nursing education nor will there be justification for the cost and effort (Bland, Topping, & Wood, 2010; Bradley, 2006; Shinnick et al., 2011) unless there is evidence that HFS promotes cognitive gains in nursing students. Learning during HFS is difficult to quantify without a reliable and valid instrument that can measure cognitive gains. Therefore, more research is necessary to substantiate HFS as a sound instructional practice and to validate claims that HOT skills such as critical thinking, clinical judgment, and decision-making abilities increase due to HFS. The first step in validating cognitive gains in undergraduate nursing students is to develop a theoretically based and psychometrically sound instrument that can assess a nursing student's baseline cognitive developmental stage of HOT. Then with a baseline assessment as a foundation (Oermann & Gaberson, 2006), nurse educators may be able to design developmentally appropriate HFS scenarios that may facilitate BSN students' cognitive development of HOT.

Learning Theory

Instructional methods that are active and student-centered such as high fidelity simulation might facilitate the development of higher order thinking in undergraduate nursing students when based on a theory of learning (Kaakinen & Arwood, 2009; Rourke, Schmidt, & Garga, 2010). However, in nursing education, the development of HFS scenarios is not typically based on learning theory (Kaakinen & Arwood, 2009; Rourke et al., 2010). Scenarios are most often based on nursing theory or a curriculum framework and are designed to meet course, level, and program outcomes. An alternative to the current foundation of curriculum framework for development of HFS scenarios is the use and application of learning theory as suggested in the simulation based on language and learning (SIMBaLL) model (Arwood & Kaakinen, 2009).

The development of the simulation thinking rubric was founded on the SIMBaLL model because it provides a learning framework specifically designed for using HFS as a learning strategy and as a systematic method to evaluate learning during HFS (Arwood & Kaakinen, 2009; Feingold, Calaluce, & Kallen, 2004; Paige & Daley, 2009). The SIMBaLL model utilizes Jean Piaget's theory of cognitive development (Inhelder & Piaget, 1958) to describe and identify four stages of cognitive development. Piaget's theory states that learning is developmental and occurs in four hierarchal and invariant cognitive stages (Driscoll, 2005; Inhelder & Piaget, 1958). One of the assumptions of the SIMBaLL model is that HOT in nursing students is developmental (Arwood & Kaakinen, 2009; Kanuka, 2010) and can be learned and measured in stages with developmentally designed HFS scenarios. Piaget's four stages of cognitive development are (a) sensorimotor operations, (b) preoperational operations, (c) concrete operations, and (d) formal operations (Inhelder & Piaget, 1958). The SIMBaLL model (Arwood & Kaakinen, 2009) applies Piaget's cognitive developmental stages to evaluate the "meaning of ideas or behaviors" of BSN nursing students engaged in high fidelity simulation (Arwood, 2011, p. 140; E. Arwood, personal communication, March 9, 2012). According to the SIMBaLL model, at the cognitive developmental stage of formal operations (Arwood & Kaakinen, 2009; Inhelder & Piaget, 1958), a nursing student has acquired the ability to provide safe and effective nursing care for multiple complex patients across a variety of contexts (Arwood & Kaakinen, 2009).

The neurosemantic learning language theory (NLLT) is the foundation for the SIMBaLL model (Arwood & Kaakinen, 2009). The NLLT (Arwood, 2011) explains how human beings process data from the outer environment into the physical body and how the data are made meaningful. In addition, the NLLT explains how language parallels cognitive development and plays an essential role in the development of higher order thinking. There are four learning stages in the NLLT: sensory, perceptual, conceptual, and language (Arwood, 2011). The neurosemantic learning language theory explains the neurobiology of learning and provides the basis for understanding concept development in nursing students engaged in high fidelity simulation.

Significance to Nursing

High fidelity simulation is an educational strategy used extensively in nursing education and is costly and time consuming (Cant & Cooper, 2009). Nurse educators support the use of HFS as a teaching strategy that facilitates higher order thinking skills, e.g., clinical judgment, critical thinking, and clinical decision-making (Burns et al., 2010). In addition, nursing organizations promote the use of HFS to augment time spent in traditional clinical education. Yet, there is little, if any, scientific basis for the assertion that the use of HFS is responsible for cognitive gains in undergraduate nursing students. Therefore, the use of HFS is not evidence-based. There is a need to establish a direct link between HFS and cognitive gains in nursing students. The current study explored the development of a new instrument, the simulation thinking rubric, based on a specific learning theory (the SIMBaLL model) that could provide a baseline assessment of nursing students' HOT skills. Further, if the STR was found to be psychometrically sound, a baseline assessment of nursing students' cognitive developmental stage of HOT would inform the developmental design of simulation learning outcomes. High fidelity simulation scenarios based on a learner's needs might assist nursing students in the acquisition of more complex conceptual knowledge. In addition, a psychometrically sound STR might be useful in future intervention studies to quantify a direct relationship between cognitive gains and HFS as a teaching-learning strategy and for augmenting clinical time (Kardong-Edgren et al., 2010; Nehring & Lashley, 2010). A psychometrically sound simulation thinking rubric that can assess student learning might contribute to the science of nursing education and evidence-based simulation practice (AACN, 2008; Cant & Cooper, 2009; Kardong-Edgren et al., 2010; Nehring & Lashley, 2010; Rhodes & Curran, 2005; Todd, Manz, Hawkins, Parsons, & Hercinger, 2008; Waxman, 2010).

CHAPTER II

REVIEW OF LITERATURE

This chapter presents a review of the literature with a fourfold purpose: (a) synthesize the literature relevant to the concept of higher order thinking (HOT), (b) provide a brief history of high fidelity simulation in nursing (HFS), (c) review the literature regarding current HFS measurement instruments and identify gaps in the current state of the science, and (d) define the theoretical framework, the simulation based on learning language model (SIMBaLL), that is the basis for the design of the simulation thinking rubric (STR).

The Concept of Higher Order Thinking

A goal for both primary and secondary institutions of learning is to graduate college students with higher order thinking skills (AACN, 2008; Barak & Shakman, 2008; Ben-Chaim al., 2000; Facione & Facione, 1996; Harrigan & Vincenti, 2004; Ivie, 1998; McGovern & Valiga, 1997; O'Connor, 2006; Oliver-Hoyo & Justice, 2008; Tanner, 2010; U.S. Department of Education [NPEC], 2000). In an outcome-driven and economically depressed academic era with decreased resources, institutions of higher learning are challenged to provide objective evidence that students are graduating with HOT abilities. College graduates are entering a complex, fast paced, technological, and information-rich 21st century environment that requires multifaceted critical thinking, decision-making, and problem solving skills in well-structured and ill structured educational and professional environments (McGovern, 1995). In contrast, the literature suggests that a college education does not necessarily facilitate the development of HOT skills in college students (Barak, Ben-Chaim, & Zoller, 2007; Glisczinski, 2007; Gruberman, 2005; King, Wood, & Mines, 1990; McGovern, 1995; McGovern & Valiga, 1997; McKinnon, 1970; Sheldon, 2005; U. S. Department of Education, 2000). Glisczinski (2007) reported that college graduates are not able to understand complex conceptual knowledge, cannot engage in critical problem solving, and are unable to view problems from another's perspective. Del Bueno (2005) suggested that new nurse graduates are not entering practice with entry-level clinical judgment skills. Similarly, McGovern and Valiga (1997) found that when tested, freshman level nursing students' baseline HOT skills were at lower stages rather than more advanced stages of cognitive development. Entry-level higher order thinking skills such as problem-solving, critical thinking, and clinical judgment skills are important in protecting patients from harm because nurses are the first healthcare professionals to assess, identify, and act on a possible patient problems (Bremner et al., 2006; Institute of Medicine, 2010; Lapkin et al., 2010). Consequently, to graduate safe and effective nursing graduates, nurse educators are called on to develop scientific, evidence-based learning strategies that will facilitate the cognitive development of higher order thinking (AACN, 2008).

Higher order thinking is not a new concept in education but has a long history and is discussed in the literature by philosophers, psychologists, curriculum theorists, and nurse educators (Arwood & Kaakinen, 2009; Barak et al., 2007; McGovern, 1995) and is of interest to a variety of disciplines such as pharmacy, medicine, music, math, science, and nursing (Barak & Shakman, 2008; Facione & Facione, 1996; Issenberg et al., 2005;

Quellmalz, 1985). A general definition of higher order thinking is thinking that is non-linear, complex, produces multiple solutions, demands application of multiple criteria, is self-regulated, and involves uncertainty (Barak & Shakman, 2008). Higher order thinking in nursing is characterized as the capacity to analyze, synthesize, apply, and evaluate knowledge, and includes the ability to recognize problems and assess alternatives while drawing conclusions and making decisions (Del Bueno, 2005; Jeffries & Norton, 2005; Oermann & Gaberson, 2006; Tanner, 2006a). Terms such as critical thinking, clinical reasoning, clinical judgment, problem solving, decision making, higher order cognitive skills, higher order reasoning, higher order learning, and higher level learning are used synonymously in the literature to represent the concept of HOT (Oermann & Gaberson, 2006; Tanner, 2006a). Despite the use of the term, there is no consensus on the definition of higher order thinking or how to assess this skill in learners (Gruberman, 2005; O'Connor, 2006).

Within the discipline of nursing, the terms problem solving, decision-making, and critical thinking are used synonymously with the term clinical judgment. Tanner (2006c) defined clinical judgment for a practicing nurse as the "interpretation or conclusion about a patient's needs, concerns, or health problems, and/or the decision to take action, use or modify standard approaches, or improvise new ones as deemed appropriate by the patient's response" (p. 204). In addition, HOT is described as the cognitive ability to apply conceptual knowledge, abstract principles, and theories, and is of interest to the discipline of nursing. The ability to apply concepts is considered an essential element in nursing education and practice because nursing students and new graduate nurses are held accountable for the provision of safe and effective nursing care (AACN, 2008; Jeffries & Norton, 2005; Nehring & Lashley, 2010; Simpson & Courtney, 2002).

Facione and Facione (1996) identified critical thinking in a nursing context as a restrictive term that does not adequately define the thinking processes and judgments that professional practicing nurses exercise and nursing students need to learn. The term critical thinking was described by Facione and Facione as "…that higher order reasoning used in reaching professionally informed judgments in high-stakes, time-constrained, and many times, novel problem situations" (p. 41). Similarly, Tanner (2006a) suggested moving away from the term critical thinking, preferring the term clinical judgment, and defined the term clinical reasoning as the process used by nurses to make clinical judgments. Tanner added that clinical judgment is an interpretation or conclusion regarding the healthcare needs of a patient in context, the ability to intervene in a timely manner if required, to use or modify standard approaches or change course, and create new approaches guided by the patient's response to care. Clinical judgment is a complex process that requires higher order thinking and enables nurses to navigate through healthcare contexts that may involve ethical dilemmas and are ill structured and value laden (McGovern & Valiga, 1997; Tanner, 2006a)

In the same way, Ivie (1998) defined higher order thinking as having the ability to demonstrate three characteristics: (a) the ability to utilize abstract structures for thinking, (b) the ability to organize information into an integrated system, and (c) the ability to use rules of judgment and logic or sound reasoning. Quellmalz (1985) defined HOT as thinking that is purposeful and extended, can identify a problem, defines and clearly discerns salient and irrelevant information, judges and links together pertinent data, and evaluates the breadth of the information and procedures to draw conclusions or solve problems. Quellmalz asserted that learners who are aware of their own thinking and develop self-monitored problem solving strategies are demonstrating the characteristics of HOT. Likewise, Gruberman (2005) defined HOT as "purposeful integration, manipulation, and orchestration of various thinking skills and knowledge applied in novel and highly adaptive arrays toward the analysis and resolution of a complex question or problem" (p. 15). Further, higher order thinking requires openness and an ability to recognize ill-structured contexts, identify salient aspects of patient care, and the ability to act on clinical judgments.

For this research, the definition of higher order thinking (see Appendix A) was based on the SIMBaLL model that defined HOT as thinking and linguistic function with maximum displacement, flexibility, and decreased redundancy at the cognitive developmental stage of formal operations (Arwood, 2011; Arwood & Kaakinen, 2009; Inhelder & Piaget, 1958). Displacement is "an expanded language function that develops as cognition increases the meaning of ideas further and further away from the physical source" (Arwood, 2011, p. 383). Flexibility is "an expanded language function that refers to the way that a person is able to use language about the particular topic in a variety of places" (Arwood, 2011, p. 384). Redundancy is "an expanded language function that refers to the way that meaning overlaps increasing the cognitive meaning while limiting the structural redundancy of language" (Arwood, 2011, p. 391). Linguistic function is the ability to create formal symbolization of concepts that cannot be seen, heard, or touched and allows for maximum displacement and flexibility, which is an ability to use formal concepts in a variety of ways to think critically, problem solve, and includes an understanding of time for planning, organization, and multi-tasking (Arwood, 2011). At the formal stage of operations (Inhelder & Piaget, 1958), the thinker is able to see the world from another's perspective and is able to use language as a tool for higher order thinking.

Piaget's (Inhelder & Piaget, 1958) four stages of cognitive development were applied in the SIMBaLL model to evaluate demonstrable or observable characteristics of HOT that can be associated with the different stages of cognitive development of a nursing student engaged in HFS. The SIMBaLL model asserted that fully developed HOT abilities represented Piaget's fourth cognitive developmental stage of formal operations (Arwood & Kaakinen, 2009; Inhelder & Piaget, 1958). Formal operations was described by Kenny (1977) as the ability to "use hypothetical reasoning based on a logic of all possible combinations…" (p. 6). For example, a formal thinker can walk in the shoes of another, consider different patient outcomes while providing nursing care for several patients across contexts, reflect on several different approaches to problem solving in novel and ill-structured situations while monitoring several different patients with complex problems, delegate and supervise nursing care, and can use language to communicate with patients and families in a way that is understandable (Arwood & Kaakinen, 2009; Ben-Chaim et al., 2000; Wang & Wang, 2011). Nursing students who have attained the cognitive developmental stage of formal operations can comprehend abstract knowledge such as nursing concepts (Kenny, 1977). Furthermore, Kenny asserted that college students enrolled in the physical sciences such as medicine, nursing, biology, chemistry, and math will struggle with abstract concepts if the stage of formal operations has not been attained.

The science of nursing involves abstract conceptual knowledge and requires a formal thinker to fully grasp multiple concepts across a variety of contexts. Therefore, the development of HOT is influenced by a nursing student's cognitive developmental stage of learning (Arwood & Kaakinen, 2009; Elder & Paul, 2010; Inhelder & Piaget, 1958; Oermann & Gaberson, 2006; Perry, 1970). The purpose of this research was to develop a theoretical and systematic method to assess the cognitive developmental stage of HOT in first semester junior year BSN nursing students with the simulation thinking rubric during high fidelity simulation.

High Fidelity Simulation

The use of educational simulation is not new nor is it new to nurse educators who began to use simulation in 1874 with the development of anatomical models such as legs and arms to teach various skills (Nehring & Lashley, 2010). As time went by and as schools of nursing moved into institutions of higher learning, a full-bodied, static manikin was introduced that had injection sites and reservoirs to teach nursing procedures (Nehring & Lashley, 2010). During the latter part of the 20th century, the advances in simulation technology evolved from low fidelity anatomical models, static task trainers, role -play, mechanical dummies and dolls (Nehring & Lashley, 2010) to medium and high fidelity patient simulation, games, standardized patients, computerized Haptic devices, and computer-assisted instruction. The term fidelity is used to describe how well a simulated scenario imitates reality (International Nursing Association for Clinical Simulation and Learning [INACSL], 2011). High fidelity simulation refers to a full body manikin with sophisticated computer technology that can replicate a realistic clinical situation and can mimic physiological responses to healthcare interventions while interacting with students. Simulation technology in the 21st century is more sophisticated, accessible, and offers low, medium, and high fidelity simulation to educators in nursing and other healthcare professions (Damasi & Sitko, 2006; Nehring & Lashley, 2010).

Currently, high fidelity simulation is an accepted mode of instruction in a variety of professions and occupations (Fernandez, Parker, Kalus, Miller, & Compton, 2007; Issenberg et al., 2005; Kramer et al., 2009; Nehring & Lashley, 2010; Okuda et al., 2009). There is a well-documented body of qualitative literature on the benefits of HFS in nursing education (Jeffries, 2007; Kardong-Edgren et al., 2010; Shinnick et al., 2011; Sullivan-Mann, Perron, & Fellner, 2009; Todd et al., 2008). Alinier et al. (2006) and Cant and Cooper (2009) found that HFS experiences promote a student's ability to synthesize and apply knowledge. In addition, nursing students report more confidence in the clinical setting and are satisfied with HFS as a teaching methodology (Blum, Borglund, & Parcells, 2010; Rourke et al., 2010; Shinnick et al., 2011; Smith & Roehrs, 2009). Other evidence suggests that high fidelity simulation offers active participation or student-centered learning and the ability to apply knowledge in simulated clinical experiences that are standardized for all students (Issenberg et al., 2005; Kuiper, Heinrich, Matthias, Graham, & Bell-Kotwall, 2008).

In tandem with the technological advancements in high fidelity simulation is a growing emphasis on safe and effective nursing care. Interested stakeholders and the American public are the forces that drive mandates to provide high quality, safe, and effective nursing care, and to transform traditional clinical education in nursing. As an example in *Preventing Medication Errors: Quality Chasm Series* (IOM, 2006) and

Health Professions Education: A Bridge to Quality (IOM, 2003), the Institute of Medicine cited an alarming occurrence of medical errors in the U.S. healthcare system and called on nursing programs to make certain that nursing students receive the kind of education that will keep the patient population safe. Also, *To Err is Human: Building a Safer Health System* (IOM, 1999) recommended the use of HFS in healthcare education to decrease medical errors. In addition, Clarke and Aiken (2003) and the IOM (2004) reported in *Keeping Patients Safe: Transforming the Work Environment of Nurses* that nurses are the largest group of healthcare providers in the United States and are more likely to identify, intervene, and prevent potential medical errors more than any other group of providers.

Along with educating nursing students to provide safe and effective nursing care, nurse educators are concerned about how to educate today's nursing students for a contemporary healthcare environment. Clinical education now and in the future has to be redesigned (Ironside & McNellis, 2011; McNellis et al., 2011) to prepare nursing students to provide nursing care for a patient population that is more diverse, older, and more acutely ill than in the past with shorter lengths of stay in the hospital. In addition, the healthcare needs of an aging population living longer with multiple chronic illnesses complicates healthcare delivery in a community context and makes acute care admissions to the hospital more challenging (Bremner et al., 2006; IOM, 2010).

Other challenges for new nurses include knowing how to manage the information explosion, integrate evidence-based research into practice, and utilize sophisticated clinical technology that can stabilize and extend life expectancy (AACN, 2008; Benner, Sutphen, Leonard, & Day, 2010; IOM, 2010). Nurse graduates will need to be educated to move beyond mastering task-based skills to demonstrating higher level competencies that provide a base for higher order cognitive abilities such as critical thinking, clinical judgment, systems thinking, and clinical decision making skills. These intellectual skills must be applicable across patient contexts, clinical situations, in the hospital, and in communities (IOM, 2010).

Traditional methods of instruction in nursing programs may not meet the demands of today's new nursing graduates (Benner et al., 2010; Brannan, White, & Bezanson, 2008; Cardoza, 2011). Consequently, the manner in which undergraduate nurses are currently educated focuses on a 20th century healthcare system that is no longer applicable today (AACN, 2008; Benner et al., 2010; IOM, 2010; Tanner, 2006b).

To meet the challenge of a shortage of clinical placements and to transform clinical education, nurse educators are considering innovative, student-centered learning activities. High fidelity simulation is considered an innovative learning strategy that can be utilized to augment time in traditional clinical (Bremner et al., 2006; Forbes & Hickey, 2009; Ironside & McNellis, 2011; Lapkin et al., 2010; Nehring, 2008; Sherwood & Drenkard, 2007; Tanner, 2006b). As an example, Hayden (2010) completed a national survey that found 83% of nursing programs augmented clinical time based on a 1:1 ratio of simulation to clinical hours. Also, 7% of the nursing programs surveyed substituted "more than" one hour of simulation and 10% substituted "less than" one hour of high fidelity simulation for one hour of clinical time (Hayden, 2010, p. 55).

The advantage of using high fidelity simulation to augment clinical hours is that each nursing student has the same opportunity to experience standardized typical and critical simulated patient scenarios (Bremner et al., 2006; Friedrich, 2002). High fidelity simulation can offer a consistent simulated clinical experience for every student with simple to complex clinical scenarios that meet learning objectives for every course in a nursing program (Bremner et al., 2006; Feingold et al., 2004; Friedrich, 2002; Lapkin et al., 2010; Larew, Lessans, Spunt, Foster, & Covington, 2006; NLN, 2005; Tanner 2006b). As an example, during the length of a nursing program in traditional clinical education, few students might provide nursing care for a post-partum patient who has a hemorrhage. However, high fidelity simulation offers all nursing students the opportunity to participate in a post-partum hemorrhage patient event in a controlled and safe environment (Blum et al., 2010; Kardong-Edgren et al., 2010).

The National Council of State Boards of Nursing (NCSBN; 2005) has been interested in examining the benefits of augmenting traditional clinical hours with high fidelity simulation. Thus, 10 nursing schools partnered with the NCSBN in a national study that began in the fall of 2011 to determine the percentage of time HFS could be used to augment traditional clinical experiences. The study examined and contrasted the benefits of 10% of clinical time in simulation with a group that spent 25% of clinical time in simulation and a group that spent 50% of clinical time in high fidelity simulation. At the end of the study, scores on the national certification licensure exams, student surveys, and summative HFS experiences for each group were used to determine which ratio of clinical hours to HFS hours was the most beneficial (NCSBN, 2011). Although there is interest in nursing education to augment clinical hours with high fidelity simulation hours, there is a lack of research that can substantiate student-learning outcomes directly related to the use of HFS as an educational strategy (Rourke et al., 2010; Schlairet & Pollock, 2008).

Additional findings indicated that high fidelity simulation enhances learning by providing a transition zone between theory classes and clinical rotations that is safe and risk free for patients and nursing students (Kardong-Edgren, 2010; Nehring & Lashley, 2010; Oermann & Gaberson, 2006). Although positive perceptions of simulation learning by both students and faculty have contributed valuable knowledge regarding the use of HFS as a learning strategy, current evidence indicates there is minimal, no, or an inverse relationship between an individual's self rating and that of an outsider reviewer (Kardong-Edgren, 2010).

Despite the widespread acceptance of high fidelity simulation, there is a lack of quantitative evidence to support the assertion that learning occurs due to HFS (Alinier et al., 2006; Blum et al., 2010; Bradley, 2006; Burns et al., 2010; Cant & Cooper, 2009; Issenberg et al., 2005; Radhakrishnan, Roche, & Cunningham, 2007; Rourke et al., 2010; Shinnick et al., 2011; Sullivan-Mann et al., 2009). One reason for the lack of evidence is that there are few reliable and valid instruments that can quantify learning due to the use of high fidelity simulation (Kardong-Edgren et al., 2010; Radhakrishnan et al., 2007).

Evaluation of High Fidelity Simulation Instruments

A review of the literature was performed to identify theoretically-based instruments that could quantify learning utilizing high fidelity simulation as an educational strategy. Specifically, the search centered on two criteria: (a) the instrument would assess a nursing student's cognitive developmental stage of higher order thinking and (b) the score could be used to guide the design of developmentally appropriate HFS scenarios. However, no instruments were found that matched the criteria. What follows is a review of instruments currently in use that offer evidence suggesting learning occurs due to the use of high fidelity simulation.

Todd et al. (2008) developed and piloted a quantitative simulation clinical evaluation (SEI) instrument. The American Association of Colleges of Nursing (2008) competencies of assessment, communication, critical thinking, and technical skills were the framework for the development of the SEI. Twenty-two behaviors were distributed among these core competencies that scored the tool. Content validity was established by seven faculty experts in simulation who rated the SEI instrument with a 4-point Likert scale. Results indicated each behavior on the instrument was valuable (3.82/4-3.84/4) and the instrument as a whole rated a 3.83/4. Inter-reliability was calculated with a percent agreement ($P_{0)}$) of 81.3 %. The developers of the SEI wanted to design an instrument that was easy to implement and that could evaluate a group of students engaged in HFS (Todd et al., 2008). There was no discussion on how to score the simulation evaluation instrument with a group of students engaged in high fidelity simulation but the rationale for a group score was that the experience should demonstrate collaborative inter-professional practice (Todd et al., 2008).

