I, Teresa J. Getha-Eby, hereby submit this original work as part of the requirements for the degree of Doctor of Philosophy in Nursing - Doctoral Program.

It is entitled:
Concept-Based Teaching and Meaningful Learning in Associate Degree Nursing Students

Student’s name: Teresa J. Getha-Eby

This work and its defense approved by:

Committee chair: Theresa Beery, PhD
Committee member: Beth O'Brien, PhD
Committee member: Yin Xu, PhD, RN
Concept-Based Teaching and Meaningful Learning
in Associate Degree Nursing Students

A dissertation submitted to the
Graduate School
of the University of Cincinnati
in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

of the College of Nursing
by

Teresa J. Getha-Eby

B.S.N. Miami University, 1986
M.S.N. University of Cincinnati, 1988
December 2012

Committee Chair: Theresa A. Beery, PhD, RN, ACNP-BC, CNE; Professor
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

Abstract

This mixed methods quantitative-dominant, explanatory sequential design study investigated meaningful learning outcomes of first semester associate degree nursing students at a private nursing college in the Midwestern United States. The quantitative strand compared meaningful learning of two groups: students who received concept-based teaching (CBT) and students who received traditional nursing pedagogy. Meaningful learning was measured by higher order thinking (HOT) gain (i.e., the difference between standardized pre- and post-test scores). The instruments used to measure HOT gain were the Assessment Technologies Institute (ATI) Critical Thinking Assessment (pre-test) and the ATI Nursing Fundamentals Assessment (post-test). The quantitative data were extracted from 346 archived student records from six consecutive cohorts. The cohorts consisted of students enrolled in the first semester nursing course between spring, 2009 and fall, 2011. Three cohorts had received CBT and three had received traditional teaching. Multiple regression was used to analyze relationships between HOT gain and the potential influencing variables of teaching method, pre-test score, age, previous science coursework, and the time interval between the pre- and post-test. The findings included: (1) no significant between group differences, and, (2) a significant inverse relationship between pre-test score and HOT gain that was not influenced by teaching method. The quantitative results were used to purposefully select the qualitative sample. The qualitative sample consisted of 11 students whose HOT post-test scores were from the uppermost quartile, and 11 students whose scores were from the lowermost quartile. This maximal variation sampling technique was used to increase understanding of the mechanisms underlying the meaningful learning process. A patient case study discussion was conducted with each of the 22 CBT students during the spring semester of 2012. Transcripts of the discussions were analyzed.
using flow mapping. Flow