An observation from a rater of the simulation evaluation instrument was that although performance was observable, learning was not (Todd et al., 2008). So a student who scored low in a simulation might have learned more from mistakes than another student who scored high and made no mistakes. This was because the scores on the SEI were based on behaviors, not on thinking or cognitive development. Unless the simulation scenarios were cued with questions that prompted a response that demonstrated a student's thinking, there was no way to know through behaviors if a student knew why they were performing an intervention. Further, the scores from the simulation evaluation instrument could not guide the design of developmentally appropriate high fidelity simulation scenarios that could progress a student from one stage of cognitive development to a higher stage.

Another instrument developed by nurse educators was the Clinical Simulation Evaluation Tool (CSET) that measures the difference in learning between traditional clinical experiences without HFS and clinical experience with 2 one hour, two patient HFS scenarios as an intervention (Radhakrishnan et al., 2007). The Clinical Simulation Evaluation Tool is a pen and pencil rubric with five measurable objectives: (a) safety and communication, (b) assessment and critical thinking, (c) diagnosis and critical thinking, (d) interventions, evaluation and critical thinking, and (e) reflection and critical thinking. The CSET is scored as students perform certain behaviors that are assigned numbers with 67 possible points. No reliability or validity statistics were reported in the article.

Radhakrishnan et al. (2007) used the clinical simulation evaluation tool in a quasi-experimental study and found that in the category of safety and basic assessment, the intervention group scored significantly higher ($p = 0.001$ and $p = 0.009$) than the control group. While this positive finding provides support for the continued use of high fidelity simulation in nursing education, this tool is a check-off list that scores nursing behaviors at one point in time and does not explain what or how students think during or due to HFS. Last, the clinical simulation evaluation tool is not based on a learning theory that might provide direction for the design of developmentally appropriate high fidelity simulation scenarios that might facilitate the cognitive development of higher order thinking (Arwood & Kaakinen, 2009).

Alinier et al. (2006) used a pretest/posttest experimental design to measure the effectiveness of high fidelity simulation training on clinical competence and confidence with the Objective Structured Clinical Examination (OSCE). This examination is used in nursing, medicine, and other healthcare professions for formative and summative testing. The study did not report on validity and reliability statistics but stated that the instrument is “recognized as a highly reliable and valid assessment method” (Alinier et al., 2006, p. 364). Alinier et al. designed a 15 station objective structured clinical examination. Four of the stations were theoretical pen and paper evaluations focused on safety and nursing practice; the other 11 stations tested a student’s skills in communication, knowledge and technical ability (Alinier et al., 2006). First, both groups went through the OSCE pretest to obtain baseline scores. Then the experimental group received normal curriculum education strategies and high fidelity simulation while the control group received traditional nursing education strategies without the effect of high fidelity simulation. The first OSCE showed no significant difference in groups. However, six months later when the second examination was given, the experimental group attained higher scores than the control group (Alinier et al., 2006). The control group improved by 7.18% and the experimental group improved by 14.18%. Since both groups improved over the six-month time period, a direct causal link to the simulation intervention was not made. However, the researchers reported with some certainty that students learned with high fidelity simulation as an educational strategy as well as in a traditional clinical setting (Alinier et al., 2006). The objective structured clinical examination is predominantly used for high stakes testing so the scores are not formative.

Schlairet and Pollock (2010) also found no difference in learning basic nursing skills with students who had a high fidelity simulation intervention and those who had traditional clinical experiences without HFS. The study measured students' performance with a pen and pencil test of sample multiple choice questions from the National Council Licensure Exam for Registered Nurses study book. Once again, these findings indicated that using high fidelity simulation as a learning strategy was equal to that of traditional teaching strategies.

Nurse educators who use high fidelity simulation as a learning strategy assert that the debriefing process is the part of the simulation experience that promotes learning. Kuiper et al. (2008) used the Outcome Present State Test (OPST) model of clinical reasoning to measure the effectiveness of debriefing immediately after nursing students engaged in a HFS scenario. Social cognitive theory was the foundation for this descriptive study that sought to compare clinical reasoning in HFS with clinical reasoning in traditional clinical experiences. Kuiper et al. (2008) explained that situating a nursing student in a realistic clinical simulation scenario "reinforces appropriate patterns of behavior from specific actions during simulation that lead to desired outcomes" (p. 2). During a faculty led debriefing process immediately after HFS, nursing students engaged in self-reflection and shared thought processes that led to correct or incorrect clinical decisions. Although the link between experience and cognitive gains was unclear, the study sought to describe through a highly structured debriefing process how nursing students learned to make clinical decisions.

Kuiper et al. (2008) reported inter-rater reliability statistics of 0.573 for the second version of the instrument (Kendall's coefficient W=0.703 X2 [24]); inter-rater reliability of the third version of the instrument was of 87% with two faculty reviewing 16 OPST worksheets (p = 0 .001). As in the previous two studies, the results showed no difference between clinical work-sheet scores and simulation work-sheet scores. The important message from this study was nursing students learned equally from both clinical experiences and simulated clinical experiences (Kuiper et al., 2008)

In another study, Fero et al. (2010) used the California Critical Thinking Disposition Inventory (CCTDI) and the California Critical Thinking Skills Test (CCTST) developed by Facione and Facione (1996). Fero et al. examined the relationship between the CCTDI and the CCTST with two different educational strategies: videotaped vignettes (VTV) and high fidelity simulation scenarios. The reliability statistic for the CCTDI was a median alpha coefficient of 0.90 and subscale coefficients ranged from 0.71 to 0.80 (Fero et al., 2010). The CCTST reported a Kuder-Richardson-20 of 0.78 to 0.80. Student performance in the videotaped vignettes and high fidelity simulation scenarios was measured with a researcher-developed assessment tool. No psychometric statistics were reported for the researcher-developed VTV/HFS tool. To implement the study, students were divided into two groups. Group A received the videotaped vignette learning strategy and group B received the high fidelity simulation learning strategy. Both groups sat for a pretest with the CCTDI and the CCTST. After each group finished with either intervention, both groups sat for a posttest with the CCTDI and the CCTST.

Neither the videotaped vignettes (75%) nor the high fidelity simulation (88.9%) group met overall performance expectations. In the videotaped vignette group--69.4 %, and in the high fidelity simulation group, 75% could not identify data to report to a physician, 95% were unable to anticipate medical orders, and 100% could not give a rationale for their decisions (Fero et al., 2010). However, those students whose CCTDI and CCTST scores fell in the strong critical thinking skills range scored higher on both the videotaped vignettes and high fidelity simulation assessment tools. The reverse was also true. Those students who did not score well on the CCTST and the CCTDI did not score well on the HFS assessment. Fero et al. (2010) based this study on the Argyris and Schön's (1974) theories of Action Espoused and Theory in Use that did not explain how learning occurred during the videotaped vignettes or high fidelity simulation. Based on the findings in this study, a theory of learning might guide nurse educators in the developmental design (Arwood & Kaakinen, 2009) of videotaped vignettes and high fidelity simulation scenarios that could promote cognitive development because gains in cognition might enable nursing students to quickly recognize and report an impending adverse patient event.

Sullivan-Mann et al. (2009) used the Health Sciences Reasoning Test (HSRT) developed by Facione and Facione (2008) to assess a change in nursing students' critical thinking skills due to a high fidelity simulation intervention. The HSRT tests interpretation, analysis, evaluation, explanation, and inference with subscales that test inductive and deductive reasoning. No psychometric statistics were reported for the tool but the researchers commented that the tool had proven reliability and validity statistics (Sullivan-Mann et al., 2009). To implement the study, nursing students were divided into a control group that attended two normally scheduled high fidelity simulation scenarios and an experimental group that engaged in the two normally planned scenarios and an additional three scenarios. A mixed-model analysis of variance (ANOVA) was conducted to measure the effect of high fidelity simulation on critical thinking. There was a significant effect over time with both groups answering more questions correctly on the posttest than on the pretest HSRT (Sullivan-Mann et al., 2009). To discover if HFS had a significant impact on critical thinking, a one-factor ANOVA was performed on all scores of the pre- and posttests. The results showed a statistically significant difference--the experimental group answered more questions correctly on the posttest than on the pretest. The control group also answered more questions on the posttest but the findings were not statistically significant (Sullivan-Mann et al., 2009).

These findings, although positive, conflicted with other studies that did not find a difference in critical thinking after simulation (Kuiper et al., 2008). One observation was that it was possible that the experimental group had better scores due to the passage of time. This inferred that critical thinking was developmental (Elder & Paul, 2010) and that over time, a nursing student's thinking skills could progress. In addition, the researchers postulated that critical thinking did not develop due to any single variable but was cumulative and occurred because of a student's experiences over time. This supported the concept that HOT is developmental and can be facilitated by purposely designing high fidelity simulation scenarios to progress a nursing student from a baseline assessment of higher order thinking to more complex cognitive developmental stages of HOT (Arwood & Kaakinen, 2009).

The Clinical Simulation Grading Rubric (CSGR; Clark, 2006) is a pen and pencil rubric developed to measure student performance in an obstetrical trauma scenario (Clark, 2006). The tool evaluates five domains: patient assessment, history gathering, critical thinking, communication, patient teaching, and lab data and diagnostic studies collection with each category receiving a score from 1 to 5. Although the rubric is based on an obstetrical trauma, Clark (2006) states the rubric is flexible enough to be used for different HFS scenarios. There were no reports of reliability or validity statistics for the clinical simulation grading rubric.

The theoretical foundation for the CSGR is a combination of Bloom's taxonomy and Benner's novice to expert (Clark, 2006). The intention of pairing these two frameworks was to provide nurse educators with the ability to evaluate the progression of thinking skills of the learners engaged in HFS (Clark, 2006). However, Bloom's taxonomy is a framework for the design of educational objectives from lower level learning to higher-level learning and Benner's theory of novice to expert characterizes a learners' experiential status as a beginner or an advanced practitioner (Clark, 2006). Neither of these theories explain how the brain learns, how to assess cognitive development, or use the scores to purposely design HFS scenarios that can facilitate the development of HOT (Arwood & Kaakinen, 2009).

Tanner's clinical judgment model (Lasater, 2006) was the theoretical framework for the development of the Lasater clinical judgment rubric (LCJR) designed to describe levels of performance of clinical judgment in undergraduate nursing students. The model describes four phases in the development of clinical judgment: noticing, interpreting, responding, and reflecting. The four developmental stages of clinical judgment are beginner, developing, accomplished, and exemplary. An expert in rubric development and an expert in clinical judgment engaged in ongoing weekly observations and revisions for three weeks (Lasater, 2006). During weeks four and five, the rubric was pilot tested by the scoring of the rubric and refinement of the rubric was completed in weeks six and seven. One of the assumptions of the clinical judgment model was that nursing students continually learn and develop clinical judgment skills during the length of a nursing program. Consequently, the score on the LCJR represented a formative assessment and identified gaps in nursing student's clinical judgment skills at one point in time. There was no description of how to use the formative assessment from the rubric score to design developmentally appropriate HFS scenarios that might facilitate a nursing student's progression of clinical judgment to higher cognitive developmental stages.

The review of the literature identified systematic reviews of instruments in nursing education that are utilized during high fidelity simulation to measure cognitive, affective, and psychomotor skills. In a review of 29 high fidelity simulation evaluation instruments, Kardong-Edgren et al. (2010) found that many of the tools did not undergo rigorous psychometric testing. Of the eight HFS cognitive evaluation instruments, one provided a content validity index (CVI) and the other a CVI with an inter-rater statistic (Kardong-Edgren et al., 2010). No psychometric statistics were offered in the other six HFS cognitive evaluation instruments. Similarly, Cant and Cooper (2009) reviewed quantitative studies that measured the effectiveness of medium and high fidelity simulation compared with other educational strategies. The review found 2,019 articles from1999 to 2009 but only 12 met criteria for the review. The 12 studies reviewed compared teaching with high fidelity simulation as an educational strategy to teach with lecture, clinical experiences, case studies, and seminars. Various instruments were utilized to measure learning: the OSCE (Alinier et al., 2006), faculty-generated questionnaires, standardized questionnaires such as the acute myocardial infarction management questionnaire (Brannan et al., 2008), and the CCTDI and CCTS (Facione & Facione, 1996). However, the developmental nature of critical thinking (Elder & Paul,

2010) was not examined. Last, not one of the 12 studies addressed higher order thinking, the developmental nature of concept acquisition, or the design of high fidelity simulation scenarios based on scores obtained from the instruments used to evaluate learning with the use of HFS.

To summarize, the instruments in these reviews add to nursing knowledge and suggest that high fidelity simulation influences learning. But none of the instruments reviewed quantified learning outcomes that resulted from HFS as an educational strategy. In addition, none of the instruments addressed the developmental nature of higher order thinking and did not provide a baseline assessment of HOT that could guide the design of developmentally appropriate HFS scenarios that might facilitate the acquisition of complex conceptual knowledge (Arwood & Kaakinen, 2009; Elder & Paul, 2010; Guhde, 2010).

Learning Theories and High Fidelity Simulation

The literature regarding high fidelity simulation suggested that theoretical frameworks are briefly mentioned, if at all, and if applied are not fully integrated into the rationale for research studies in HFS (Kaakinen & Arwood, 2009; Rourke et al., 2010). Nurse researchers used a variety of multi-disciplinary theories to explain the role of HFS in nursing education. A few examples were Roy’s adaptation model (Sullivan-Mann et al., 2009), Bandura’s theory of self-efficacy (LeFlore, Anderson, Michael, Engle, & Anderson, 2007; Rhodes & Curran, 2005), situated cognition (Kuiper et al., 2008; Paige & Daley, 2009), Benner’s theory of novice to expert (Larew et al., 2006; Lasater, 2006), diffusion of innovation (Starkweather & Kardong-Edgren, 2008), the nursing education simulation framework (Jeffries, 2007), Lasater’s clinical judgment model (Blum et al., 2010), and Kolb's theory of experiential learning (Waldner & Olson, 2007). While these theories add to nursing's knowledge base regarding HFS in nursing education, there is a gap in the literature regarding the use of a simulation learning theory. A theory of learning in simulation can provide a universal framework that can describe, explain, predict, and control learning outcomes with HFS as a teaching methodology (Gall, Gall, & Borg, 2007). Larew et al. (2006) pointed out a need for theory based simulation protocols that are reproducible, rigorous, and can be used for student evaluations and for research. Rourke et al. (2010) also found that theoretically based research is lacking in HFS studies. The literature suggested that HFS influences learning but research produced conflicting evidence that was fragmented and lacked external validity. Research studies that are based on and are congruent with a theoretical framework can generate hypotheses, guide data collection, and produce findings that are coherent and can be generalized to larger nursing communities involved in HFS (Gall et al., 2007; Rourke et al., 2010). Because high fidelity simulation is a widespread and popular teaching methodology that is continuing to evolve, an important next step might be the adoption of a simulation learning theory. Theoretically-based high fidelity simulation research can bring together the findings from quantitative and qualitative findings into a body of coherent evidence that has meaning and can generate ongoing research that might quantify learning due to HFS.

Theoretical Framework

The theoretical framework for this methodological study was based on the simulation based on learning language model (SIMBaLL; see Appendix B) that utilized Piaget's (Inhelder & Piaget, 1958) four stages of cognitive development to "provide a framework for evaluating the meaning of ideas or behaviors" (Arwood, 2011. p. 140) and the four stages of learning in the neurosemantic learning language theory (NLLT). Interactional developmental theories and a constructivist world-view provided the philosophical underpinnings of this research (see Appendix C). Piaget, Bruner, and Vygotsky are interactional developmental theorists who believe the learner constructs knowledge and that acquisition of conceptual knowledge is a socio-cognitive process (Arwood & Kaakinen, 2009; Driscoll, 2005). To a constructivist educator, human beings are active organisms that seek to know, understand, and find meaning in their world (Driscoll, 2005). Likewise, the SIMBaLL model's assertion is that the experience of nursing care during an appropriately designed HFS scenario facilitates cognitive gains in nursing students who seek to learn, understand, and find meaningful knowledge in a nursing context (Arwood & Kaakinen, 2009). Similarly, constructivists' learning goals are focused on contextual learning, reasoning, critical thinking, understanding the use of knowledge, self-regulation, and reflection (Driscoll, 2005). Other constructivist learning goals are to promote the ability of a learner to solve ill-structured problems and to develop cognitive flexibility, critical thinking, and collaborative skills (Driscoll, 2005).

The constructivist conditions for instruction include complex and relevant learning environments, social negotiation, and self-awareness of knowledge construction (Driscoll, 2005). The design of an HFS patient care scenario can be simple or complex; can stimulate thinking skills, language functions, and social negotiation skills; and takes place in a simulated nursing environment. High fidelity simulation is a learning strategy that is congruent with the constructivist method of instruction that utilizes goal-based scenarios and problem-based learning that are similar to solving a real patient problem in traditional clinical and in professional nursing practice (Driscoll, 2005). Last, the design of HFS scenarios based on a learning theory might facilitate a nursing student's progress from simple to more complex cognitive developmental stages of higher order thinking and might increase a nursing student's ability to decrease the risk to patient safety (Lapkin et al., 2010).

Simulation Based on Learning Language Model

The simulation based on learning language model, based on the neurosemantic learning language theory (Arwood, 2011), is a theoretical framework that can guide the assessment and evaluation of the cognitive developmental stage of higher order thinking specific to nursing students engaged in high fidelity simulation. According to the SIMBaLL model, a baseline assessment of learners' cognitive developmental stages of HOT informs the design of HFS scenarios that are cued with language that purposely facilitates learners' staged progressions from baseline cognitive developmental stages to higher cognitive developmental stages of HOT. One of the models' assertions is that language function parallels cognition and is the developmental output of each of the four cognitive developmental stages (see Appendix D). Consequently, the language a student uses during HFS demonstrates a student's cognitive developmental stage of HOT. The SIMBaLL model utilizes Piaget's four cognitive developmental stages to evaluate the behaviors of nursing students engaged in high fidelity simulation: (a) the sensorimotor stage, (b) the preoperational stage, (c) the concrete operations stage, and (d) the formal operations stage (Arwood, 2011; Arwood & Kaakinen, 2009; Inhelder & Piaget, 1958). Piaget's four cognitive developmental stages were applied in the SIMBaLL model to conceptual, behavioral, and language operators and are presented in table format in Appendix E.

The first stage of the simulation based on learning language model (Arwood & Kaakinen, 2009) is the cognitive developmental stage of sensorimotor operations (Inhelder & Piaget, 1958). In this stage, the nursing student receives sensory input from the eyes, ears, skin, nose, and mouth. As an example, in skills laboratory, nursing students gather information from the senses by watching and listening to a laboratory instructor who demonstrates a skill and by touching equipment in the skills laboratory. These learners are not aware of concepts and do not have a mental picture of him/herself when caring for a simulated patient in HFS. There is little social or language development because the student cannot operate independently or use language to explain the rationale behind nursing actions. The sensorimotor learner is not sure why a task is needed, how to effectively perform a task, and will require assistance to perform tasks during HFS. If an HFS scenario requires even a beginning understanding of concepts, the student might panic, freeze, or leave the simulation room.

In the preoperational stage of cognitive development (Arwood & Kaakinen, 2009; Inhelder & Piaget, 1958), incoming sensory data is integrated in the midbrain into recognizable perceptual patterns. These recognizable patterns are the lowest level of conceptual development but are necessary for the development of language and concept acquisition (Arwood, 2011; Arwood & Kaakinen, 2009; Piaget, 1950). At this stage of learning, the nursing student can visualize him/herself in the simulation providing nursing care but there is no mental picture of the patient or family. During simulation, the preoperational student will struggle to mimic or replicate motor tasks the way the skill was taught but might be disorganized and forgetful. The preoperational learner is focused on the performance of tasks or on showing what they can do independent of the patient and family. As a result, if the simulation presents the student with a nursing task different from the textbook or skills laboratory or is asked to explain a nursing concept, the student might become confused or visibly upset during a HFS scenario. Then the nursing student might not respond to or might ignore patient cues and responses to care. This learner has a preoperational awareness of concepts and can recognize concepts discussed by other individuals. However, when asked to use language to explain a concept, a preoperational learner might struggle to find words that demonstrate conceptual understanding. Last, the nursing student can answer questions from the patient and family by restating what others say or by repeating an explanation from a textbook. As the nursing student gathers more experience, conceptual knowledge becomes more complex and this moves the learner to the cognitive developmental stage of concrete operations.

The nursing student in the cognitive developmental stage of concrete operations (Arwood & Kaakinen, 2009; Inhelder & Piaget, 1958) can share conceptual knowledge and can independently perform nursing care based on rules on several complex patients one at a time. The learner develops depth and dimension to conceptual knowledge and thinking in this stage, is rule based, and focuses on correctly performing nursing care based on clinical pathways and on the right and wrong things to do. The concrete learner now has a mental picture of both self and the patient in the provision of nursing care. Social interactions are based on what the family and patient can bring to the relationship.

Language function demonstrates a desire to share ideas with others on morality, on what is right and wrong, but this is based on what others think and say.

The last stage in the SIMBaLL model is the cognitive developmental stage of formal operations (Arwood & Kaakinen, 2009; Inhelder & Piaget, 1958). Socially, the formal thinker is able to empathize with others and sees life from others' perspectives. Language functions go beyond rule-based thinking to the expression of ideals that are abstract and principles such as truth, freedom, and human caring that are not limited by time and space. In HFS, the formal thinker can navigate a multi-patient scenario with complex patient care that is detailed; multi-faceted that requires time management, organization, and leadership skills; and prioritized. At the cognitive developmental stage of formal operations, a nurse can provide safe and effective nursing care in complex and ill-structured contexts and can explain the rationale for care decisions in a way that patients, families, and other healthcare professionals can understand.

The simulation based on learning language model has four assumptions:

1. High fidelity simulation scenarios can be designed to follow a hierarchal pattern of concept development (see Appendix F).
2. Because language represents concept development, nurse educators might assess language to establish the student's conceptual understanding during a high fidelity simulation scenario.
3. Nursing faculty can alter their language to promote students' conceptual learning from HFS scenarios.

4. Students' comprehension of the concepts underlying a HFS scenario might be assessed by an analysis of the language used to respond to fundamental questions about the simulation experience (Arwood & Kaakinen, 2009).

The four assumptions of the SIMBaLL model are important because the identification of a student's cognitive developmental stage is the first step in gaining understanding into how students think. The purpose of the score on the simulation thinking rubric (see Appendix G) is to identify nursing students' cognitive developmental stage of higher order thinking. If a nurse educator can assess a student's baseline cognitive developmental stage of HOT, the SIMBaLL model might be able to inform the design of developmentally appropriate HFS scenarios that can be designed for each of the four stages. As an example, if a learner is assessed at the sensorimotor stage of cognitive development of higher order thinking, a scenario can be designed to progress the student to the preoperational stage of HOT. Cues can be embedded into the scenario to encourage the student to visualize him/herself providing nursing care. Also, cues that remind the student to perform the next step can be embedded: "What are you going to do next?" In addition, lower level questions can be embedded in the scenario such as "Why are you giving me Lasix?" or "What are my vital signs?" Because the sensorimotor learner does not picture him/herself in the scenario, the cues from the manikin will bring the learner back into the picture (see Appendix H). A nursing student might be able to progress from one stage to a higher stage of higher order thinking during the length of the nursing program by the ongoing design of simulation scenarios based on a needs assessment of the learner.

The Neurosemantic Learning Language Theory

The foundation for the simulation based on learning model is the neurosemantic learning language theory (NLLT). The first three steps in the NLLT are based on theories of the neuroscience of learning (E. Arwood, personal communication, March 10, 2012); the fourth step is based on semantics, pragmatics, and the philosophy of language and explains how the acquisition of language contributes to the acquisition of more complex conceptual knowledge (E. Arwood, personal communication, March 9, 2012). Arwood added the fourth step from her expertise for over 35 years as a speech and language pathologist working with children with neurogenic disabilities (Arwood, 2011). This theory describes how the human body turns physical input from the environment into meaningful thinking and explains how a learner uses language to be literate. There are four steps of learning: sensory input, pattern organization, concepts, and language (Arwood, 2011).

The first learning step in the NLLT is sensory input and describes how the physical body accepts information from the physical world with sensory receptors in the eyes, ears, mouth, nose, and skin. The eyes accept light waves, the nose accepts aromas, the skin senses pressure as in touch or pain, the mouth has receptors for taste, and the ears accept sound waves. Sensory input is converted to chemical messengers that pulse from cell to cell along neural pathways from the periphery to the brain. Once the sensory data are accepted, the human learning system can progress to the second step of the NLLT (Arwood, 2011).

The second learning step of the NLLT is pattern recognition. In this step, the midbrain sorts and organizes simultaneous incoming sensory input from multiple receptors and organizes the data into recognizable perceptual patterns. In this phase of neurobiological learning, acoustic data overlap with other acoustic data, light waves overlap with other light waves, and acoustic data overlap with visual data (Arwood, 2011). Throughout this process, the neural system provides feedback to previously established patterns in earlier steps with new incoming data and this process changes the structure of the cells for pattern recognition. In addition, these cellular structures are unique and meaningful to each learner because individuals process information in different ways (Arwood, 2011).

The third learning step of the NLLT is concepts. In this step, the learner changes perceptual sets of patterns into larger sets of meaningful patterns or concepts. To develop concepts, a feedback system discriminates between old or new patterns and prevents old patterns from connecting with input that is not needed. When new information is recognized, connected, and integrated with old information, the messages become more complex, larger, and more abstract. Then these chunks of old patterns integrate with more input and become large cortical messages. These larger cortical messages facilitate the development of conceptual knowledge (Arwood, 2011). Thinking or cognition occurs when the cells on the surface of the cerebral cortex become active (Arwood, 2011). Now at each level of learning, the learning system is more complex and continues to produce even more feedback with increasingly complex functions. The development of complex concepts is dependent on cross-modal integration or the layering of visual data over visual data, acoustic over acoustic data, and acoustic data over visual data (Arwood, 2011). In this stage, cross modal integration produces auditory concepts, visual constructs, and visual constructs like mental pictures or mental movies; most importantly, the overlapping of visual patterns creates concepts for language learning.

Language is the fourth step of the NLLT (Arwood, 2011). Concepts are recognized through language function that assigns meaning to abstractions with words; this propagates the development of even more semantic relationships (Arwood, 2011). At this final stage in the NLLT (Arwood, 2011), language represents the depth and dimension of what the learner knows and thinks. Learners use language that demonstrates conceptual understanding of multiple concepts in a variety of contexts, across time and space, and the learner can communicate complex principles and theories in a way that others can understand (Arwood & Kaakinen, 2009). This is the basis for using language as one way to assess students' cognitive development. Language is the phenomenon that represents a student's conceptual knowledge and is one of the operational definitions of higher order thinking (Gall et al., 2007). The NLLT theory asserts that it is possible to measure HOT by assessing language because words can identify a student's conceptual understanding (Arwood, 2011).

The Simulation Based on Learning Language Model

Applying the simulation based on learning language model (Arwood & Kaakinen, 2009), one can explain and describe a nursing student's first day of school in the skills laboratory using the example of learning how to measure blood pressure. In the sensorimotor stage of HOT, a nursing student can see the outline of the instructor demonstrating the measurement of blood pressure and accepts visual and acoustic input from the sensory organs by integrating the patterns of the spoken word "blood pressure" and the visual outline of the instructor's demonstration. Additional sensory input comes from the facial expressions of the instructor, the touch and feel of the blood pressure cuff, the sensation of securing the blood pressure cuff to a classmate's arm (Arwood, 2011), and any associated smells in the skills laboratory.

In the preoperational stage of cognitive development of HOT, the nursing student sorts and organizes simultaneous incoming sensory input from light and sound waves, the sensation produced by skin receptors, and any smells in the skills laboratory. Now more sensory data are added from measuring blood pressure on family members, friends, and on patients of different age groups, genders, and in a variety of health states. Once the pattern of "blood pressure" is recognized as meaningful, the nursing student is stimulated to respond with the psychomotor ability to perform the task of measuring blood pressure. Also, the nursing student can mimic the words of the instructor regarding blood pressure. In addition, the student can use words, "I can measure blood pressure." However, because the concept of blood pressure is not yet developed, there is no meaning or interpretation of blood pressure.

In the concrete operational, cognitive developmental stage of HOT, the nursing student has the ability to interpret blood pressure in the here and now on different patients. The nursing student continues to learn the theory related to measuring blood pressure and gathers experience measuring blood pressure on a variety of patients with diverse disease states. As the nursing student gathers new information, the perceptual feedback system either integrates the new input with old data or inhibits the input if it is not usable or if no connection is needed. As other pertinent input is gathered, the nursing student accepts, sorts, organizes, integrates or inhibits, overlaps, and layers this new visual data with acoustic data into larger chunks of data that require higher brain structures for higher order thinking. Now the nursing student can think about and consider the concept of blood pressure based on rules with several different patients and disease states but in the here and now.

The fourth cognitive developmental stage of higher order thinking is formal operations. The nursing student thinks about, understands, and can use language to explain the concept of blood pressure for multiple complex patients across a variety of novel and ill-structured contexts unbound by time or space. The nursing student can think beyond the present to analyze and apply theoretical constructs to multiple complex patients with differing blood pressure readings. Last, a nursing student who has attained the formal stage of cognitive development can use language to communicate complex theories with patients and families in a way that is understandable. At the formal operations stage of cognitive development, a nursing student's use of language (Arwood, 2011) is parallel to their conceptual understanding of the concept of blood pressure. According to Vygotsky (1934/1987), this complexity generates a relationship between cognition and language that is synergistic and parallel to the feedback of the central nervous system.

The State of the Science of High Fidelity Simulation in Nursing Education

A wide body of qualitative knowledge research supports the use of high fidelity simulation in nursing education. Both nurse educators and students find HFS to be a positive and beneficial learning experience (Kardong-Edgren, 2010; Waldner & Olson, 2007). In addition, there are quantitative studies that measure different thinking attributes in nursing students with a variety of researcher-designed and standardized instruments such as the OSCE, HSRT, CCTDI, and the CCTST. Moreover, there are studies that measure learning outcomes between HFS as a learning strategy and lecture, traditional clinical time, case studies, and videotaped vignettes that provide evidence of the benefits of using HFS in nursing education (Alinier et al., 2006; Blum et al., 2010; Radhakrishnan et al., 2007; Shinnick et al., 2011; Sullivan-Mann et al., 2009). Other research currently underway is the NCSBN (2011) national study to determine what percentage of clinical time can be augmented with clinical simulation time.

Several articles support the use of theory as a framework for high fidelity simulation research. Some of the theories that guide HFS research are Benner's (1984) model of novice to expert, Kolb's (1984) theory of experiential learning, situated learning (Lave & Wagner, 1991), Bandura's (1995) self efficacy theory, and adult learning theory (Knowles, 1980). The International Nursing Association of Simulation and Clinical Learning is conducting a survey and examination of Jeffries (2007) nursing education simulation framework (NESF; Kardong-Edgren, 2011). The goal is to query nurse educators on a national level to investigate the feasibility of moving the NESF to a theory. The knowledge acquired thus far from qualitative and quantitative studies informs nurse educators that HFS as a learning strategy is a popular and widespread learning strategy used by nurse educators. However, learning outcomes from the use of HFS have not been consistently validated. Nurse educators still do not have concrete evidence of how, what, or if nursing students learn during HFS (Kardong-Edgren, 2011; Rourke et al., 2010; Sanford, 2010). Currently, leaders in nursing simulation are calling on researchers to examine the reliability and validity of existing instruments in use today to quantify learning with HFS. Also, Rourke et al. (2010) point out that the lack of a theoretical framework to guide HFS research is one reason why quantitative studies produce inconsistent results. When research is based on a theoretical framework, the collection of data, the interpretation of results, and the collection of studies can become a reasoned, generalized, unified, and progressive body of knowledge (Rourke et al., 2010). Future research is moving toward rigorous quantitative studies that can quantify learning, are based on a theory, and are measured with reliable and valid HFS instruments (Arwood & Kaakinen, 2009; Cardoza, 2011; Kardong-Edgren et al., 2010; Radhakrishnan et al., 2007).

The rationale, conceptual framework, and review of the literature for the development of the simulation thinking rubric (STR) with the application of the simulation based on learning language (SIMBaLL) model were presented in this chapter. The review of the literature supported the need for a quantitative, theoretically-based instrument to assess student's cognitive developmental stage of higher order thinking. The development of a psychometrically sound STR might inform the design of developmentally appropriate HFS scenarios that might foster the cognitive development of higher order thinking.

CHAPTER III

METHODOLOGY

Research Design

This methodological study used a non-experimental research design. The aim of the study was to test the psychometric properties of the simulation thinking rubric (STR), a tool created to assess higher order thinking (HOT) during high fidelity simulation (HFS).

Sample

The target population was all nursing students in the United States. The accessible population was nursing students enrolled at the University of Nevada, Las Vegas (UNLV). An *a priori* power analysis was calculated to determine the sample size for an ANOVA 2-tailed F test with α of .05 at 0 .80 power (Faul, Erdfelder, Lang, & Buchner, 2007). According to the power analysis, a sample size of at least 128 scored rubrics was required for statistical significance.

Setting

The setting for the simulation videotaping was the UNLV Shadow Lane Campus Clinical Simulation Center of Las Vegas (CSC-LV). The CSC-LV is a collaborative clinical laboratory shared by UNLV, Nevada State College, and the University of Nevada, Reno Medical School. The CSC-LV is a 31,000 square foot facility with medical and nursing skills labs, simulation rooms, debriefing rooms, smart classrooms and faculty offices. The facility has seven HFS manikins with appropriate equipment and supplies; three simulation technicians manage the technology at the CSC-LV.

Protection of Human Subjects

The study and consent forms were approved by both University of Nevada at Las Vegas (UNLV) and University of Northern Colorado Institutional Review Boards. A faculty member other than the researcher introduced the study and provided a letter of invitation to participate and a consent form (see Appendix I) during normally scheduled lecture classes for first and fourth semester BSN students. Potential student participants were informed of the purpose of the study, the voluntary nature of their participation, the ability to withdraw at any time without penalty, that no personal identifying information would be included on the simulation thinking rubrics, and that no reference would be made in written or oral materials that could link the scored rubric to the student. Also, the students were reassured that their participation or lack of participation and their scores on the rubrics would in no way affect their class or course grades. Faculty explained that anonymity could not be maintained because the students’ faces could be recognized in the digital recordings; however, confidentiality would be respected. The students were informed that the study might cause the same discomfort students normally feel when they are recorded in curriculum planned simulation activities. Students were given an opportunity to ask questions. All consent forms were placed in a large envelope and sealed. A research assistant opened the envelope and removed non-consented students’ digital recordings from the sample. The researcher did not know who consented to participate in the study. The researcher did not review the HFS digital recordings and only saw the data in the form of the scored rubrics. The paper and pencil-scored simulation thinking rubrics and the digital recordings were stored on a secure password protected server and will be saved for three years for audit purposes in a locked file cabinet in the researcher's locked office at the UNLV Shadow Lane Campus Clinical Simulation Center of Las Vegas (CSC-LV). All electronic data such as SPSS files were stored in a secure password protected computer program. The only individuals who had access to the study data were those directly involved in the research including the researcher and the research assistant.

Data Collection Plan

Data Collection Tool

The simulation thinking rubric is in a rubric format with two vertical columns and four horizontal rows (see Appendix G). The first column heading is titled Scoring and the second column is titled Developmental Level of Language and Knowing. There are four rows with two scores per row. Scores 0--*Stops actions during simulation, such as crying, freezing or walking out of the room* and 1-*Completes some pieces of some assessments* are aligned horizontally with seven empirical indicators and an overall description of a sensori-motor thinker in simulation. In the first column second row, the score of 2--*Completes routine actions but does not intervene or take actions* and 3--*Completes routine actions with some attempt to intervene usually with other's help* are aligned with seven empirical indicators and an overall description of a preoperational thinker in simulation. In the scoring column third row, scores 4--C*ompletes several assessments and then intervenes* and 5--C*ompletes one assessment at a time and responds with an intervention based on that assessment* are aligned with seven empirical indicators and an overall description of a concrete thinker in simulation. In the scoring column fourth row, the scores 6--*Notices problem and begins care according to this patient's needs* and 7--*Notices problem, educates patient and family while efficiently caring for complex problems including psychosocial as well as physical needs* are aligned with seven empirical indicators and an overall description of a formal thinker in simulation.

The simulation thinking rubric was designed for scoring during a review of a student's digitally recorded HFS scenario. This gives nurse educators the opportunity to pause and rewind when necessary to accurately score the rubric. Scoring any instrument while watching a live simulation is difficult because a user must look away from the rubric to observe participants and then look away from the participates to score the STR. While a user's eyes are looking at the rubric, a participant's behaviors and language could be missed. The simulation thinking rubric required a high fidelity simulation scenario that could capture the ability to link multiple concepts together to demonstrate language and behavioral indicators characteristic of higher order thinking (Arwood, personal communication, May, 2011). The concepts would vary depending on the level of the student, learning objectives, and course outcomes. An HFS scenario was specifically designed for this research that was appropriate for first semester BSN nursing student's expected ability to think, communicate, and act on the embedded nursing concepts of dyspnea, abnormal vital signs, and pain (see Appendix H).

The Development of the Simulation Thinking Rubric

The simulation thinking rubric is a criterion-referenced measurement that provides a baseline mastery score of the cognitive developmental stage of higher order thinking of a nursing student during the high fidelity simulation scenario. The definition of HOT is theoretically based on the SIMBaLL model (Arwood & Kaakinen, 2009;

Inhelder & Piaget, 1958) that uses Piaget's four stages of cognitive development to define and describe a nursing student's cognitive stage of development of HOT (see Appendix A). Based on the theoretical definition, a worksheet was developed with behavioral and language indicators for each stage of cognitive development of HOT: (a) sensorimotor operations, (b) preoperational operations, (c) concrete operations, and (d) formal operations (see Appendix D). The behavioral and language indicators on the STR increase in complexity from the cognitive developmental stage of sensorimotor stage of operations to the formal operations stage (Arwood & Kaakinen, 2009: Inhelder & Piaget, 1958). Drawing a circle around the behavioral indicators that were the closest fit to the student's behavior during an HFS scenario scored the rubric. A score of 0 or 1 was assigned to a nursing student whose behaviors most closely matched the indicators in the sensorimotor stage (see Appendix G). A nursing student whose behaviors matched the indicators in the preoperational stage scored a 2 or 3. A nursing student who exhibited behaviors in concrete thinking scored a 4 or 5 and a score of 6 or 7 represented the cognitive developmental stage of formal operations during HFS. If a student received a score of 2 in one stage of thinking in simulation and a score of 5 in a different stage of thinking in simulation, the student received a score of 2.

The data collected for this study were the 264 numerically scored STRS of 22 first semester junior year and 22 fourth semester senior year BSN students engaged in HFS. Six raters independently scored 44 HFS scenarios with the STR.

Data Management

After each normally scheduled clinical simulation day, all of the students' digital recordings were coded and stored on a password protected shared drive. The digital HFS recordings of the students who consented to participate were coded by the research assistant and a simulation technician and stored on the secure shared drive. The raters made appointments to review the digital recordings to score the STR at the CSC-LV in a debriefing room with technical support from a simulation technician. The researcher was available by email, phone, or in person to answer questions. A research assistant collected the scored rubrics and stored the forms in a locked file box in the researcher's locked office at the CSC-LV. The researcher entered the scores of the rubrics into SPSS 19 for data analysis. Once the data were entered, the rubrics were stored in a locked file box in a locked cabinet in the researcher's locked office. They will remain there for three years and then will be shredded. The SIMBaLL developers were contacted by phone or by email for consultation. The researcher was readily available to the raters as needed to provide for successful implementation of the study.

Data Analysis

Study Aim #1--Content Validity

The content validity for the simulation thinking rubric was analyzed with a content validity index (CVI). This statistic was chosen because it could estimate the degree to which the items on the rubric represented the construct of higher order thinking. The CVI procedure provided an item, scale, and universal validity index. Using these three estimates of content validity provided an analysis of content validity that could be diagnostic of strengths and weaknesses in a cognitive measurement (Waltz, Strickland, & Lenz, 2010).

According to Polit and Beck (2008), three to five experts are needed to establish content validity of a new instrument. Three content experts were chosen to evaluate the content validity of the STR. Two of the content experts were the SIMBall model developers, doctoral-prepared faculty with more than 50 years combined expertise in simulation and nursing education. The third content expert was a doctoral-prepared nurse educator with more than 30 years teaching experience and 10 years in high fidelity simulation. The content experts rated the content relevance of each item on the STR with a 4-point Likert scale. The four points on the Likert scale were 1--*Not relevant*, 2--*Unable to assess relevance without revision*, 3--*Relevant but needs minor revision*, and 4--*Very relevant and succinct.*

Study Aim #2--Construct Validity

To provide evidence of construct validity, a contrasted groups procedure was conducted. An analysis of variance statistic was chosen because nursing students are known to change over time due to content gained in nursing courses from time in clinical rotations and for maturation during the nursing program. An analysis of variance *F*- test (ANOVA) measured the difference or contrast between the means of the two groups and determined if the mean differences between groups were greater than the differences within the two groups (Polit & Beck, 2008).

To further examine construct validity, a factor analysis procedure was conducted. A principle component analysis (PCA) was chosen because this procedure could identify underlying constructs of a measuring instrument. The expectation was that the scores on the STR would cluster together in four principal components that represented the four cognitive developmental stages of HOT.

Study Aim #3—Internal Consistency Reliability

The determination of internal consistency of the simulation thinking rubric was calculated with a Cronbach's coefficient alpha. This statistic was chosen because it calculated the degree to which items on an instrument were correlated and consistently measured the same concept. A Cronbach's alpha of 0 indicated an instrument was not measuring the same concept and was unreliable. A score of +1.00 indicated an instrument consistently measured the same concept and was a reliable instrument. Therefore, higher values for the alpha coefficient suggested less error in measurement of the construct, whereas lower values suggested greater error, indicating that the items in the instrument did not measure the same construct.

Study Aim #4--Inter-rater Agreement

An inter-rater training and agreement procedure was conducted because these are effective in reducing observer error and could enhance the reliability of the scoring of the STR. Six raters agreed to participate in the psychometric testing of the rubric. The criteria for selecting raters were based on the following criteria: (a) had experience in immersive HFS training, (b) were currently engaged in HFS, and (c) had at least three years of HFS practice in nursing education.

To strengthen the reliability of the rubric, the researcher and the SIMBaLL model developers conducted a train-the-rater workshop before the study began. An orientation packet was provided for each rater that included information on the simulation based on learning language model, a description of the rater's role, and a copy of the simulation thinking rubric with written scoring instructions. In addition, the theoretical, operational, and behavioral indicators for each cognitive developmental stage of higher order thinking were explained according to the SIMBaLL model. To further assure the reliability of the scores on the rubrics, the raters practiced scoring HFS scenarios that were similar to the research scenario. An inter-rater agreement procedure took place prior to data collection.

CHAPTER IV

FINDINGS

This chapter begins with a description of the study participants followed by descriptive statistics of the raters' ratings. The findings for the psychometric testing of the simulation thinking rubric (STR) are presented for each of the four study aims.

Description of the Sample

After Institutional Review Board approval by both UNLV and the University of Northern Colorado, recruitment for participation in the study was conducted. Forty-eight first semester junior year and 48 fourth semester senior year BSN students were invited to participate in the study. All but one student gave consent but due to the timing of IRB approval, semester end times, the timeframe for concurrent curriculum planned HFS, and the research scenario, there was not enough time to engage the total number of students who gave consent to participate. Therefore, 22 first semester and 22 fourth semester BSN nursing students participated in the testing of the STR. Six raters reviewed digitally recorded HFS scenarios to score the rubric. The 264 scored STRs for these 44 students comprised the sample for the study. Demographic data including age, gender, ethnicity, and semester level were collected during the study and are presented in Table 1.

Table 1

Demographic Summary of First and Fourth Semester Student Participants

Characteristic	Semester 1 (*n* = 22)	Semester 4 (*n* = 22)	Total (*N* = 44)
Age	*M* = 23.5 years	*M* = 24.5 years	*M* = 24 years
Gender			
Male	31.8%	18.2%	25%
Female	68.2%	81.8%	75%
Ethnicity			
Caucasian	50.0%	40.9%	45.5%
Asian	13.6%	22.7%	20.5%
Hispanic	13.6 %	13.6%	13.6%
African American	0%	9.1%	4.5%
Pacific Islander or Native American	4.5%	0%	2.3%
Two or more races (Not Hispanic or Latino)	18.3 %	13.6%	13.6%

Of the 22 first semester BSN students, 7 were male and 15 were female. Ages ranged from 21 to 32 years of age with a mean age of 23.5 years. The ethnicities of first semester BSN students were 11 Caucasian, 3 Hispanic, 3 Asian (not Hispanic or Latino), 4 two or more races, and 1Native Hawaiian or Pacific Islander (not Hispanic or Latino). Of the 22 fourth semester BSN students, 4 were male and 18 were female. Ages ranged from 21 to 34 years with a mean age of 25.41 years. The ethnic backgrounds of fourth semester BSN students were 9 Caucasian, 2 African American (not Hispanic or Latino), 5

Asian (not Hispanic or Latino), 3 Hispanic, and 3 two or more races (not Hispanic or Latino).

Raters' Ratings

The descriptive statistics shown in Table 2 include the means and standard deviations of the 44 HFS scenario STR scores. Appendix K contains histograms with normal curve overlays for the raters' ratings of each of the 44 students' scored digital HFS recordings. The standard deviations did not significantly deviate from the mean. This indicated that the distributions of the raters' ratings were consistent. The scores ranged from one to seven.

A Pearson's product-moment correlation coefficient (*r*) was calculated to show the direction and strength of the relationship between the STR scores of the six raters. The direction of the relationship was positive but the strength of the correlation between raters varied (see Table 3). The relationship between rater one and four was negatively correlated(r = .-01) and the majority of the correlations were $< .50$. The relationship between rater three and rater one was the only value that showed a positive strong correlation ($r = .59$, $p < .01$).

Table 2

Descriptive Statistics for the Raters' Ratings of the 44 Scenarios

Scenario	*M*	*SD*
Scenario 1	3.17	1.72
Scenario 2	3.83	1.33
Scenario 3	2.83	1.17
Scenario 4	4.00	1.10
Scenario 5	4.17	1.33
Scenario 6	2.00	1.10
Scenario 7	2.33	1.03
Scenario 8	2.83	1.17
Scenario 9	3.67	1.63
Scenario 10	3.33	1.21
Scenario 11*	3.00	0.00
Scenario 12	3.17	1.17
Scenario 13	2.17	0.98
Scenario 14	3.83	0.98
Scenario 15	2.83	1.17
Scenario 16	3.50	1.38
Scenario 17	4.50	1.76
Scenario 18	4.50	1.52
Scenario 19	2.50	1.23
Scenario 20	5.00	0.89
Scenario 21	4.33	0.82
Scenario 22	3.17	0.98
Scenario 23	4.67	1.86
Scenario 24	3.50	1.76
Scenario 25	3.83	2.04
Scenario 26	3.33	2.25
Scenario 27	4.17	1.47
Scenario 28	3.83	2.04
Scenario 29	3.00	1.27
Scenario 30	3.83	1.47
Scenario 31	5.00	0.89
Scenario 32	2.83	0.98
Scenario 33	2.50	1.23
Scenario 34	3.50	1.38
Scenario 35	2.67	1.03
Scenario 36	5.00	1.41
Scenario 37	5.00	1.41
Scenario 38*	3.67	0.82
Scenario 39	4.83	1.72
Scenario 40	4.50	1.38
Scenario 41	4.17	1.72
Scenario 42	4.33	1.52
Scenario 43	3.50	1.52
Scenario 44	4.50	1.38

Note. Items marked with an asterisk (*) were removed from final EFA because these particular scenarios did not load or cluster together with any factor.

Table 3

Pearson's Product-Moment Correlation Coefficients of Raters' Ratings of the Rubric

Rater	1	2	3	4	5	6
1	--	.26*	.59**	.39**	.47**	.47**
2		--	.49**	.44**	.28*	.05
3			--	.34*	.31*	.43**
4				--	.35*	-.01
5					--	.40**
						--

* $p < .05$ ** $p < .01$

An inter-rater reliability procedure was completed before data collection began. Each rater achieved a Cronbach's alpha of .90 between their scores and the simulation based on learning language model developers' scores with the simulation thinking rubric. However, according to the Pearson product moment coefficient, the correlation between the raters' ratings was not adequate.

Study Aim #1 to Test Content Validity

Three content experts completed a Likert scale to judge each of the variables on the STR independently and sent the results electronically by email to the researcher. The four ordinal points on the scale were 1--*Not relevant*, 2--*Unable to assess relevance without revision*, 3--*Relevant but needs minor revision*, and 4--*Very relevant and succinct*. An item content validity index (I-CVI), a Scale-CVI/Average (S-CVI/Ave), and an S-CVI/Universal Agreement (S-CVI/UA) were calculated.

The literature suggested that when there are three content experts, the item index for each individual item must be 1.00 to provide evidence of a content valid instrument (Lynn, 1986). However, Polit and Beck (2008) stated that an S-CVI/AVE should be at least .90 to provide evidence of excellent content validity. The S-CVI/Ave for the STR was .976 (see Table 3). The content experts were in universal agreement on 26 out of 28 items for an S-CVI/UA of .928. Two items had an I-CVI of 0.67. Content experts #1 and #3 were in universal agreement on all 28 items. But content expert #2 rated item 1d (Vocalizes about random actions and procedures that are inappropriate to the patient's needs) and item 3e (Asks obvious questions according to rules without consideration of patient's signs or symptoms) as a 2. These two items were considered "fair" items and would need revision or elimination from the simulation thinking rubric (Polit, Tatano Beck, & Owen, 2007).

Polit et al. (2007) developed a table for a modified kappa statistic (*k*) that makes adjustments for chance agreement on relevance when calculating a content validity index. With three experts and an I-CVI of 1.00, the modified *k* was 1.00 or the item had excellent relevance. An I-CVI of 0.67 had a *k* of .47 and was considered a fair item. Any I-CVI greater to or equal to .78 was considered to be excellent regardless of the number of content experts (Polit et al., 2007). According to Table 4, the I-CVI/Ave of .928 for the simulation thinking rubric met criteria for an instrument with excellent relevance.

Table 4

Content Validity Index Likert Scale Results

Item	CE 1	CE 2	CE 3	*CE in Agreement	I–CVI
1a	3	3	4	3	1.00
1b	4	4	4	3	1.00
1c	4	4	3	3	1.00
1d	4	2	4	2	0.67
1e	3	4	4	3	1.00
1f	4	3	4	3	1.00
1g	4	3	3	3	1.00
2a	3	4	4	3	1.00
2b	3	3	3	3	1.00
2c	3	3	4	3	1.00
2d	3	3	3	3	1.00
2e	3	4	4	3	1.00
2f	3	3	4	3	1.00
2g	4	4	4	3	1.00
2h	3	4	4	3	1.00
3a	3	3	4	3	1.00
3b	3	3	4	3	1.00
3c	3	4	4	3	1.00
3d	3	3	4	3	1.00
3e	3	2	3	2	0.67
3f	4	3	3	3	1.00
4a	3	4	4	3	1.00
4b	3	3	4	3	1.00
4c	3	4	4	3	1.00
4d	3	4	4	3	1.00
4e	3	3	4	2	1.00
4f	4	4	4	3	1.00
4g	4	3	4	3	1.00
	1.00	.928	1.00	I- CVI/Ave = 27.34/	28 = .9764

1--*Not relevant*, 2--*Unable to assess relevance without revision*, 3--*Relevant but needs minor revision*, 4--*Very relevant and succinct*. S-CVI/Universal = 3 raters agreed that 26 out of 28 items were content valid = .92857

- Denotes the number of CES who scored the item a 3 or a 4.

Study Aim #2 to Test Construct Validity

To determine the construct validity of the simulation thinking rubric, an exploratory factor analysis (EFA) and a one-way analysis of variance (ANOVA *F*-test) were conducted.

Exploratory Factor Analysis

An exploratory factor analysis was performed to describe and summarize the scores on the simulation thinking rubric. A principal component factor analysis (PCA) procedure was chosen to discover if and how the scores on the rubrics clustered together to form components (Tabachnick & Fidell, 2007). Specifically, the goal was to see if the scores would cluster together to form the four stages of cognitive development of higher order thinking. The scores on the STR for each cognitive stage of development were as follows: 0--*Stops actions during simulation, such as crying, freezing or walking out of the room;* 1--*Completes some pieces of some assessments*; 2--*Completes routine actions but does not intervene or take action;* 3--*Completes routine actions with some attempt to intervene usually with other's help*; 4--*Completes several assessments and then intervenes;* 5--*Completes one assessment at a time and responds with an intervention based on that assessment;* 6--*Notices problem and begins care according to this patient's needs;* and 7--*Notices problem, educates patient and family while efficiently caring for complex problems including psychosocial as well as physical needs.*

The raters' ratings (264) were screened for scores that were unusually high or low and also to see if certain scores clustered together differently than the majority of simulation thinking rubric scores (Tabachnick & Fidell, 2007). Only 3 out of the 44 HFS scenario STR scores had outliers. In addition, histograms with a normal curve overlay (see Appendix K) were examined for skewness and kurtosis. The histograms for the 44 HFS scenarios for each of the six raters demonstrated slight kurtosis (peaked normal curves with values ranging from .85 to 3.60) and skewness (scores to the left or right of the median ranging from 0.45 to -1.94). The skewness and kurtosis values did not deviate enough from a normal curve to negatively impact the PCA procedure and analysis. Linear plots such as a normal Q-Q plot (see Figure 1) and box plot (see Figure 2) provided evidence that the data were linear and there were no multi-collinear abnormalities.

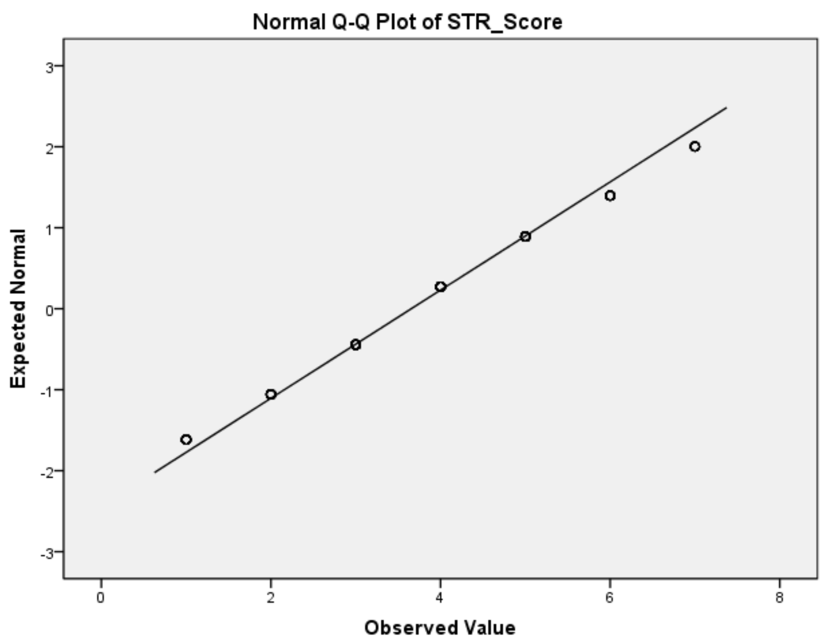

Figure 1. Q-Q plot of 44 scored high fidelity simulation scenarios across six raters.

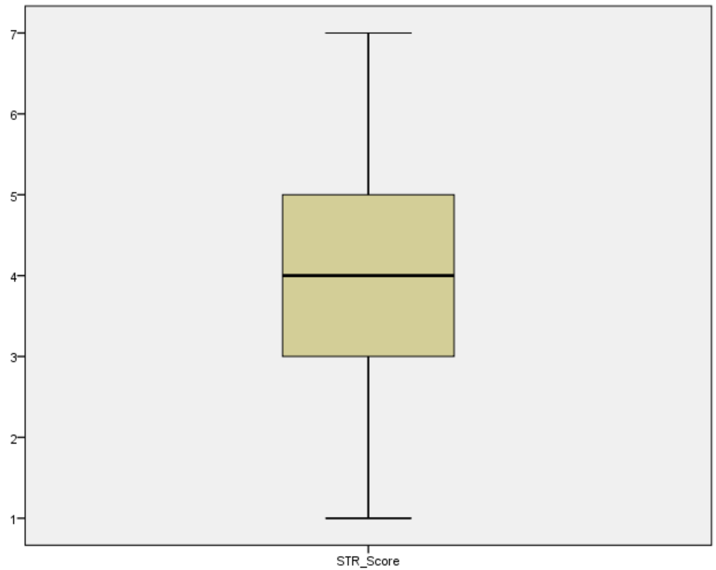

Figure 2. Box plot of 44 scored high fidelity simulation scenarios across six raters.

Last, an inspection of the correlation matrix showed correlations greater than.3. Therefore, the data were suitable for a factor analysis (Tabachnick & Fidell, 2007). Each of the factor analysis assumptions mentioned above were met as well as the homogeneity of error variance assumption for the ANOVA analysis.

The scores on the 264 simulation thinking rubrics were subjected to a principal component analysis (PCA) extraction using promax (oblique) rotation with Kaiser normalization. The oblique rotation was chosen because the score on the rubric represents different dimensions of one construct. Therefore, the scores were correlated with the construct of HOT. This produced a correlation matrix that represented all of the possible linear combinations between the raters' ratings of 264 STR scores. Only factors that had strong coefficients ($\geq .40$) were reported. Also, all component eigenvalues were > 3 (see Figure 3) and this surpassed the required ≥ 1 cut-off value (Tabachnick & Fidell, 2007).

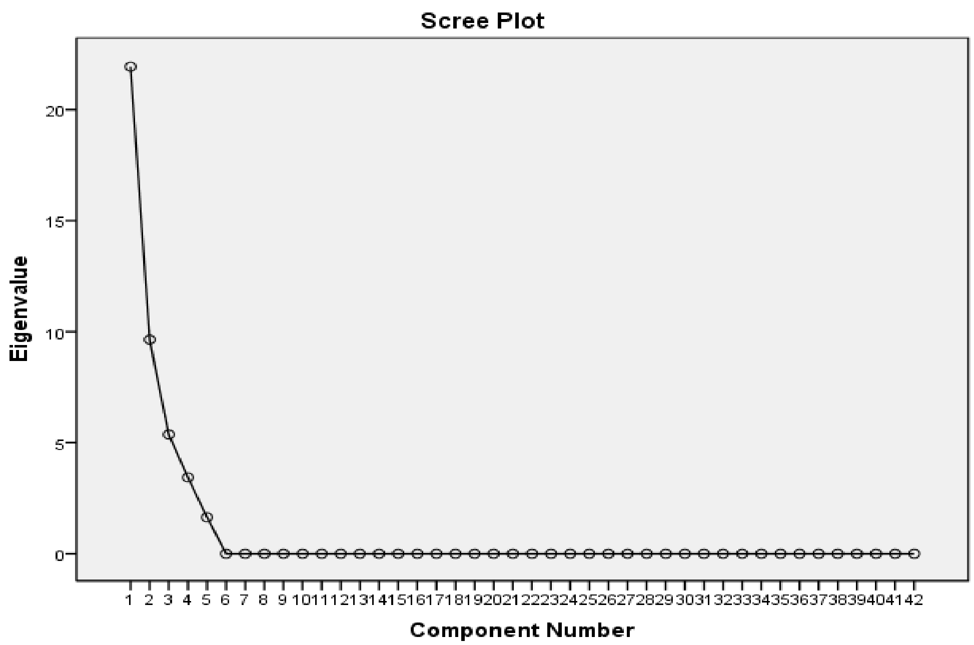

Figure 3. Catell's scree test graphic representation of eigenvalues. Eignevalues are shown on the vertical axis. Factor loadings are on the horizontal axis.

According to the scree plot, four principal components were highly correlated (see Figure 3). The plot line began at an eigenvalue of 20 and decreased to 10. Then there was a slight change in the slope of the line from 10 to about 5 and then to approximately 3; there was a negligible change in the slope of the line thereafter. This provided a first look at the possibility that there were four principal components on the simulation thinking rubric. A scree plot is not an exact procedure but involves subjectivity or interpretation by the researcher (Tabachnick & Fidell, 2007). The PCA procedure found four principal components that accounted for 96.12 % (see Appendix L) of the variance in the six raters' ratings of 44 HFS scenarios using the STR.

A second PCA procedure was conducted, removing the scores from HFS scenarios 11 and 38 because they did not cluster together with any of the groupings. All of the loadings ranged from .51 to 1.00 with most of the scores loading on one of four components. Some of the scores loaded on more than one component but the higher loading was chosen. The grey highlighted numbers in Table 5 are examples of scores that clumped together with two factors. Those scores that loaded onto more than one factor that were near one another in magnitude (± 5) were difficult to interpret. The complex scenarios (those that loaded on more than one factor) were scenario 43--loading on components 1 and 2 and scenario 16--loading on components 1 and 4. Factor correlations ranged from .11 to .45, suggesting a correlated factor structure; this supported choosing the Promax oblique rotation as opposed to the Varimax orthogonal rotation.

The similarities in the groupings of the four principal components represented the cognitive developmental stages of preoperations 2 and 3 and the concrete stage of cognitive developments 4 and 5 (see Table 5)

Table 5

Promax Oblique Rotation Pattern Matrix of the Raters' Ratings of the Simulation Thinking Rubric

Items	F1	F2	F3	F4
Scenario 3	1.065			
Scenario 24	.97			
Scenario 25	.95			
Scenario 42	.90			
Scenario 22	.89			
Scenario 28	.80			
Scenario15	.69			
Scenario 44	.66	[.55]		
Scenario 34	.66	[.55]		
Scenario 6	.65		[.57]	
Scenario 26	.64			
Scenario 43	.56	[.56]		
Scenario 20		.99		
Scenario 37		.97		
Scenario 17		.92		
Scenario 32		.90		
Scenario 14		.90		
Scenario 30		.88		
Scenario 29		.84		
Scenario 40		.77		
Scenario 41		.69		
Scenario 2		.67		
Scenario 9		.55		
Scenario 1			1.038	
Scenario 7			1.018	
Scenario 27			.93	
Scenario 21	[.49]		.91	
Scenario 4			.87	
Scenario 23			.84	
Scenario 35			.82	
Scenario 18	[.53]		.75	
Scenario 39			.72	
Scenario 5		[.57]	.70	
Scenario 36				.95
Scenario 31		[.67]		.82
Scenario 13				.74
Scenario 10				.70
Scenario 8				.68
Scenario 16	[.57]			.58
Scenario 12				.57
Scenario 19				.51
Scenario 33				.51
Label	Preop 2	Preop 3	Concrete 4	Concrete 5

Note. Eigenvalues of the four components before rotation were 21.93, 9.64, 5.36, and 3.43. This matrix excludes Scenario 11 and 38 because they did not cluster with any of the factors. Scenarios with loadings greater than .40 are reported. Loadings in brackets suggest a complex structure, as they load on more than one component.

[a] Label indicates the suggested factor (i.e., extracted factor) name.

One-way Analysis of Variance

The results of the ANOVA *f*-test suggest (see Tables 6 and 7 and Figure 4) that there were mean differences between raters' ratings of 22 first semester junior year and 22 fourth semester senior year BSN students, $f(2,11) = 3.73$, $p > .05$, $\eta^2 = .21$. The results were not statistically significant ($p = 130$) due to a small sample size with a reported power of .32. However, the eta or magnitude of the differences in the two means scores was significant ($\eta^2 = .21$). An eta of .01 is considered a small effect size, whereas a .06 is a moderate effect size and .14 and above is considered a large effect size (Cohen, 1992). The η^2 of .21 indicates that the semester level accounted for 21% of the variance in raters' ratings of students. The raters scored fourth semester students higher (see Figure 2) on the HFS scenarios using the STR (*M* = 4.11, *SD* = 1.12) when compared to Level 1 students (*M* = 3.20, *SD* = 0.74).

Table 6

One-way Analysis of Variance Descriptive Data

Semester					95% Confidence Interval for Mean			
	N	Mean	SD	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
First	6	3.20	1.306	.114	2.98	3.43	1	6
Fourth	6	4.11	1.545	.134	3.84	4.37	1	7
Total	12	3.66	1.497	.092	3.47	3.84	1	7

Table 7

Dependent Variable: Simulation Thinking Rubric Composite

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	2.438[a]	1	2.438	2.717	.130	.214	2.717	.320
Intercept	160.335	1	160.335	178.690	.000	.947	178.690	1.000
Level	2.438	1	2.438	2.717	.130	.214	2.717	.320
Error	8.973	10	.897					
Total	171.746	12						
Corrected Total	11.411	11						

a. R Squared = .214 (Adjusted R Squared = .135)
b. Computed using alpha = .05

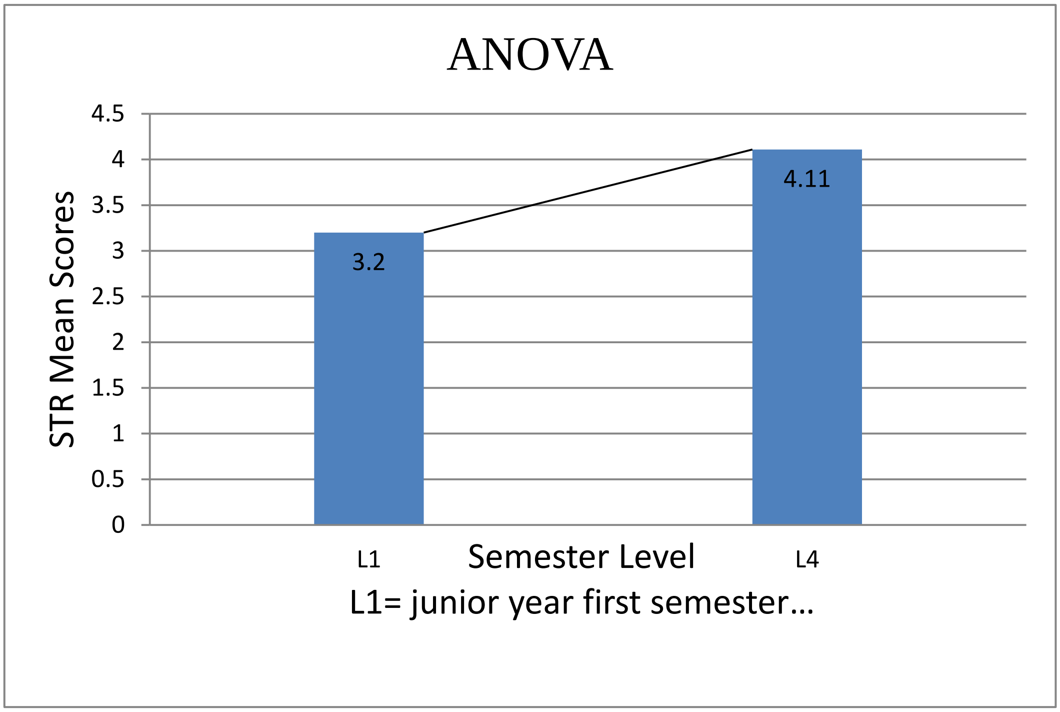

Figure 4. Analysis of variance histogram depicting semester one with semester four mean scores.

Study Aim # 3 to Test Internal Consistency Reliability

The determination of internal consistency for the simulation thinking rubric was calculated with a reliability coefficient Cronbach's Alpha (α). For a new instrument such as the STR, the criterion level for Cronbach's α is .70 or above (Nunnally & Bernstein, 1994). Cronbach's α for the rater's 264 scored rubrics was .74, indicating weak internal consistency (see Appendix K).

Study Aim #4 Inter-rater Agreement

Six trained raters scored eight high fidelity simulation scenarios similar to the research scenario. The raters' ratings were compared to the ratings by the SIMBaLL model developers. Each rater achieved a Cronbach's alpha of .90 before data collection began.

Summary

This chapter discussed the statistical findings for each of the study aims. Psychometric testing included a content validity index, construct validity with both a factor analysis and an ANOVA *f* –test, and a reliability coefficient Cronbach's Alpha (α). A discussion regarding the findings, strengths, and limitations of the study as well as recommendations for further research and a conclusion to the study are presented in Chapter V.

CHAPTER V

ANALYSIS AND RECOMMENDATIONS

This chapter discusses the study findings, implications for nursing, and recommendations for further research. In addition, there is a discussion of the study limitations.

Interpretation of Findings

The content validity index indicated that the simulation thinking rubric (STR) measured the construct of higher order thinking (HOT). However, two of the content experts were the SIMBaLL model developers. The content validity procedure would have produced rigorous results had the content experts been other than the SIMBaLL model developers.

The theoretical structure of the simulation thinking rubric was examined with a principle component analysis (PCA) procedure. The results were that the scores on the STR clustered together in the preoperational (scores 2 and 3) and the concrete (scores 4 and 5) cognitive stages of development of higher order thinking. The sensorimotor and formal operations stages of cognitive development were not represented in the PCA. This might be because the scores on the rubric represented four dimensions of one construct. As a result, there might not have been enough variation between the items on the STR that represented each of the four cognitive development stages of HOT. In addition, according to Piaget (1950), most of the adult population has attained a concrete or formal cognitive stage of development (Inhelder & Piaget, 1958; Wadsworth, 2004). One could make the assertion that since the adult population is known to have at least reached the concrete cognitive stage of development, then college-age nursing students have developed HOT beyond the sensorimotor and preoperational stage but might not have attained the cognitive stage of formal operations. According to Piaget, a child who is preoperational (two to seven years of age) is beginning to develop conceptual knowledge. We can expect a college-age nursing student to have attained and passed the preoperational stage of cognitive development even if concepts new to nursing students are the focus of measurement. Nursing concepts are new knowledge but the cognitive ability to process new concepts is established by adolescence (Wadsworth, 2004). In this regard, the SIMBaLL model did not define, describe, or explain how adults acquire conceptual knowledge. Consequently, the empirical indicators of HOT were developed based on stages an adult has previously gained and were not accurate for an adult learner. This might be one reason the PCA did not accurately represent the four dimensions of higher order thinking.

The ANOVA procedure showed that first semester junior year nursing students scored lower and fourth semester senior year nursing students scored higher on the STR. Even though the results were not statistically significant, the finding was encouraging. This finding indicated the empirical indicators of HOT on the rubric were able to show a difference in scores for the two semester levels.

The reliability procedures indicated that the STR scores were inconsistent with wide variation. The raters' ratings of any one HFS scenario scored a nursing student in the sensorimotor, preoperational, concrete, and formal stages of cognitive development of

HOT no matter the semester level. The raters observed nursing students who demonstrated empirical indicators that were in multiple stages of cognitive development of HOT but tried to score the students in only one stage of cognitive development. One reason the raters had trouble with scoring consistency was because the learning process was multi-dimensional; it was hard to capture with a measurement instrument. The expectation that each first semester and fourth semester nursing student would demonstrate different levels of understanding of each of the three concepts embedded in the HFS scenario (abnormal vital signs, dyspnea, and pain) was not an unreasonable expectation.

The simulation thinking rubric did not capture higher order thinking that demonstrated nursing students' knowing, thinking, and doing during the research HFS. Piaget's (1950) theory of cognitive development stated that the stages of cognitive development are hierarchal and invariant, meaning that a child has to attain a lower stage of cognitive development before they can move back and forth from a lower to a higher stage (Wadsworth, 2004). However, the SIMBaLL model fell short in describing or defining this movement. Maybe it is possible that nursing students could be at different stages of cognitive development of nursing concepts and could go back and forth between the stages. This would be difficult to measure. As an example, a student might have an understanding of oxygenation at the formal operational stage of cognitive development and demonstrate a concrete understanding of the concept of pain. Consequently, several raters indicated the STR was hard to score because the empirical indicators in the cognitive developmental stages seemed to overlap or were not clearly demarcated. One rater commented, "Scoring was difficult in that some of the parameters were true for a student but not all for a particular level. There were too many qualifiers perhaps or mixed levels."

The column heading for the empirical indicators of higher order thinking was labeled the developmental level of language and knowing. As an example, according to the SIMBaLL model, a sensorimotor thinker might not acknowledge a patient's questions and language used to converse off topic or engage in pleasantries. In contrast, a formal thinker could use language to address a patient's questions and might anticipate what a patient will ask next. Patients routinely ask nursing students questions about their condition, medications, diagnostic procedures, or other concerns. Sometimes the students answered the questions; at other times, the nursing students told the patient they do not know but would ask their nursing instructor. In this research, all 44 students were asked questions during the research HFS scenario such as "Why is my blood pressure so high?" and "Why is my breathing so difficult?" Some of the students did not answer or talked off topic; some answered correctly but did not link vital signs with the side effect from the administration of albuterol or the diagnosis of chronic pulmonary disease and pneumonia. Further, some answered correctly and linked the concepts of pain, dyspnea, and abnormal vital signs with the medical diagnosis. Those students who could link concepts together also answered the patient's (manikin) questions in language a patient could understand. However, it is not known if other students had the same knowledge and were unable to answer the questions because of other variables such as anxiety, an inconsistency in the research HFS scenario, or lack of self-confidence.

The rater's ratings of the 44 HFS scenarios varied widely, rendering the STR an unreliable instrument. Prior to data collection, an inter rater agreement procedure was conducted. Each rater attained a .90 agreement with the model developers and the researcher by the end of the rater procedure. However, in spite of the researcher's efforts to train six raters, scoring the rubric was still difficult and unclear when tested. The data collection period spanned two months without the researcher making periodic rater checks. This lack of attention to the raters might be one reason why the reliability estimates were poor. The STR was difficult for trained raters to score and therefore would be extremely difficult for nurse educators to use. An instrument must have practical application. Nurse educators who utilize high fidelity simulation as a learning strategy would not find the simulation rubric easy to score and therefore would not use it.

One solution to the difficulty involved in scoring the STR would have been for the researcher to digitally record a HFS research scenario for each of the four stages of cognitive development as an exemplar for future raters. This would enable the raters to review the exemplar of the researcher acting in the HFS scenario for each of the stages of cognitive development. These could be saved on a digital visual disk as a resource that raters could easily access.

Implications for Nursing

This study sought to test a theoretically-based, psychometrically sound instrument that would be able to assess HOT related to HFS. What this study added was an inside look into the difficult and challenging process of tool development. The knowledge gained from this study might assist other researchers in avoiding the same limitations. The main learning point is that the importance of a theoretical basis for tool development cannot be overstated. The score on the simulation thinking rubric represented an adult nursing student's cognitive stage of development as defined by a theory that described how children develop conceptual knowledge. Without a strong theoretical basis that describes, defines, and explains the phenomenon of higher order thinking, the results of psychometric testing of the STR had no meaning. The simulation thinking rubric was not a valid or reliable instrument. In addition, learning is a multidimensional process; a one-dimensional instrument (such as the STR) that uses checklists and rubrics might not adequately measure student nurses' knowing, thinking, and doing.

Nurse educators are interested in active learning strategies that foster HOT skills such as HFS. Consequently, there is a need for the development of theoretically-based, psychometrically sound instruments that can accurately measure learning outcomes related to HFS as an active learning strategy. The development and psychometric testing of the simulation thinking rubric was a response to calls by nurse educators in simulation, healthcare, and nursing organizations to quantify cognitive gains due to high fidelity simulation. With a decrease in clinical sites and concerns regarding patient safety, nurse educators are using HFS to augment or as a replacement for clinical time. Another concern is evidence that new nurse graduates might not have entry level thinking skills for practice in the current healthcare system (Del Bueno, 2005). Some nurse educators assert that HFS is one solution to those nursing problems. The rationale is that HFS is a learning strategy that is "action-oriented learning," can simulate real world clinical nursing experience, and "spurs the brain's bio-chemical energy" (Cardoza, 2011, p. e205). Tools have been developed to measure different dimensions of learning in HFS. Nursing simulation experts have called for a moratorium on new tool development and encourage the further development and testing of existing HFS tools (Kardong-Edgren et al., 2010). Consequently, the implications for nursing are that without more research on instrument development, it will be difficult to provide evidence that HFS is an active learning strategy that facilitates cognitive gains, can be an effective replacement for time spent in hospital clinical, and contributes to new nursing graduates who have entry level thinking skills.

Limitations of the Study

The major limitation of this study was the theoretical basis for the simulation thinking rubric. The SIMBaLL model was based on the neurosemantic learning language theory that used Piaget's (1950) theory of cognitive development to assess and facilitate HOT in nursing students related to HFS. However, Piaget's four cognitive developmental stages are laws and principles that explain how children acquire conceptual knowledge. In contrast, the SIMBaLL model defines, describes, and explains the cognitive development of HOT in adult nursing students during HFS. The fourth or formal operations stage of cognitive development might be attained by the time a child is 15-years-old or later, or not at all (Wadsworth, 2004). This means that there are adults, inclusive of nursing students, who have attained the concrete stage but might or might not have attained the formal stage of cognitive development. However, the SIMBaLL model asserted that an adult nursing student could demonstrate the sensorimotor (birth to age 2) or preoperational stages (two years to seven years) of cognitive development of higher order thinking. The empirical indicators on the STR were developed and based on this premise. However, the testing of the rubric failed to show support for measuring HOT based on the SIMBALL model. The SimbaLL model asserted that a nursing student who attained the concrete or formal stage of operations was a nursing student who would graduate as a safe and effective practitioner. However, no evidence supported this assertion and it might be an unreasonable expectation.

Some researchers have extended the application of Piaget's (1950) theory to young adults through research on college-age students. However, the theory has not been tested and there are no studies that support its use for college-age nursing students in HFS. Piaget's stages did not hold up under the testing of the STR used in this study. In spite of this, the theoretical basis for the tool did allow testing of the construct of HOT through the development of empirical indicators appropriate for psychometric testing and validation.

Problems with consistency in implementing the research HFS scenario occurred during the process of this study. Other more practical efforts to standardize the HFS scenario such as minimizing the differences between simulation technicians, consistent set up of the simulation room and set up times, debriefing timelines after the scenario, and the timeline for moving nursing students through the scenario were planned but were not implemented with consistency. In the future, training one technician would lend more consistency to the process. The duration time for the research HFS scenario should be investigated first before assigning a timeline. The 10-minute scenario duration time might or might not have been an appropriate time span for students to demonstrate higher order thinking. Also the addition of 10 more minutes for a total of 20 minutes would provide time for other adjustments needed to prepare for the next scenario. To further lend consistency to the process, an additional research team member could do the debrief session with each of the students. Standardization in the research process is important because without standardization, other variables interfere with the focus of the study. As an example, if the hospital bed is not flat in every setup, then some nursing students will not have the opportunity to sit the manikin up and see an increase in oxygen saturation on the monitor. A lack of consistency in the HFS scenarios translates to inconsistent student responses and behaviors and, consequently, inconsistent scoring.

Recommendations for Future Research

Further research should focus on examining other learning theories, e.g., the neuroscience of learning and adult theories of learning, as a theoretical basis for a new instrument that might be able to measure higher order thinking related to HFS. The importance of learning theory as a foundation for instrument development cannot be overstated. A theoretical foundation provides a set of interrelated concepts that are defined, described, explained, and, as a result, can be measured. The following recommendations are made for future research: (a) examine the literature for adult theories of learning, (b) conduct a concept analysis on the construct of higher order htinking, (c) sample the domain of higher order thinking based on the concept analysis, and (d) develop items for a new instrument.

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APPENDIX A

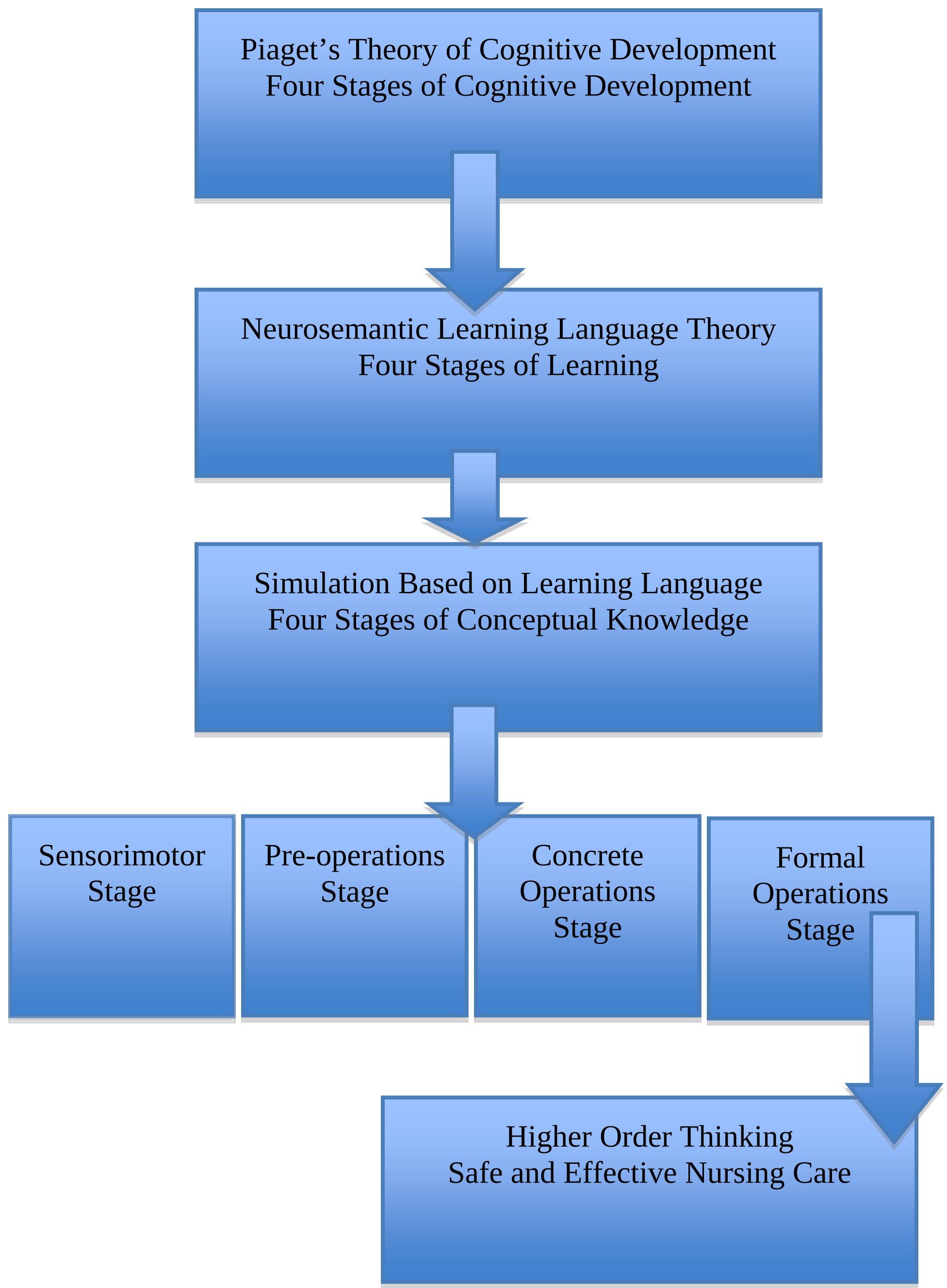
CONCEPTUAL DEFINITION OF HIGHER ORDER THINKING

Conceptual Definition of Higher Order Thinking

Concept	Theoretical Definition	Operational Definition
Higher-Order Thinking	Higher Order Thinking is thinking and linguistic function with maximum displacement and flexibility and decreased redundancy at the cognitive developmental stage of formal operations.	Score on the Simulation Thinking Rubric

APPENDIX B

THEORETICAL FRAMEWORK


Piaget's Theory of Cognitive Development
Four Stages of Cognitive Development
Neurosemantic Learning Language Theory
Four Stages of Learning
Simulation Based on Learning Language
Four Stages of Conceptual Knowledge
Sensorimotor Stage
Pre-operations Stage
Concrete Operations Stage
Formal Operations Stage
Higher Order Thinking
Safe and Effective Nursing Care

APPENDIX C

NEUROSEMANTIC LEARNING LANGUAGE THEORY

The Neurosemantic Learning Language Theory

Steps	Neuro-Education	Learner Development	Language
1. Sensory input; receiving sights, sounds, tastes, touch and smells into the human body (Arwood, 2011, p. 43)	Information from the environment is received and transmitted by sensory receptors in the skin, eyes, ears, nose, and mouth and is taken into the body in the form of light waves, sound waves, smells, tastes, and pressure receptors in the skin.	Sensory Input only. Determine sensory deficits because a deficit changes how the learner takes in sensory data.	There is no meaning or interpretation of the information from sensory input.
2. Sensory input is sorted and organized into perceptual patterns. (Arwood, 2011, p. 44)	The simultaneous input of sensory input from different sensory organs creates patterns. Patterns consist of sets of sensory data. Cell structures in the brain recognize patterns of from the present and the past (Arwood, 2011, p. 45)	Pattern organization produces a motor response. Pattern recognition can be taught. Low level learning such as mimicking, repeating, copying, filling in patterns or blanks, and modeling.	The organizations of sensory patterns have different meanings to each unique human being. Words and sounds can be repeated but there is no meaningful language function or concept development.

Steps	Neuro-Education	Learner Development	Language
3. Sets of meaningful patterns over lap to form complex systems of patterns or concepts (Arwood, 2011, p. 36)	Meaningful perceptual patterns overlap and layer and are transmitted from the periphery of the CNS to higher more complex structures of the brain that either inhibits or integrates old patterns with new information to form even larger cortical chunks of knowledge that are systems of concepts. Cellular activity at the level of the cortex of the brain completes the learning of concepts both socially and cognitively.	Learning becomes part of the mind not just of the brain (Arwood, 2011, p. 59). This phase is where thinking (cognition) begins (Arwood, 2011) Conceptual thinking or knowledge occurs when the cells of the outer most part of the cerebrum, the surface cortex, become active.	Conceptual knowledge represents underlying meaningful patterns and semantic relationships. Concepts build overtime and the sum is greater than their parts (Arwood, 2011).
4. Language represents conceptual knowledge (Arwood, 2011, p. 36).	Language represents the concepts the learner has developed from the neural processes of integration and inhibition and by the creation of neuronal circuits for ever larger and more complex sets of perceptual patterns formed form sensory input. Language functions allow for greater acquisition of conceptual meaning.	Assess learners thinking by examining the learner’s language because cognitive development parallels language development.	Language assigns meaning to underlying concepts and creates long-term semantic memory.

APPENDIX D

WORKSHEET OF BEHAVIORAL AND LANGUAGE EXAMPLES

Worksheet of Behavioral and Language Examples

Behaviors and language can be used to determine level of cognition and therefore can indicate levels of conceptual thinking.

1. Sensorimotor Operations
   A. Sensorimotor learner:
   - Is able to copy or mimic a model performing a skill and/or replicate a procedure.
   - Cannot explain nursing care to a patient.
   - Is able to perform nursing skills in a timid and restrained manner without speaking to the patient.
   - Student may stop, walk out, bursts into tears, or freeze in response to patient questions.

   B. Behavioral indicators
   - Is non-verbal, does not verbalize an understanding of the rational of a task.
   - Is unable to complete simulation because the student “freezes” or leaves an independent or autonomous physical assessment.
2. Preoperational Operations
   A. Preoperational learner;
   - Replicates nursing skills such as hand washing, ID band check, vital signs and physical assessment.
   - Performs tasks in a routine way independent of patient needs or others’ comments therefore focusing on the task, not the patient or the family.
   - Answers questions that reflect the ability to perform a skill with correct procedures.
   - Performs nursing skills in an uncomplicated routine nursing context.
   - Interprets data from the performance of nursing skills, such as vital signs in isolation without application to the patient.
   - Recognizes a concept when verbalized by another individual but will not be able to articulate the concept or be fully aware of what it means.
   - States a rule or procedure but may not be able to verbalize when to use the procedure.

   B. Behavioral Indicators
   - Does not respond or ignores patient cues and responses to care.
   - Obtains pertinent subjective and objective data in a routine manner.
   - Uses correct technique during procedures.
   - Is unable to interpret data as it pertains to the patient.
   - Performs patient assessments are sequential and systematic in manner.
   - Interprets rules in relationship to self in performing care.
   - May be able to communicate what he or she did but is not able to clearly communicate findings because about a patient’s status.

3. Concrete Operations
   A. Concrete Learner
      - Understands that the patient is central to the nurse's actions and words.
      - Provides nursing care specific to patient cues and responses.
      - Articulates during a scenario why specific nursing care is being provided to one simple patient care situation.
      - Has ideas about the patient's status.
      - Applies a nursing concept or procedure to the need of a specific patient.

   B. Behavioral Indicators
      - Communicates findings to patient and family according to what the family knows.
      - Interprets data.
      - Identifies cause and effect of one or two issues.
      - Recognizes relationships between sets of data.
      - Discriminates between relevant from irrelevant data.
      - Explains "why" for uncomplicated patient.

4. Formal Operations
   A. Formal Learner
      - Analyzes, synthesizes and articulates theoretical constructs to complex multiple patients.
      - Communicates with other healthcare providers and the patients while also being able to maintain routine assessments.
      - Reports abnormal findings quickly with prioritized time.
      - Uses SBAR or RBO correctly when communicating with healthcare providers.
      - Explains procedures in family terms and is sensitive to cultural and linguistic learning differences.

APPENDIX E

SIMULATION BASED ON LEARNING LANGUAGE MODEL CONCEPTUAL, BEHAVIORAL, AND LANGUAGE INDICATORS

Simulation Based On Learning Language Model Conceptual, Behavioral and Language Indicators

Thinking	Doing	Behavior	Language
Sensorimotor Operations. The student is unaware of concepts.	A sensorimotor learner does without thinking	Learner is able to move in a haphazard manner through the rote use of patterns without awareness for appropriateness or contextual relationship of the patterns. Performs basic psychomotor tasks in a fragmented manner without logical flow or organization. Performs nursing care such as measuring vital signs or raising the head of the bed without understanding why	Needs prompting to communicate. May not be able to respond to patient or family without freezing or walking out of the room.
Preoperational Operations. The student learns about concepts in general.	Learner has a beginning awareness of concepts and is able to interpret assessment data according to patterns, parameters, textbook criteria, pathways or algorithms without knowing why.	Asks for assessment data as required by textbook or protocol. Can distinguish and interpret normal from abnormal assessment data by recognizing the patterns of what fits or doesn't fit. Unable to prioritize assessment data.	Language reflects an understanding of here and now concepts as they relate to the student *(student talks about what he or she does for the patient).* Explains correct action to patient and family by restating what he or she has read, been told, or seen

Thinking	Doing	Behavior	Language
Concrete Operations. Conceptual knowledge is realized and can be shared with others.	Learner develops depth and dimension to conceptual knowledge in relationship to rules. Thinking is rule based right and wrong.	Able to recognize conceptual knowledge as it applies to one patient in one context	Explains nursing care as based on rules, protocols and right and wrong "ways to proceed" with medical jargon.
Formal Operations. Complex concepts, principles and theories are known, understood and are articulated at an understandable level for the patient and others.	Student or learner thinks in abstract or symbolized concepts that represent maximum displacement, semanticity, flexibility, productivity, and efficiency. Thinking includes multiple perspectives—family, multiple patients (future and present), programs, organizations and so forth.	Responds to multiple complex patients in an organized and efficient manner. Able to multi-task and delegate with ease. Can relate or empathize from patients' perspective Able to analyze and synthesize assessment data from multiple entry points. Able to reflect and evaluate nursing care.	Learner uses language symbols for safe and effective representation of nursing concepts, principles, and theories. Able to explain the "why" of nursing care, difficult concepts, principles, and theories across contexts in language patients understand (student is able to link cause and effect and articulate the pathophysiology of disease processes at the cellular level.

APPENDIX F

GUIDELINE FOR DEVELOPMENTALLY APPROPRIATE HIGHER ORDER THINKING SCENARIOS

Cognitive Level	**Social Level**	**Language Level**	**Performance Level**
Sensori-Motor Responses	Dependent on others	Language function does not demonstrate conceptual knowledge.	Simulation case studies facilitate psychomotor nursing tasks (Arwood & Kaakinen, 2009)
Pre-Operations	Learner is the only in the picture and the patient is in his/her own picture; the two pictures are separate.	"I know what I can do and if I can't do something it is because you have not told me or taught me how to do it."	Simulation case studies facilitate showing what the student does but not what the student knows (Arwood & Kaakinen, 2009).
Concrete Operations	Patient is in the learner's picture, the learner can relate to the patient and the patient's needs.	"I learn the rules and I know what is right and wrong in providing nursing care for a patient.	Simulation case studies facilitate the ability to provide rule- based nursing care for several patients with similar health problems (Arwood & Kaakinen, 2009).
Formal Operations	Learner can see another person's perspective.	"I learn by analyzing and synthesizing theories, principles and complex concepts."	Simulation case studies facilitate the ability to provide care for patients with multiple complex health problems that require higher order thinking and problem solving (Arwood & Kaakinen, 2009).

APPENDIX G

SIMULATION THINKING RUBRIC

Simulation Thinking Rubric:
Purpose is to determine student's level of thinking while caring for patient.

Scoring	**Developmental Level of Language and Knowing**
0=Stops actions during simulation, such as crying, freezing or walking out of the room 1=Completes pieces of some assessments	Sensorimotor Thinking for Sim: I cannot act on what I see and hear; so, I cannot assess patient or complete sim. • Does routine care such as starting an assessment, but gets distracted and/or does not finish task or assessment • Takes an unusual amount of time to minimally complete tasks • Converses off-topic or talks about "pleasantries" instead of performing care • Vocalizes about random actions and procedures that are inappropriate to the patient's needs • Does not address patient's questions • Leaves room with work unfinished or in a way that compromises patient safety • Demonstrates extraneous movements, such as moving around the room or fiddling with equipment like twirling the diaphragm on a stethoscope Overall: Does not recognize primary problem and looks for external answers to problems. This student nurse is unsafe in practice.
2=Completes routine actions but does not intervene or take action 3=Completes routine actions with some attempt to intervene usually with other's help	Preoperational Thinking for Sim: I assess patient based on memorized order of what I have been trained to do. • Follows routine order of assessment without consideration of patient's primary problem • May start over if a step in an assessment or action is missed • Continues to collect data without taking action • Minimally answers patient's questions • Asks obvious questions according to

Scoring	**Developmental Level of Language and Knowing**
	rules without consideration of patient's signs or symptoms • Limited interventions for primary problem • Uses self- talk to seek out information to direct action • Does not educate patient or family Overall: Provides routine order of assessment of a patient, not this patient. Thinking rationale is unclear. This student nurse is unsafe in practice.
4=Completes several assessments and then intervenes 5=Assesses and responds with an intervention based on that assessment	Concrete Thinking for Sim: I assess patient's needs and then intervene according to nursing rules • Begins routine assessment and then recognizes the patient's needs • Performs typically organized skills in a fluid and somewhat confident manner • Collects a lot of data and asks a lot of questions but will probably start with patient's obvious needs • Addresses patient's needs based on what patient says (for example, "Help me sit up higher so I can breathe better.") • Does one assessment and then asks for help before assessing related parameters • Answers patient and family questions but does not educate about the why of the action Overall: Rule governed assessments with subsequent obvious interventions. This student nurse is a safe practitioner.

Scoring	Developmental Level of Language and Knowing
6=Notices problem and begins care according to THIS patient's needs 7=Notices problem, educates patient and family while efficiently caring for complex problems including psychosocial as well as physical needs	Formal Thinking for Sim: I prioritize my intervention actions through continuous assessment practices according to patient's needs and safe nursing • Recognizes problem immediately • Asks focused assessment questions addressing on obvious needs of this patient • Begins to immediately intervene • Multi-tasks while providing care that addresses this patient's questions and needs (so is talking and doing simultaneously) • Anticipates what patient will say in response to questions • Anticipates what changes should occur in response to actions taken • Informs family and patient why and what while doing actions • Educates family and patient what they can do to improve the patient's outcome Overall: Simultaneous continuous assessment informing intervention practice. This student nurse can provide safe and effective nursing care.

APPENDIX H

HIGH FIDELITY SIMULATION SCENARIO

Fundamental HFS Scenario

Joe Andretti is a 65-year-old Italian male with a history of COPD admitted to the medical surgical unit with left lower lobe (LLL) bacterial pneumonia and dehydration. The patient has a peripheral intravenous catheter (PIV) infusing NS at 150 ml/hr to his right forearm. Oxygen is administered at 2L/min with a nasal cannula. Mr. Andretti has a cough that is productive of moderate amounts of thick yellow mucus that he is able to expectorate. The cough is painful preventing the patient from a restful night's sleep. While providing nursing care Mr. Andretti is often observed holding the left side of his ribcage. Mr. Andretti is complaining of pain and experiences episodes of dyspnea during the day. Mrs. Andretti is always at her husband's bedside and is an attentive and caring wife. The student nurse enters the room first thing in the morning after receiving report from the nightshift RN. The nurse observes Mr. Andretti sitting upright in bed holding onto the side rails and leaning forward to ease his breathing. When attempting to answer questions the patient can only say 2-3 words but then has to stop and catch is breath.

Objective Data:

BP 152/92	Pulse 100
RR 28 and shallow	T (oral) 100.5' F. Oral
Oxygen Saturation;	90%

Lungs: Inspiratory rales, lower left lobe
Heart: S_1 S_2 with regular rate and rhythm
Abdomen: active bowel sounds all four quadrants
Musculoskeletal: FROM
Neurological: interactive, alert, oriented x 3, restless and easily distracted
Subjective data:
"I can't breath."
Pain level; "It hurts when I cough" pain scale 8(10)

Physicians Orders
Admit to medical surgical unit
Diagnosis: LLL Pneumonia, Dehydration Condition: Stable
Vital signs every four hours
Allergies: NKDA
Nursing: Call house officer for T>101, HR>110, SBP>170 or <90, O2sat <89% if no improvement with breathing treatment
O2 at 2L NC, titrate to O2 sat 89-93% Pulse Oximetry
Diet: low sodium cardiac
Activity: as tolerated
Labs: CMP, CBC in AM; sputum cultures, blood cultures x 2
IV Fluids: NS at 150 cc/hr
Studies: EKG on arrival to the floor, CXR PA/lateral
Medications:
Aspirin 81mg one tablet PO every day

Lisinopril 10 mg one tablet PO every day
Moxifloxacin 400 mg IV every day
Duoneb 500 mcg/2.5 mg/3ml every 4 hours as needed for wheezing, shortness of breath
Guafenesin 10 ml PO q4 hrs prn for cough
Percocet 5/325 1 tablet PO every 4 hours for pain > 5
Percoet 5/325 2 tablets PO every four hours for pain>7

Why is my blood pressure so high?
Will that help me with my cough?

APPENDIX I

STUDENT CONSENT TO PARTICIPATE

UNIVERSITY of NORTHERN COLORADO

Title of Study: The Development of the Simulation Thinking Rubric
Investigator(s) and Contact Phone Number: Jessica Doolen 702-895-4719

Dear Student,

You are being asked to allow the review of your high fidelity simulation recording of Andretti #4 for psychometric testing of a theoretically based, psychometrically sound instrument as part of this researcher's doctoral dissertation. The newly proposed Simulation Thinking Rubric (STR) may be utilized to assess the cognitive development of higher order thinking (HOT) in first semester baccalaureate (BSN) nursing students. You are being asked to allow six nurse educators to review one of your pre-recorded HFS scenarios because of your status as a nursing student and because you meet the following criteria: (1) you are practicing the role of registered nurse, and (2) simulation activities are a customary and required educational experience in the school of nursing.

Your performance in simulation is not being tested or graded and the recordings are only to be reviewed for scoring of the STR. The reviewers will score the rubric while watching your recorded simulation in a debrief room at the Clinical Simulation Center of Las Vegas. Your names will not be included on the STR or on the HFS recording and there will be no other information on the STR that can be linked to you. However, because you are being observed in the HFS recording confidentiality cannot be maintained we are offering this letter of consent.

The study will not take any extra time as the Andretti #4 HFS scenario will be incorporated into your normally scheduled simulation activities. Because simulation is a normal part of your nursing education you will not be compensated for your time, obtain extra points or a grade.

Permission for the review of your HFS Andretti #4 is voluntary. You may withdraw your permission at any time without penalty. A copy of the tool is attached at the end of this document. You are encouraged to ask questions about the STR at any time.

Participant Consent

I have read the above information and agree to allow six nurse educators to review my HFS recording Andretti #4, to score the STR. I understand that my performance in HFS is ungraded and that I can withdraw my permission for the review of my HFS Andretti #4 by six nurse educators at anytime without penalty. I am at least 18 years of age and am currently enrolled in either a first semester Fundamentals of Nursing or a fourth semester Critical Care course that includes clinical HFS activities. A copy of this form has been given to me.

A research assistant will collect the consent forms. The consent forms will be kept in a lockbox in a secure office at the Clinical Simulation Center of Las Vegas. The HFS scenario, Andretti #4,will be numbered 1-44. Your name will not be on the STR nor will there be any other information on the STR that can be linked to you. By signing this consent you agree to allow the viewing of your digitally recorded simulation by the raters who will be scoring the new rubric. The score will be part of the data that establishes the reliability and validity of the STR. The statistical data that establishes the reliability and validity of the tool will be published in aggregate form in the researchers dissertation.

____

Subject’s Signature   Date

____

Researcher’s Signature   Date

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

EXEMPT RESEARCH STUDY

INFORMATION SHEET

Department of Nursing

Title of Study: The Development of the Simulation Thinking Rubric

Investigator(s) and Contact Phone Number: Jessica Doolen 702-895-4719

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Your performance in simulation is not being tested or graded and the recordings are only to be reviewed for scoring of the STR. The reviewers will score the rubric while watching your recorded simulation in a debrief room at the Clinical Simulation Center of Las Vegas. Your names will not be included on the STR or on the HFS recording and there will be no other information on the STR that can be linked to you. However, because you are being observed in the HFS recording confidentiality cannot be maintained we are offering this letter of consent.

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____

Subject’s Signature Date

____

Researcher’s Signature Date

APPENDIX J

INSTITUTIONAL REVIEW BOARD PERMISSION AND ACCEPTANCE

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Biomedical IRB
Notice of Excluded Activity

DATE: June 21, 2011

TO: **Dr. Jessica Doolen,** Psychosocial Nursing

FROM: Office of Research Integrity – Human Subjects

RE: Notification of review by
Protocol Title: **The Development of the Higher Order Thinking Rubric**
Protocol# 1106-3847M

This memorandum is notification that the project referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46.

The protocol has been reviewed and deemed excluded from IRB review. It is not in need of further review or approval by the IRB.

Any changes to the excluded activity may cause this project to require a different level of IRB review. Should any changes need to be made, please submit a Modification Form.

If you have questions or require any assistance, please contact the Office of Research Integrity – Human Subjects at IRB@unlv.edu or call 895-2794.

Office of Research Integrity – Human Subjects 4505 Maryland Parkway • Box 451047 •
Las Vegas, Nevada 89154-1047 (702) 895-2794 • FAX: (702) 895-0805

UNIVERSITY of
NORTHERN COLORADO
Institutional Review Board (IRB)

March 8, 2012

TO: Susan Collins
Gerontology

FROM: Gary Heise, Co-Chair GDH
UNC Institutional Review Board

RE: Expedited Review of Proposal, *The Development of the Simulation Thinking Rubric,* submitted by Jessica Doolen (Research Advisor: Janice Hayes)

First Consultant: The above proposal is being submitted to you for an expedited review. Please review the proposal in light of the Committee's charge and direct requests for changes directly to the researcher or researcher's advisor. If you have any unresolved concerns, please contact Gary Heise, School of Sport and Exercise Science, Campus Box 39, (x1738). When you are ready to recommend approval, sign this form and return to me.

I recommend approval as is. Susan Collins 3/27/12
Signature of First Consultant Date

The above referenced prospectus has been reviewed for compliance with HHS guidelines for ethical principles in human subjects research. The decision of the Institutional Review Board is that the project is approved as proposed for a period of one year: 4/5/2012 to 4/5/2013.

Gary D. Heise 4/5/2012
Gary D. Heise, Co-Chair Date

Comments: The cover pages are attached to the revised version of the application
S. Collins 3/27/12

APPENDIX K

DESCRIPTIVE DATA WITH HISTOGRAM OVERLAY WITH NORMAL CURVE

```
FREQUENCIES VARIABLES=Andretti1 Andretti2 Andretti3 Andretti4 Andretti5 Andretti6
Andretti7 Andretti8 Andretti9 Andretti10 Andretti12 Andretti13 Andretti14 Andretti15
Andretti16 Andretti17 Andretti18 Andretti19 Andretti20 Andretti21 Andretti22 Andretti23
Andretti24 Andretti25 Andretti26 Andretti27 Andretti28 Andretti29 Andretti30 Andretti31
Andretti32 Andretti33 Andretti34 Andretti35 Andretti36 Andretti37 Andretti39 Andretti40
Andretti41 Andretti42 Andretti43 Andretti44
  /HISTOGRAM NORMAL
  /ORDER=ANALYSIS.
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Frequencies

Notes

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Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data.
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REVISED.sav
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Frequency Table

Andretti1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	2	33.3	33.3	33.3
	Completes several assessments and the intervenes	3	50.0	50.0	83.3
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	1	16.7	16.7	33.3
	Completes several assessments and the intervenes	3	50.0	50.0	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions but does not intervene or take action	1	16.7	16.7	33.3
	Completes routine actions with some attempt to intervene	2	33.3	33.3	66.7
	Completes several assessments and the intervenes	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Andretti4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions with some attempt to intervene	2	33.3	33.3	33.3
	Completes several assessments and the intervenes	3	50.0	50.0	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes several assessments and the intervenes	3	50.0	50.0	66.7
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	3	50.0	50.0	50.0
	Completes routine actions with some attempt to intervene	3	50.0	50.0	100.0
	Total	6	100.0	100.0	

Andretti7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	2	33.3	33.3	33.3
	Completes routine actions with some attempt to intervene	4	66.7	66.7	100.0
	Total	6	100.0	100.0	

Andretti8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions but does not intervene or take action	1	16.7	16.7	33.3
	Completes routine actions with some attempt to intervene	2	33.3	33.3	66.7
	Completes several assessments and the intervenes	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Andretti9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	1	16.7	16.7	33.3
	Completes several assessments and the intervenes	3	50.0	50.0	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	1	16.7	16.7	33.3
	Completes several assessments and the intervenes	4	66.7	66.7	100.0
	Total	6	100.0	100.0	

Andretti12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	2	33.3	33.3	50.0
	Completes several assessments and the intervenes	3	50.0	50.0	100.0
	Total	6	100.0	100.0	

Andretti13

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	2	33.3	33.3	33.3
	Completes routine actions but does not intervene or take action	1	16.7	16.7	50.0
	Completes routine actions with some attempt to intervene	3	50.0	50.0	100.0
	Total	6	100.0	100.0	

Andretti14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions with some attempt to intervene	3	50.0	50.0	50.0
	Completes several assessments and the intervenes	1	16.7	16.7	66.7
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Andretti15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions but does not intervene or take action	1	16.7	16.7	33.3
	Completes routine actions with some attempt to intervene	2	33.3	33.3	66.7
	Completes several assessments and the intervenes	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Andretti16

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	1	16.7	16.7	33.3
	Completes several assessments and the intervenes	3	50.0	50.0	83.3
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti17

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes several assessments and the intervenes	3	50.0	50.0	66.7
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti18

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions with some attempt to intervene	2	33.3	33.3	33.3
	Completes several assessments and the intervenes	1	16.7	16.7	50.0
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	2	33.3	33.3	33.3
	Completes routine actions with some attempt to intervene	3	50.0	50.0	83.3
	Completes several assessments and the intervenes	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti20

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes several assessments and the intervenes	2	33.3	33.3	33.3
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	66.7
	Notices problem and begins care according to THIS patient's needs	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Andretti21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions with some attempt to intervene	1	16.7	16.7	16.7
	Completes several assessments and the intervenes	2	33.3	33.3	50.0
	Assesses and responds with an intervention based on that assessment	3	50.0	50.0	100.0
	Total	6	100.0	100.0	

Andretti22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	4	66.7	66.7	83.3
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti23

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	1	16.7	16.7	33.3
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	66.7
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti24

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	3	50.0	50.0	66.7
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti25

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	2	33.3	33.3	50.0
	Completes several assessments and the intervenes	1	16.7	16.7	66.7
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti26

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	2	33.3	33.3	33.3
	Completes routine actions with some attempt to intervene	1	16.7	16.7	50.0
	Completes several assessments and the intervenes	2	33.3	33.3	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti27

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	1	16.7	16.7	33.3
	Completes several assessments and the intervenes	1	16.7	16.7	50.0
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti28

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	1	16.7	16.7	33.3
	Completes several assessments and the intervenes	2	33.3	33.3	66.7
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti29

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions but does not intervene or take action	1	16.7	16.7	33.3
	Completes routine actions with some attempt to intervene	1	16.7	16.7	50.0
	Completes several assessments and the intervenes	3	50.0	50.0	100.0
	Total	6	100.0	100.0	

Andretti30

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	2	33.3	33.3	50.0
	Completes several assessments and the intervenes	1	16.7	16.7	66.7
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti31

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes several assessments and the intervenes	2	33.3	33.3	33.3
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	66.7
	Notices problem and begins care according to THIS patient's needs	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Andretti32

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	3	50.0	50.0	50.0
	Completes routine actions with some attempt to intervene	1	16.7	16.7	66.7
	Completes several assessments and the intervenes	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Andretti33

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	2	33.3	33.3	33.3
	Completes routine actions with some attempt to intervene	3	50.0	50.0	83.3
	Completes several assessments and the intervenes	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti34

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	3	50.0	50.0	66.7
	Completes several assessments and the intervenes	1	16.7	16.7	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti35

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes pieces of some assessments	1	16.7	16.7	16.7
	Completes routine actions but does not intervene or take action	1	16.7	16.7	33.3
	Completes routine actions with some attempt to intervene	3	50.0	50.0	83.3
	Completes several assessments and the intervenes	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti36

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions with some attempt to intervene	1	16.7	16.7	16.7
	Completes several assessments and the intervenes	1	16.7	16.7	33.3
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	66.7
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti37

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions with some attempt to intervene	1	16.7	16.7	16.7
	Completes several assessments and the intervenes	1	16.7	16.7	33.3
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	66.7
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti39

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes several assessments and the intervenes	1	16.7	16.7	33.3
	Assesses and responds with an intervention based on that assessment	2	33.3	33.3	66.7
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti40

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes several assessments and the intervenes	1	16.7	16.7	33.3
	Assesses and responds with an intervention based on that assessment	3	50.0	50.0	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti41

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	1	16.7	16.7	16.7
	Completes routine actions with some attempt to intervene	1	16.7	16.7	33.3
	Completes several assessments and the intervenes	2	33.3	33.3	66.7
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Andretti42

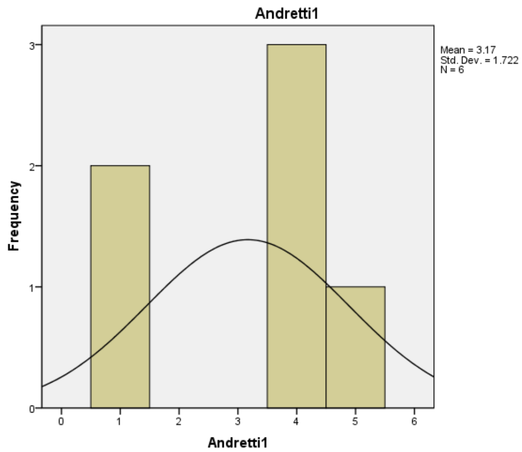
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions with some attempt to intervene	2	33.3	33.3	33.3
	Completes several assessments and the intervenes	2	33.3	33.3	66.7
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

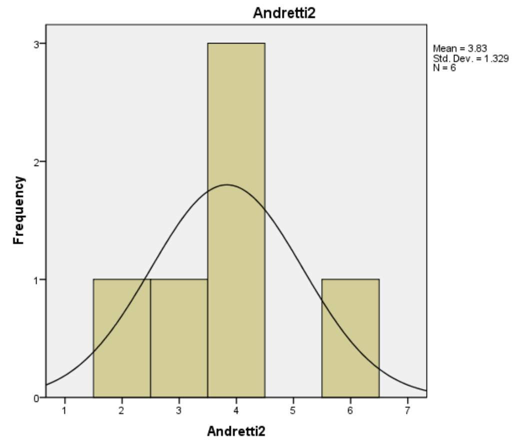
Andretti43

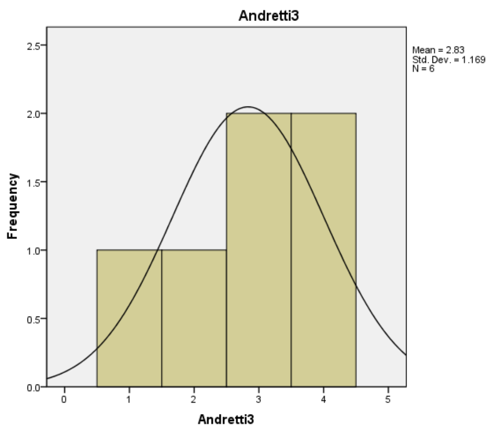
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions but does not intervene or take action	2	33.3	33.3	33.3
	Completes routine actions with some attempt to intervene	1	16.7	16.7	50.0
	Completes several assessments and the intervenes	2	33.3	33.3	83.3
	Notices problem and begins care according to THIS patient's needs	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

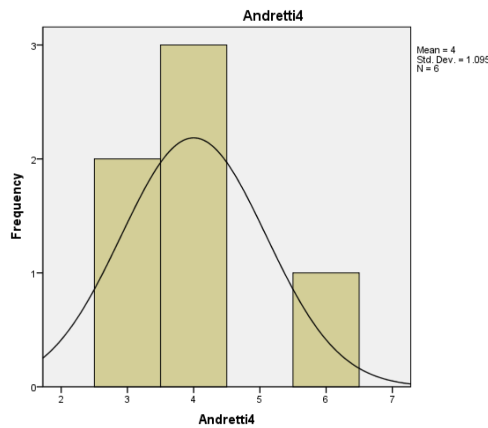
Andretti44

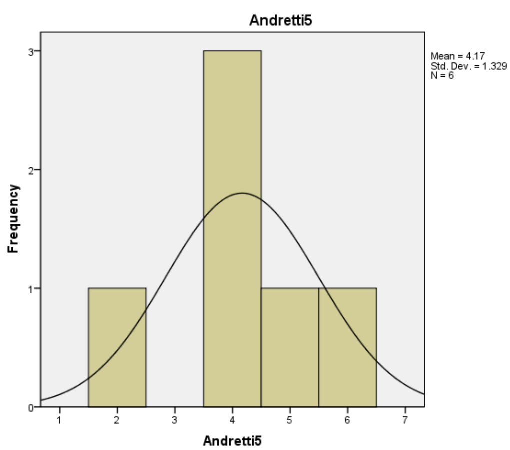
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completes routine actions with some attempt to intervene	1	16.7	16.7	16.7
	Completes several assessments and the intervenes	3	50.0	50.0	66.7
	Assesses and responds with an intervention based on that assessment	1	16.7	16.7	83.3
	Notices problem, educates patient and family while efficiently caring for complex problems	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

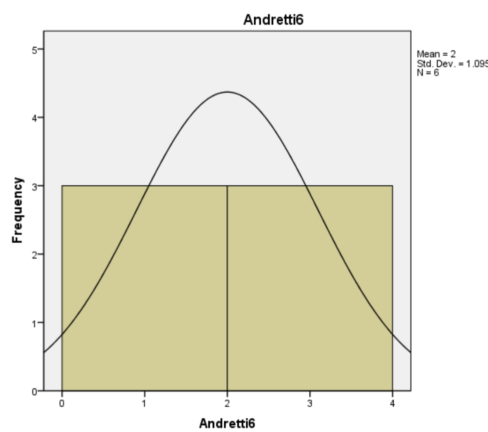

Andretti1
Mean = 3.17
Std. Dev. = 1.722
N = 6
Frequency
Andretti1

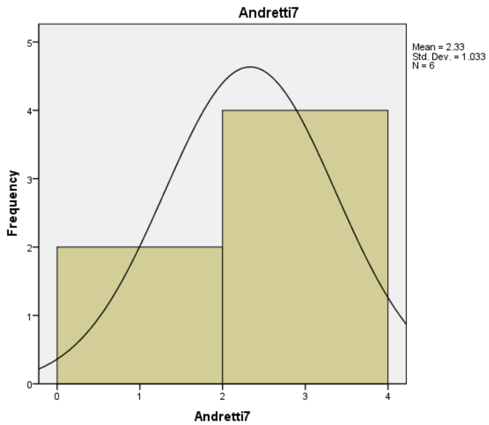

Andretti2
Mean = 3.83
Std. Dev. = 1.329
N = 6
Frequency
Andretti2

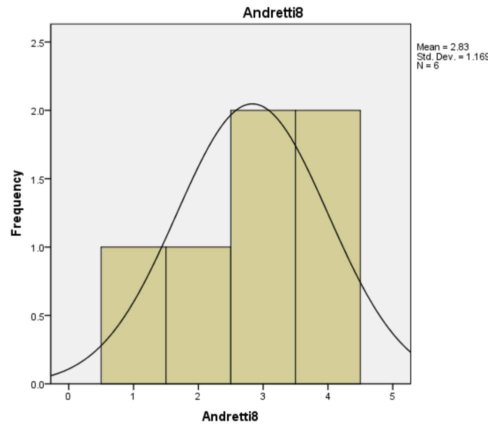

Andretti3
Mean = 2.83
Std. Dev. = 1.169
N = 6
Frequency
Andretti3

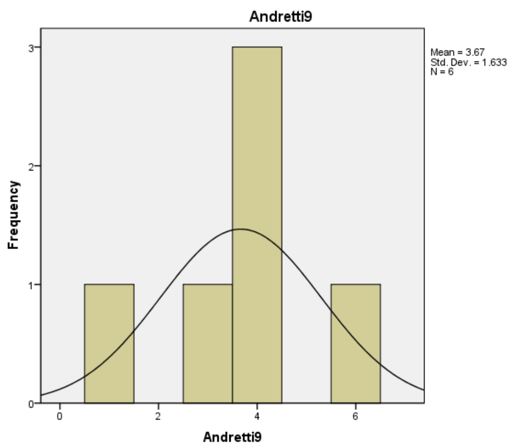

Andretti4
Mean = 4
Std. Dev. = 1.095
N = 6
Frequency
Andretti4

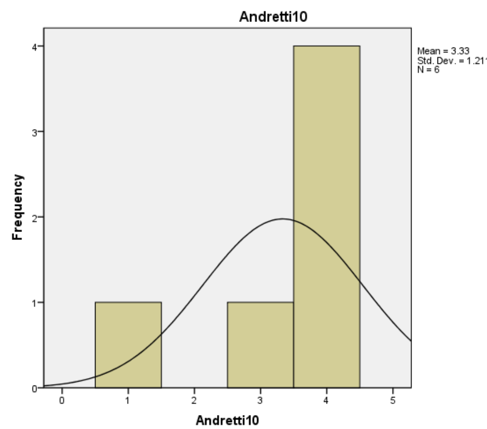

Andretti5
Mean = 4.17
Std. Dev. = 1.329
N = 6
Frequency
Andretti5

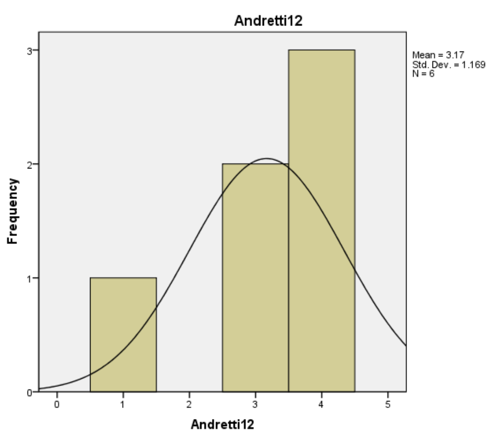

Andretti6
Mean = 2
Std. Dev. = 1.095
N = 6
Frequency
Andretti6

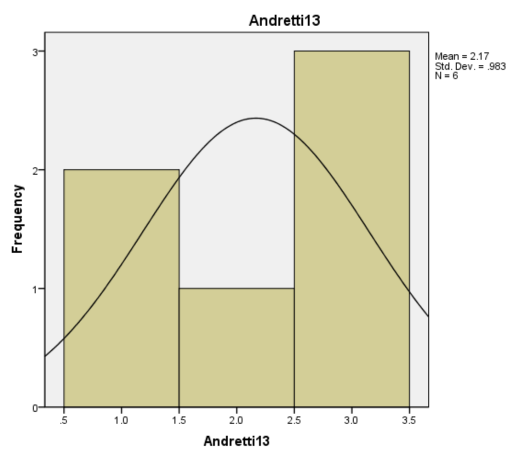

Andretti7
Mean = 2.33
Std. Dev. = 1.033
N = 6
Frequency
Andretti7

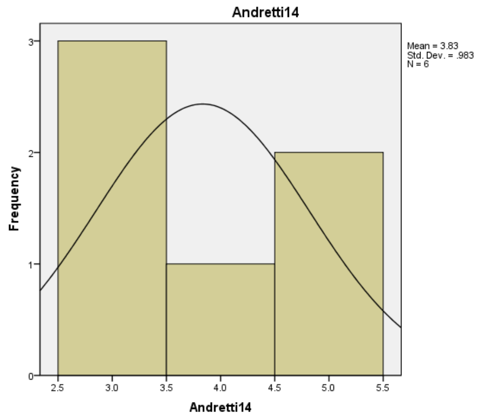

Andretti8
Mean = 2.83
Std. Dev. = 1.169
N = 6
Frequency
Andretti8


Andretti9
Mean = 3.67
Std. Dev. = 1.633
N = 6
Frequency
Andretti9


Andretti10
Mean = 3.33
Std. Dev. = 1.211
N = 6
Frequency
Andretti10


Andretti12
Mean = 3.17
Std. Dev. = 1.169
N = 6
Frequency
Andretti12


Andretti13
Mean = 2.17
Std. Dev. = .983
N = 6
Frequency
Andretti13


Andretti14
Mean = 3.83
Std. Dev. = .983
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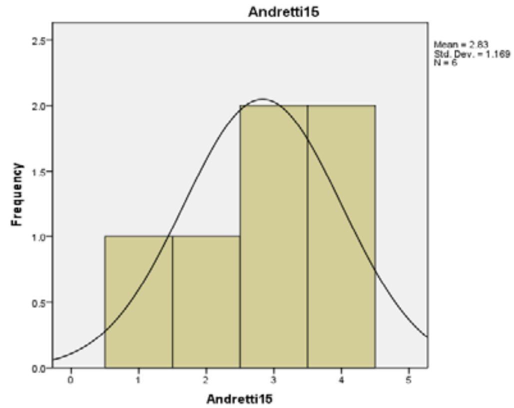
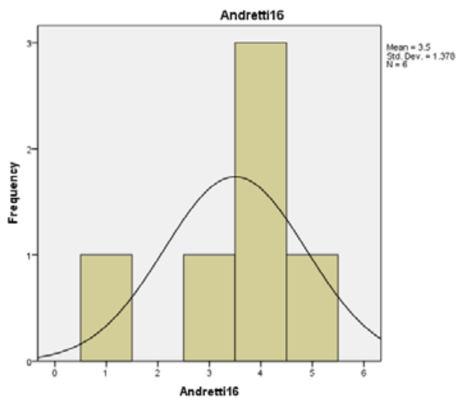
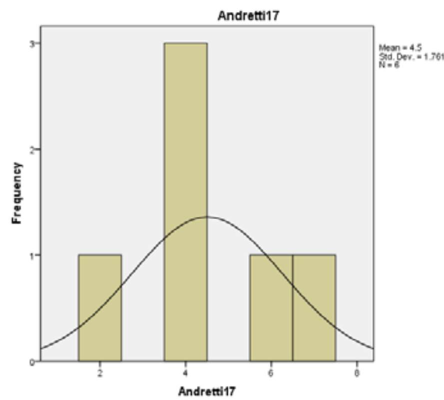
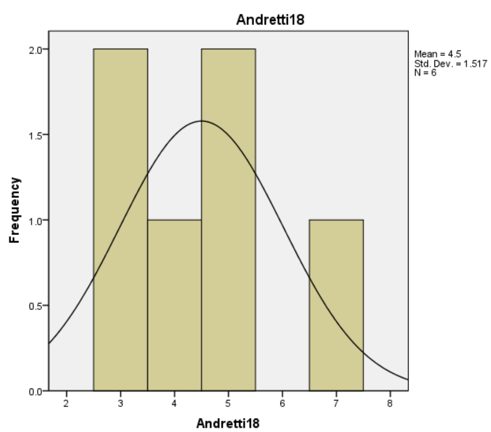
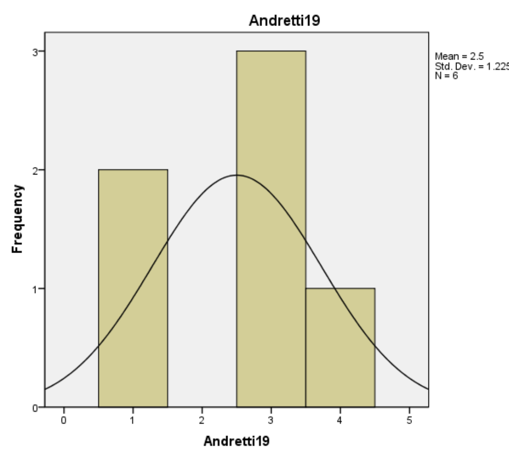
Frequency
Andretti14

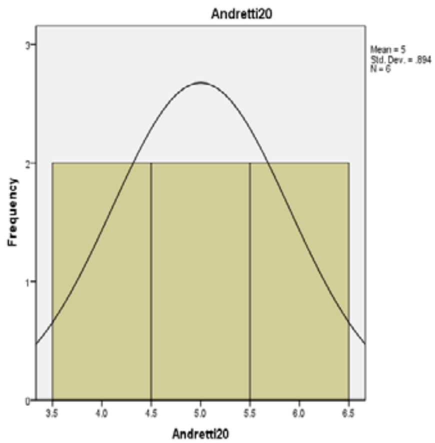

Andretti15
Mean = 2.83
Std. Dev. = 1.169
N = 6
Frequency
Andretti15

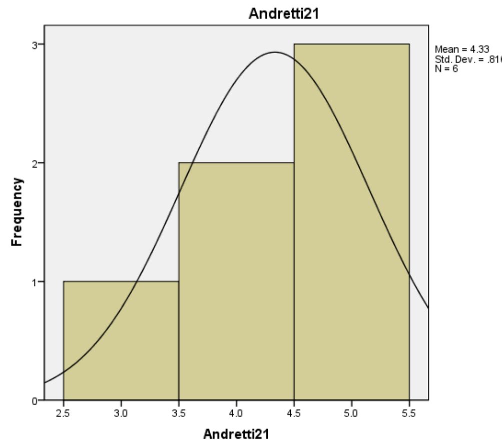

Andretti16
Mean = 3.5
Std. Dev. = 1.378
N = 6
Frequency
Andretti16

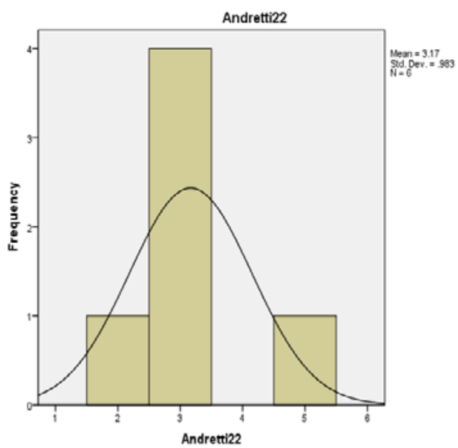

Andretti17
Mean = 4.5
Std. Dev. = 1.761
N = 6
Frequency
Andretti17

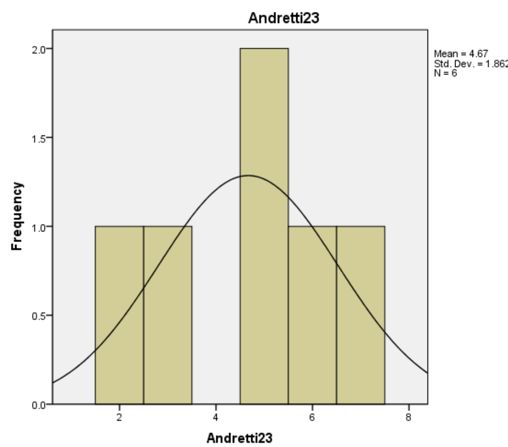

Andretti18
Mean = 4.5
Std. Dev. = 1.517
N = 6
Frequency
Andretti18

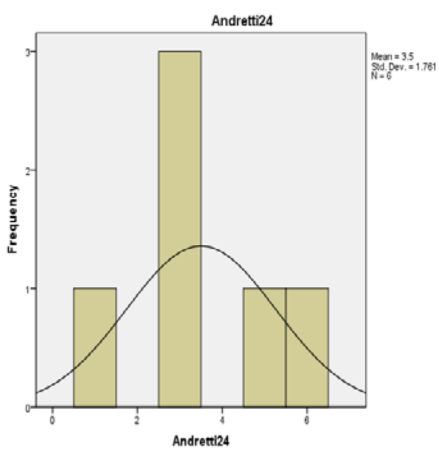

Andretti19
Mean = 2.5
Std. Dev. = 1.225
N = 6
Frequency
Andretti19

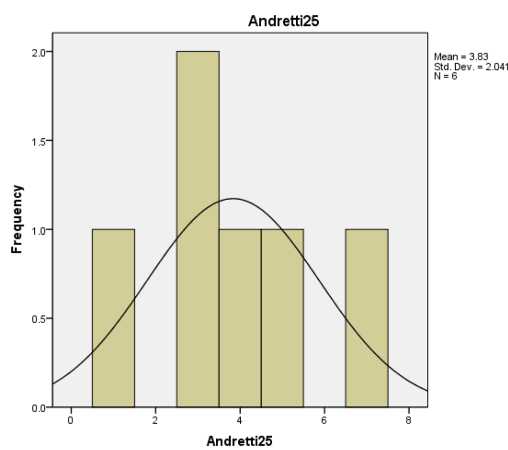

Andretti20
Mean = 5
Std. Dev. = .894
N = 6
Frequency
0
1
2
3
3.5 4.0 4.5 5.0 5.5 6.0 6.5
Andretti20

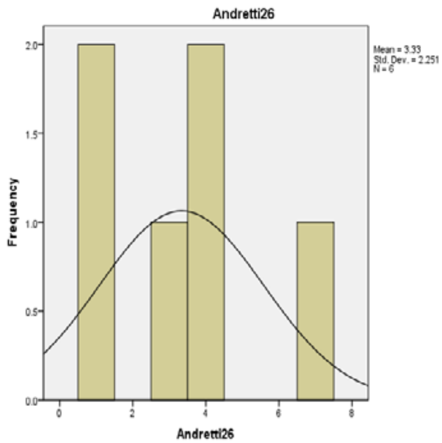

Andretti21
Mean = 4.33
Std. Dev. = .816
N = 6
Frequency
0
1
2
3
2.5 3.0 3.5 4.0 4.5 5.0 5.5
Andretti21

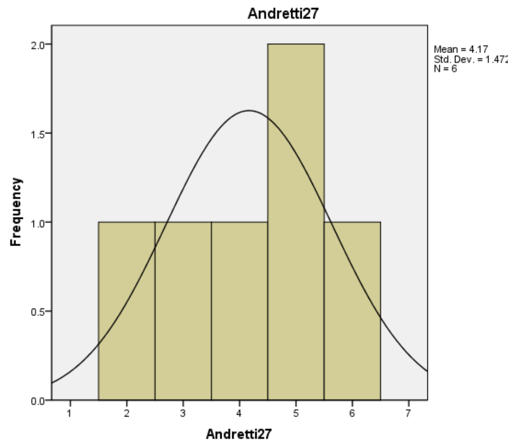

Andretti22
Mean = 3.17
Std. Dev. = .983
N = 6
Frequency
0
1
2
3
4
1 2 3 4 5 6
Andretti22

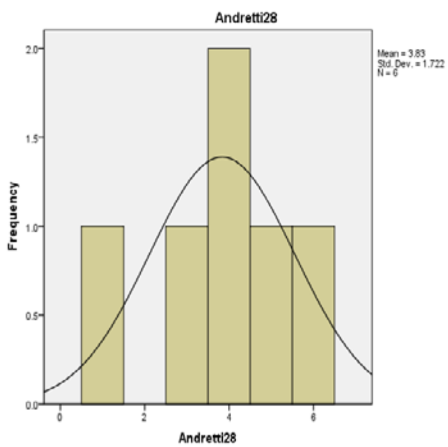

Andretti23
Mean = 4.67
Std. Dev. = 1.862
N = 6
Frequency
0.0
0.5
1.0
1.5
2.0
2 4 6 8
Andretti23

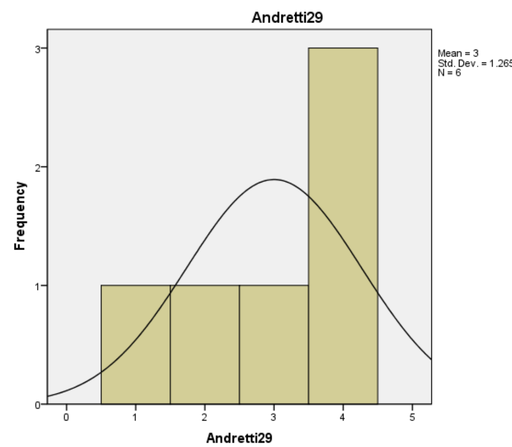

Andretti24
Mean = 3.5
Std. Dev. = 1.761
N = 6
Frequency
0
1
2
3
0 2 4 6
Andretti24

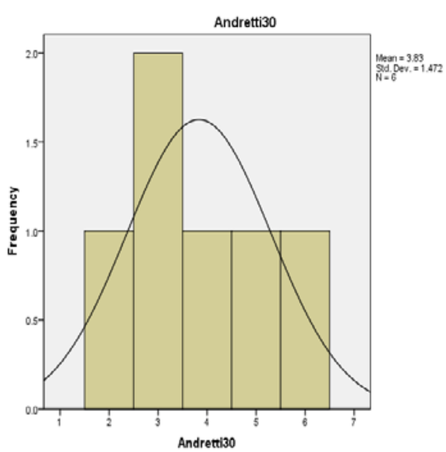

Andretti25
Mean = 3.83
Std. Dev. = 2.041
N = 6
Frequency
0.0
0.5
1.0
1.5
2.0
0 2 4 6 8
Andretti25

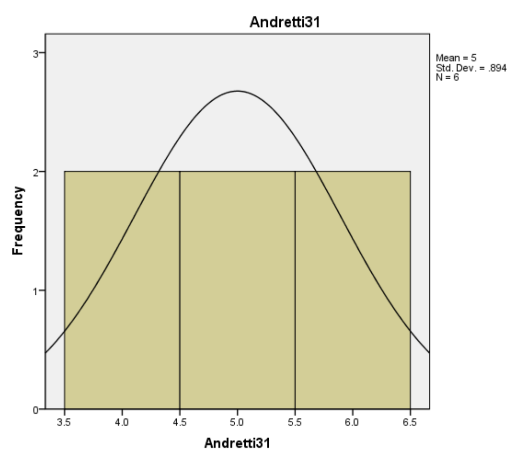

Andretti26
Mean = 3.33
Std. Dev. = 2.251
N = 6
Frequency
Andretti26

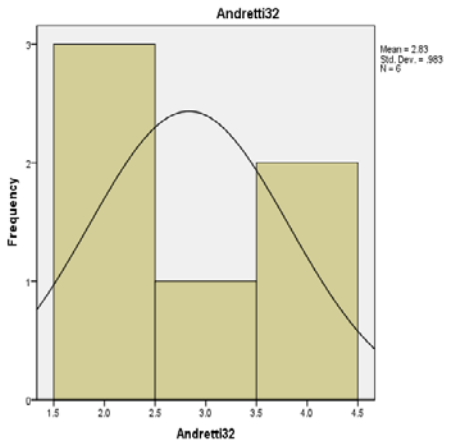

Andretti27
Mean = 4.17
Std. Dev. = 1.472
N = 6
Frequency
Andretti27

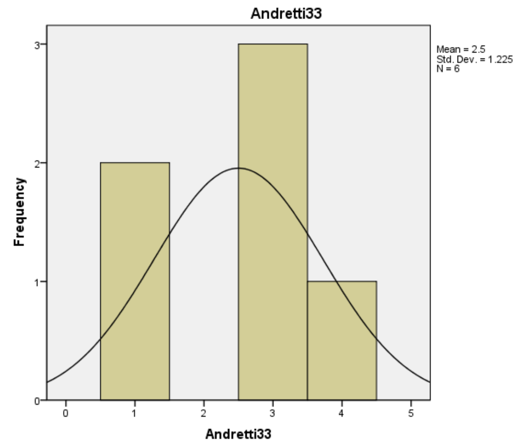

Andretti28
Mean = 3.83
Std. Dev. = 1.722
N = 6
Frequency
Andretti28

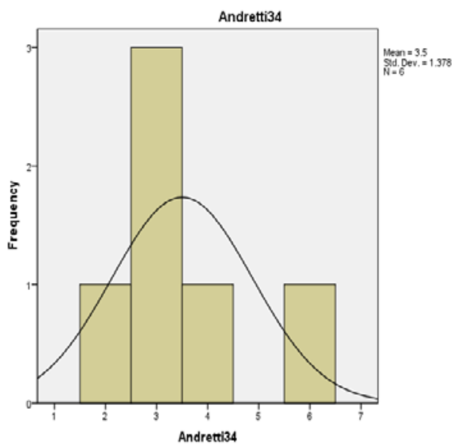

Andretti29
Mean = 3
Std. Dev. = 1.265
N = 6
Frequency
Andretti29

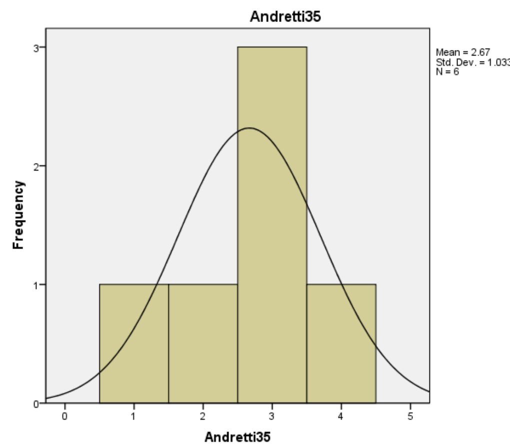

Andretti30
Mean = 3.83
Std. Dev. = 1.472
N = 6
Frequency
Andretti30

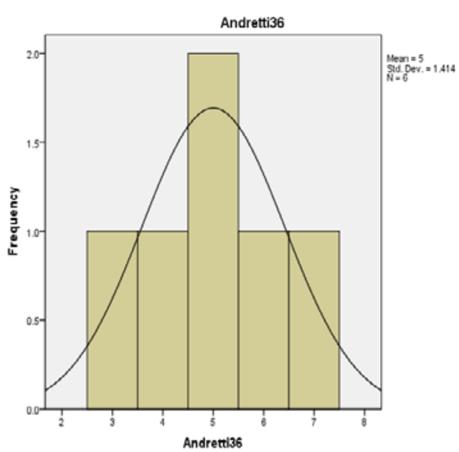

Andretti31
Mean = 5
Std. Dev. = .894
N = 6
Frequency
Andretti31

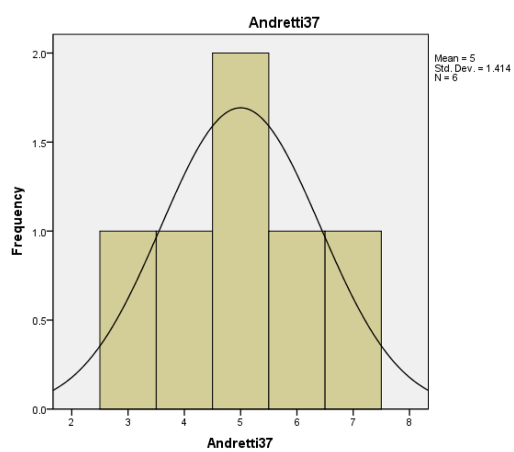

Andretti32
Mean = 2.83
Std. Dev. = .983
N = 6
Frequency
Andretti32

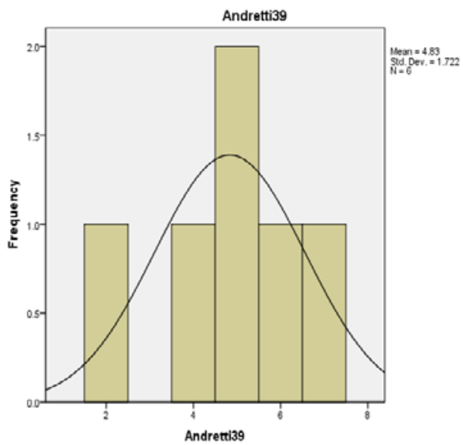

Andretti33
Mean = 2.5
Std. Dev. = 1.225
N = 6
Frequency
Andretti33

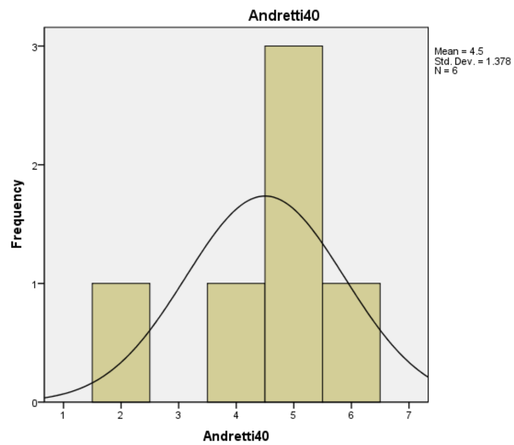

Andretti34
Mean = 3.5
Std. Dev. = 1.378
N = 6
Frequency
Andretti34

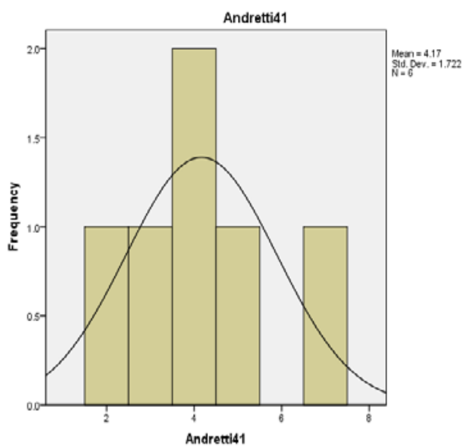

Andretti35
Mean = 2.67
Std. Dev. = 1.033
N = 6
Frequency
Andretti35

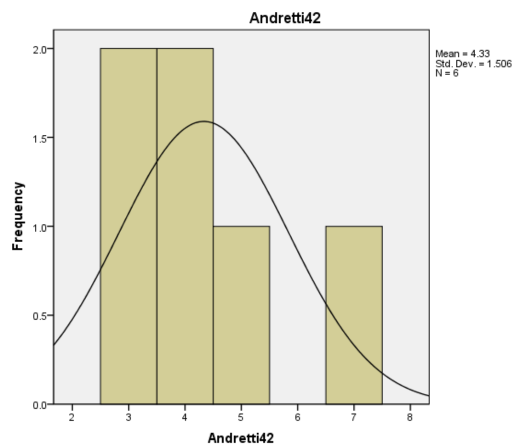

Andretti36
Mean = 5
Std. Dev. = 1.414
N = 6
Frequency
Andretti36

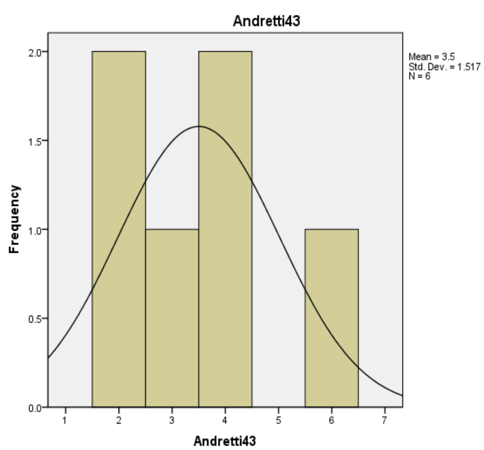

Andretti37
Mean = 5
Std. Dev. = 1.414
N = 6
Frequency
Andretti37

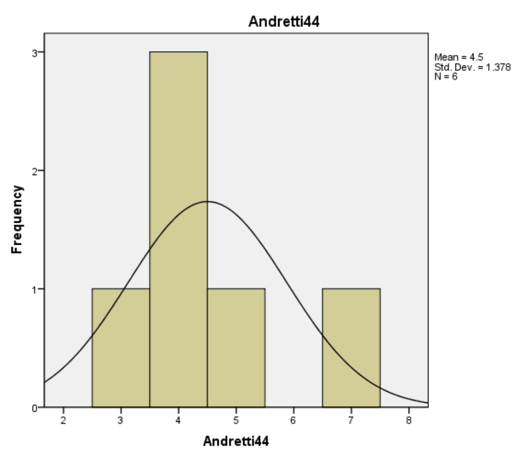

Andretti39
Mean = 4.83
Std. Dev. = 1.722
N = 6
Frequency
Andretti39


Andretti40
Mean = 4.5
Std. Dev. = 1.378
N = 6
Frequency
Andretti40


Andretti41
Mean = 4.17
Std. Dev. = 1.722
N = 6
Frequency
Andretti41


Andretti42
Mean = 4.33
Std. Dev. = 1.506
N = 6
Frequency
Andretti42


Andretti43
Mean = 3.5
Std. Dev. = 1.517
N = 6
Frequency
Andretti43


Andretti44
Mean = 4.5
Std. Dev. = 1.378
N = 6
Frequency
Andretti44

APPENDIX L

EXPLORATORY FACTOR ANALYSIS

Factor Analysis--> Oblique, Promax

```
FACTOR
  /VARIABLES Andretti1 Andretti2 Andretti3 Andretti4 Andretti5 Andretti6 Andretti7
Andretti8 Andretti9 Andretti10 Andretti12 Andretti13 Andretti14 Andretti15 Andretti16
Andretti17 Andretti18 Andretti19 Andretti20 Andretti21 Andretti22 Andretti23
Andretti24 Andretti25 Andretti26 Andretti27 Andretti28 Andretti29 Andretti30
Andretti31 Andretti32 Andretti33 Andretti34 Andretti35 Andretti36 Andretti37
Andretti39 Andretti40 Andretti41 Andretti42 Andretti43 Andretti44
  /MISSING LISTWISE
  /ANALYSIS Andretti1 Andretti2 Andretti3 Andretti4 Andretti5 Andretti6 Andretti7
Andretti8 Andretti9 Andretti10 Andretti12 Andretti13 Andretti14 Andretti15 Andretti16
Andretti17 Andretti18 Andretti19 Andretti20 Andretti21 Andretti22 Andretti23
Andretti24
Andretti25 Andretti26 Andretti27 Andretti28 Andretti29 Andretti30 Andretti31
Andretti32 Andretti33 Andretti34 Andretti35 Andretti36 Andretti37 Andretti39
Andretti40 Andretti41 Andretti42 Andretti43 Andretti44
  /PRINT INITIAL EXTRACTION ROTATION
  /FORMAT SORT BLANK(.48)
  /PLOT EIGEN
  /CRITERIA FACTORS(4) ITERATE(50)
  /EXTRACTION PC
  /CRITERIA ITERATE(25)
  /ROTATION PROMAX(4)
  /METHOD=CORRELATION.
```

Communalities

	Initial	Extraction
Andretti1	1.000	1.000
Andretti2	1.000	.814
Andretti3	1.000	.969
Andretti4	1.000	.999
Andretti5	1.000	.995
Andretti6	1.000	.999
Andretti7	1.000	1.000
Andretti8	1.000	.956
Andretti9	1.000	.992
Andretti10	1.000	.985
Andretti12	1.000	.946
Andretti13	1.000	.939
Andretti14	1.000	.974
Andretti15	1.000	.937
Andretti16	1.000	.889
Andretti17	1.000	.977
Andretti18	1.000	.996
Andretti19	1.000	1.000
Andretti20	1.000	.906
Andretti21	1.000	.964
Andretti22	1.000	.919
Andretti23	1.000	.996
Andretti24	1.000	.967
Andretti25	1.000	1.000
Andretti26	1.000	.981
Andretti27	1.000	.976
Andretti28	1.000	.991
Andretti29	1.000	.810
Andretti30	1.000	.979
Andretti31	1.000	.865
Andretti32	1.000	.974
Andretti33	1.000	1.000
Andretti34	1.000	.923
Andretti35	1.000	.927
Andretti36	1.000	.984
Andretti37	1.000	.981
Andretti39	1.000	.992
Andretti40	1.000	.982
Andretti41	1.000	.971
Andretti42	1.000	.991
Andretti43	1.000	1.000
Andretti44	1.000	.923

Extraction Method: Principal Component Analysis.

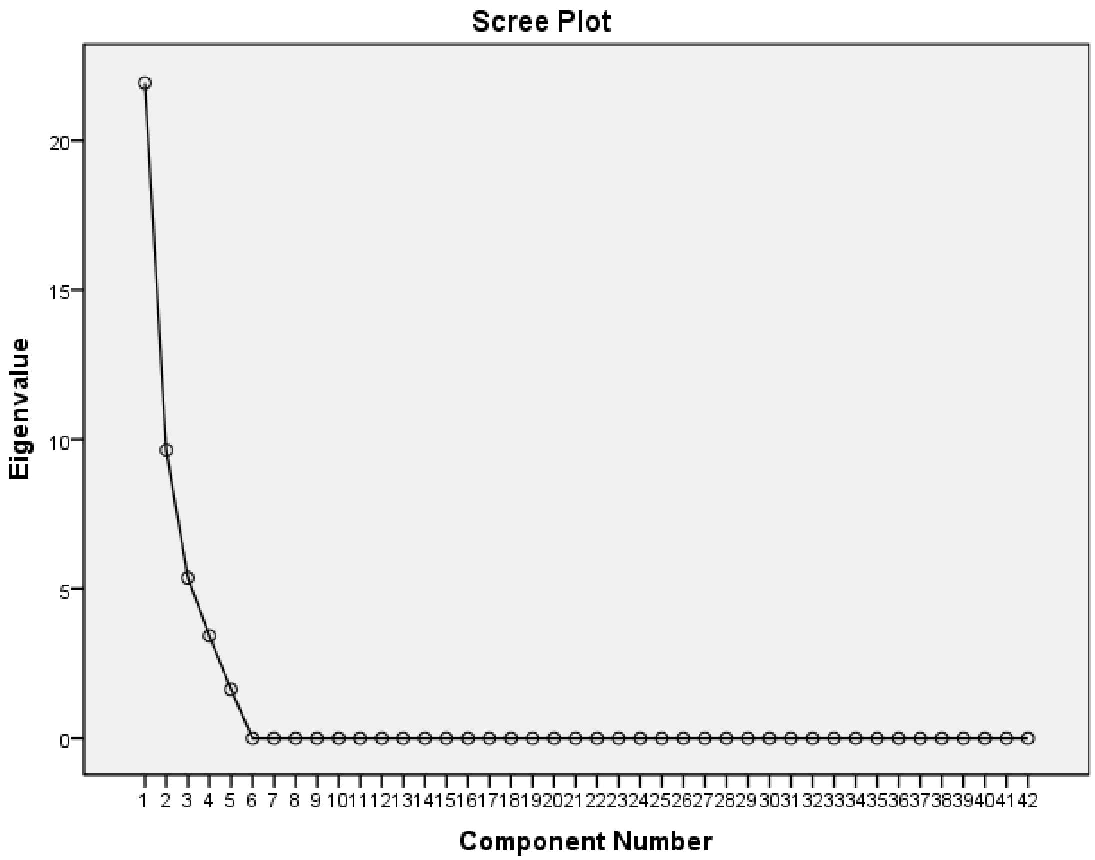
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	21.931	52.216	52.216	21.931	52.216	52.216	16.952
2	9.643	22.959	75.175	9.643	22.959	75.175	16.737
3	5.366	12.775	87.950	5.366	12.775	87.950	10.843
4	3.430	8.166	96.116	3.430	8.166	96.116	10.501
5	1.631	3.884	100.000				
6	6.383E-15	1.520E-14	100.000				
7	3.446E-15	8.204E-15	100.000				
8	1.940E-15	4.619E-15	100.000				
9	1.357E-15	3.231E-15	100.000				
10	1.009E-15	2.402E-15	100.000				
11	7.844E-16	1.868E-15	100.000				
12	6.889E-16	1.640E-15	100.000				
13	6.429E-16	1.531E-15	100.000				
14	5.940E-16	1.414E-15	100.000				
15	4.434E-16	1.056E-15	100.000				
16	3.909E-16	9.308E-16	100.000				
17	3.373E-16	8.031E-16	100.000				
18	2.752E-16	6.553E-16	100.000				
19	2.509E-16	5.973E-16	100.000				
20	2.059E-16	4.903E-16	100.000				
21	1.608E-16	3.829E-16	100.000				
22	1.109E-16	2.642E-16	100.000				
23	7.019E-17	1.671E-16	100.000				
24	3.313E-17	7.888E-17	100.000				
25	1.051E-17	2.502E-17	100.000				
26	-3.929E-17	-9.355E-17	100.000				
27	-7.756E-17	-1.847E-16	100.000				
28	-1.004E-16	-2.390E-16	100.000				
29	-1.629E-16	-3.879E-16	100.000				
30	-1.945E-16	-4.630E-16	100.000				
31	-2.272E-16	-5.411E-16	100.000				
32	-2.840E-16	-6.762E-16	100.000				
33	-3.174E-16	-7.557E-16	100.000				
34	-3.650E-16	-8.690E-16	100.000				
35	-4.162E-16	-9.910E-16	100.000				
36	-4.949E-16	-1.178E-15	100.000				
37	-5.181E-16	-1.234E-15	100.000				
38	-6.771E-16	-1.612E-15	100.000				
39	-8.257E-16	-1.966E-15	100.000				
40	-9.921E-16	-2.362E-15	100.000				
41	-1.605E-15	-3.821E-15	100.000				
42	-2.917E-15	-6.946E-15	100.000				

Extraction Method: Principal Component Analysis.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	21.931	52.216	52.216	21.931	52.216	52.216	16.952
2	9.643	22.959	75.175	9.643	22.959	75.175	16.737
3	5.366	12.775	87.950	5.366	12.775	87.950	10.843
4	3.430	8.166	96.116	3.430	8.166	96.116	10.501
5	1.631	3.884	100.000				
6	6.383E-15	1.520E-14	100.000				
7	3.446E-15	8.204E-15	100.000				
8	1.940E-15	4.619E-15	100.000				
9	1.357E-15	3.231E-15	100.000				
10	1.009E-15	2.402E-15	100.000				
11	7.844E-16	1.868E-15	100.000				
12	6.889E-16	1.640E-15	100.000				
13	6.429E-16	1.531E-15	100.000				
14	5.940E-16	1.414E-15	100.000				
15	4.434E-16	1.056E-15	100.000				
16	3.909E-16	9.308E-16	100.000				
17	3.373E-16	8.031E-16	100.000				
18	2.752E-16	6.553E-16	100.000				
19	2.509E-16	5.973E-16	100.000				
20	2.059E-16	4.903E-16	100.000				
21	1.608E-16	3.829E-16	100.000				
22	1.109E-16	2.642E-16	100.000				
23	7.019E-17	1.671E-16	100.000				
24	3.313E-17	7.888E-17	100.000				
25	1.051E-17	2.502E-17	100.000				
26	-3.929E-17	-9.355E-17	100.000				
27	-7.756E-17	-1.847E-16	100.000				
28	-1.004E-16	-2.390E-16	100.000				
29	-1.629E-16	-3.879E-16	100.000				
30	-1.945E-16	-4.630E-16	100.000				
31	-2.272E-16	-5.411E-16	100.000				
32	-2.840E-16	-6.762E-16	100.000				
33	-3.174E-16	-7.557E-16	100.000				
34	-3.650E-16	-8.690E-16	100.000				
35	-4.162E-16	-9.910E-16	100.000				
36	-4.949E-16	-1.178E-15	100.000				
37	-5.181E-16	-1.234E-15	100.000				
38	-6.771E-16	-1.612E-15	100.000				
39	-8.257E-16	-1.966E-15	100.000				
40	-9.921E-16	-2.362E-15	100.000				
41	-1.605E-15	-3.821E-15	100.000				
42	-2.917E-15	-6.946E-15	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.


Scree Plot
Eigenvalue
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Component Number

Component Matrix[a]

	Component			
	1	2	3	4
Andretti43	.988			
Andretti26	.968			
Andretti41	.963			
Andretti33	.949			
Andretti19	.949			
Andretti9	.939			
Andretti28	.874			
Andretti25	.873			
Andretti17	.861			
Andretti44	.859			
Andretti34	.859			
Andretti15	.858			
Andretti24	.841			
Andretti22	.836			
Andretti8	.821			
Andretti42	.821			.541
Andretti32	.815		.514	
Andretti14	.815		.514	
Andretti39	.802	.542		
Andretti13	.780			-.494
Andretti2	.778			
Andretti30	.773		.582	
Andretti40	.759	.545		
Andretti10	.739			-.600
Andretti29	.736			
Andretti23	.719	.587		
Andretti18	.687	.603		
Andretti37	.674		.673	
Andretti16	.630	-.600		
Andretti3	.618		-.486	
Andretti4		.981		
Andretti27		.923		
Andretti5		.896		
Andretti1		.855		
Andretti35		-.788		
Andretti7		.724	-.579	
Andretti12	.611	-.723		
Andretti36		.716		.561
Andretti21		.709		.547
Andretti6	.691		-.720	
Andretti20		.506	.711	
Andretti31		.501	.681	

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

Varimax Orthogonal Analysis

Pattern Matrix[a]

	Component			
	1	2	3	4
Andretti3	1.065			
Andretti24	.968			
Andretti25	.948			
Andretti42	.903			
Andretti22	.889			
Andretti28	.802			
Andretti15	.687			
Andretti44	.661	.548		
Andretti34	.661	.548		
Andretti6	.652		.573	
Andretti26	.640			
Andretti43	.562	.556		
Andretti20	-.739	.992		
Andretti37		.969		
Andretti17		.922		
Andretti32		.904		
Andretti14		.904		
Andretti30		.877		
Andretti29		.836		
Andretti40		.769		
Andretti41		.694		
Andretti2		.674		
Andretti9		.553		
Andretti1			1.038	
Andretti7			1.018	
Andretti27			.929	
Andretti21	.487		.908	-.525
Andretti4			.867	
Andretti23			.839	
Andretti35			-.818	
Andretti18	.530		.748	
Andretti39			.722	
Andretti5	-.480	.574	.700	
Andretti36				-.946
Andretti31		.686		-.824
Andretti13				.740
Andretti10				.701
Andretti8				.680
Andretti16	.573			.580
Andretti12				.573
Andretti19				.512
Andretti33				.512

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

Structure Matrix

	Component			
	1	2	3	4
Andretti25	.988			.498
Andretti24	.981			
Andretti28	.959	.512		.642
Andretti22	.926	.589		
Andretti3	.920			
Andretti15	.894	.494		.718
Andretti42	.886	.646		
Andretti26	.875	.680		.616
Andretti43	.849	.844		.491
Andretti44	.837	.751		
Andretti34	.837	.751		
Andretti6	.718		.557	.672
Andretti17	.482	.977		
Andretti41	.704	.910		.512
Andretti32	.601	.906		
Andretti14	.601	.906		
Andretti37		.902		
Andretti30	.618	.887		
Andretti40		.880	.683	
Andretti29		.875		
Andretti9	.611	.844	.586	.602
Andretti2		.831	.580	
Andretti20		.623		
Andretti1			.983	
Andretti7			.968	
Andretti27			.963	
Andretti23	.495	.519	.900	
Andretti39	.500	.666	.848	
Andretti5		.564	.833	
Andretti18	.529	.567	.814	
Andretti4			.811	
Andretti21			.800	
Andretti35	.544		-.644	
Andretti13	.570	.622		.876
Andretti8	.556	.596	.501	.842
Andretti33	.791	.707		.798
Andretti19	.791	.707		.798
Andretti10		.684	.545	.779
Andretti16	.758			.773
Andretti36				-.769
Andretti12	.714			.749
Andretti31				-.641

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

Component Correlation Matrix

Component	1	2	3	4
1	1.000	.445	.082	.436
2	.445	1.000	.307	.286
3	.082	.307	1.000	.112
4	.436	.286	.112	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

Factor Analysis--> Orthogonal, Varimax

[DataSet1] C:\Users\Antonio Gutierrez\Desktop\Statistics Consultations\Jessica Doolen\EFA REVISED.sav

Communalities

	Initial	Extraction
Andretti1	1.000	1.000
Andretti2	1.000	.801
Andretti3	1.000	.975
Andretti4	1.000	1.000
Andretti5	1.000	.995
Andretti6	1.000	1.000
Andretti7	1.000	1.000
Andretti8	1.000	.948
Andretti9	1.000	.988
Andretti10	1.000	.989
Andretti12	1.000	.936
Andretti13	1.000	.927
Andretti14	1.000	.981
Andretti15	1.000	.948
Andretti16	1.000	.902
Andretti17	1.000	.971
Andretti18	1.000	.995
Andretti19	1.000	.998
Andretti20	1.000	.906
Andretti21	1.000	.962
Andretti22	1.000	.907
Andretti23	1.000	.998
Andretti24	1.000	.975
Andretti25	1.000	.999
Andretti26	1.000	.975
Andretti27	1.000	.976
Andretti28	1.000	.995
Andretti29	1.000	.823
Andretti30	1.000	.984
Andretti31	1.000	.867
Andretti32	1.000	.981
Andretti33	1.000	.998
Andretti34	1.000	.910
Andretti35	1.000	.936
Andretti36	1.000	.982
Andretti37	1.000	.985
Andretti38	1.000	.435
Andretti39	1.000	.994
Andretti40	1.000	.985
Andretti41	1.000	.962
Andretti42	1.000	.995
Andretti43	1.000	1.000
Andretti44	1.000	.910

Extraction Method: Principal Component Analysis.

Total Variance Explained

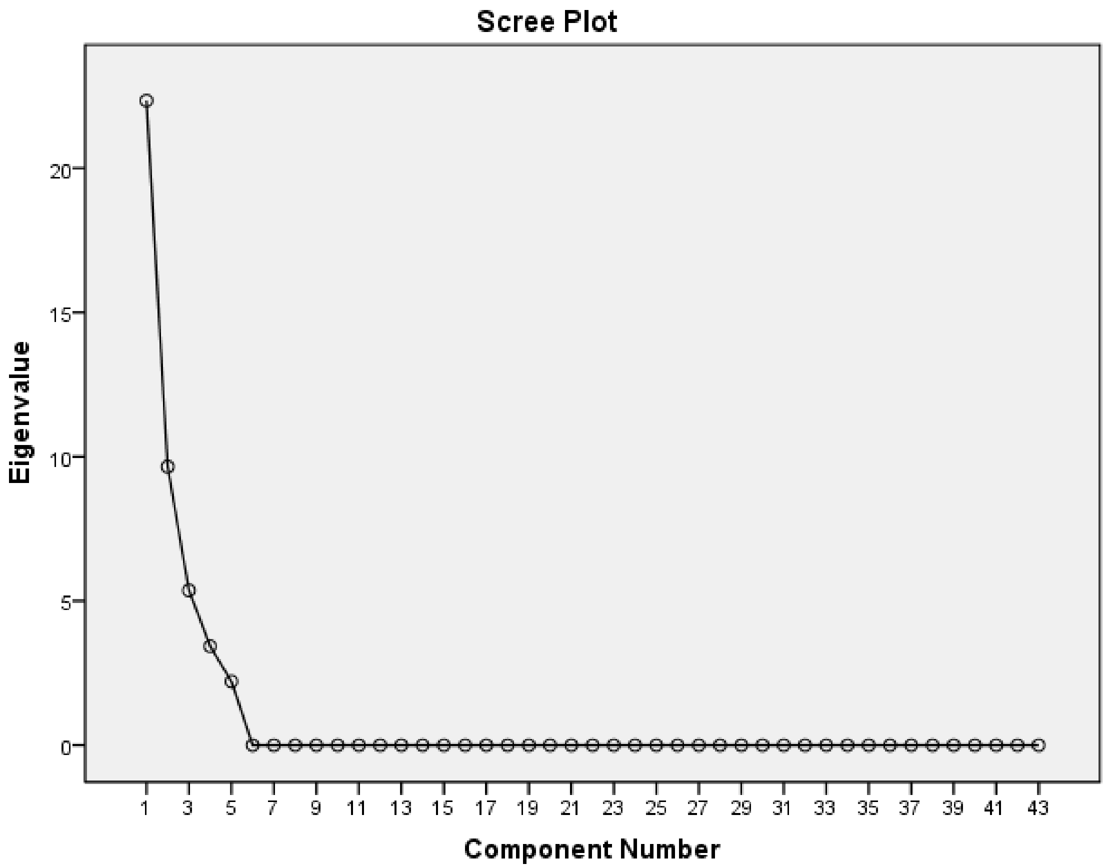
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total		Cumulative %
1	22.343	51.960	51.960	22.343	51.960	51.960	13.461	31.306	31.306
2	9.653	22.449	74.409	9.653	22.449	74.409	11.734	27.287	58.593
3	5.366	12.479	86.887	5.366	12.479	86.887	9.585	22.291	80.884
4	3.430	7.976	94.863	3.430	7.976	94.863	6.011	13.979	94.863
5	2.209	5.137	100.000						
6	3.395E-15	7.895E-15	100.000						
7	2.052E-15	4.772E-15	100.000						
8	1.353E-15	3.145E-15	100.000						
9	1.217E-15	2.830E-15	100.000						
10	7.061E-16	1.642E-15	100.000						
11	6.525E-16	1.517E-15	100.000						
12	5.800E-16	1.349E-15	100.000						
13	5.126E-16	1.192E-15	100.000						
14	4.978E-16	1.158E-15	100.000						
15	3.359E-16	7.811E-16	100.000						
16	2.962E-16	6.889E-16	100.000						
17	2.722E-16	6.329E-16	100.000						
18	2.077E-16	4.830E-16	100.000						
19	1.945E-16	4.524E-16	100.000						
20	1.476E-16	3.433E-16	100.000						
21	1.070E-16	2.489E-16	100.000						
22	7.881E-17	1.833E-16	100.000						
23	3.420E-17	7.953E-17	100.000						
24	1.615E-17	3.756E-17	100.000						
25	-2.884E-17	-6.708E-17	100.000						
26	-7.326E-17	-1.704E-16	100.000						
27	-1.346E-16	-3.131E-16	100.000						
28	-1.393E-16	-3.240E-16	100.000						
29	-1.712E-16	-3.981E-16	100.000						
30	-2.159E-16	-5.022E-16	100.000						
31	-2.292E-16	-5.330E-16	100.000						
32	-2.584E-16	-6.010E-16	100.000						
33	-3.037E-16	-7.062E-16	100.000						
34	-3.162E-16	-7.354E-16	100.000						
35	-3.803E-16	-8.844E-16	100.000						
36	-4.381E-16	-1.019E-15	100.000						
37	-5.133E-16	-1.194E-15	100.000						
38	-6.749E-16	-1.570E-15	100.000						
39	-9.114E-16	-2.120E-15	100.000						
40	-1.036E-15	-2.410E-15	100.000						
41	-1.339E-15	-3.114E-15	100.000						
42	-1.495E-15	-3.477E-15	100.000						
43	-4.679E-15	-1.088E-14	100.000						

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component			
	1	2	3	4
Andretti43	.989			
Andretti26	.964			
Andretti41	.958			
Andretti33	.949			
Andretti19	.949			
Andretti9	.935			
Andretti28	.878			
Andretti25	.873			
Andretti15	.865			
Andretti17	.857			
Andretti44	.854			
Andretti34	.854			
Andretti24	.846			
Andretti22	.830			
Andretti42	.823			.541
Andretti32	.820		.514	
Andretti14	.820		.514	
Andretti8	.815			
Andretti39	.801	.546		
Andretti30	.777		.582	
Andretti13	.775			-.493
Andretti2	.765			
Andretti40	.760	.548		
Andretti29	.745			
Andretti10	.741			-.600
Andretti23	.717	.590		
Andretti18	.682	.608		
Andretti37	.676		.673	
Andretti38	.651			
Andretti16	.641	-.600		
Andretti3	.624		-.486	
Andretti4		.980		
Andretti27		.923		
Andretti5		.898		
Andretti1		.856		
Andretti35		-.788		
Andretti7		.726	-.579	
Andretti12	.609	-.717		
Andretti36		.714		.561
Andretti21		.708		.547
Andretti6	.691		-.721	
Andretti20		.503	.712	
Andretti31		.505	.681	

Extraction Method: Principal Component Analysis.
a. 4 components extracted.


Scree Plot
Eigenvalue
0
5
10
15
20
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43
Component Number

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Andretti24	.952			
Andretti3	.952			
Andretti25	.945			
Andretti28	.883			
Andretti22	.880			
Andretti42	.863			
Andretti15	.805			.480
Andretti26	.763			
Andretti44	.745	.589		
Andretti34	.745	.589		
Andretti43	.722	.649		
Andretti16	.689			.618
Andretti6	.674		.535	.500
Andretti33	.634	.503		.565
Andretti19	.634	.503		.565
Andretti12	.614			.594
Andretti38	.482			
Andretti17		.901		
Andretti37		.875		
Andretti32		.854		
Andretti14		.854		
Andretti29		.824		
Andretti30	.515	.820		
Andretti40		.792	.561	
Andretti20	-.485	.790		
Andretti41	.540	.752		
Andretti2		.707		
Andretti9		.663		
Andretti1			.998	
Andretti7			.974	
Andretti27			.940	
Andretti23			.849	
Andretti4			.843	
Andretti21			.834	
Andretti5		.555	.772	
Andretti39			.768	
Andretti18	.498		.762	
Andretti35	.480		-.732	
Andretti36				-.847
Andretti31		.522		-.747
Andretti13		.501		.728
Andretti8				.686
Andretti10		.574		.674

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 10 iterations.

Component Transformation Matrix

Component	1	2	3	4
1	.692	.611	.250	.291
2	-.365	.203	.859	-.297
3	-.267	.710	-.446	-.475
4	.562	-.284	.038	-.776

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

APPENDIX M

ONE-WAY ANALYSIS OF VARIANCE

Univariate Analysis of Variance (ANOVA)

Between-Subjects Factors

		Value Label	N
Student Level	1	Level 1	6
	2	Level 4	6

Levene's Test of Equality of Error Variances[a]

Dependent Variable:STR Composite

F	df1	df2	Sig.
1.047	1	10	.330

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Student Level

Tests of Between-Subjects Effects

Dependent Variable:STR Composite

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	2.521[a]	1	2.521	3.594	.087	.264	3.594	.403
Intercept	155.062	1	155.062	221.071	.000	.957	221.071	1.000
Student Level	2.521	1	2.521	3.594	.087	.264	3.594	.403
Error	7.014	10	.701					
Total	164.597	12						
Corrected Total	9.535	11						

a. R Squared = .264 (Adjusted R Squared = .191)

b. Computed using alpha = .05

Descriptive Statistics

Dependent Variable:STR Composite

StudentLevel	Mean	Std. Deviation	*N*
Level 1	3.1364	.64539	6
Level 4	4.0530	.99312	6
Total	3.5947	.93103	12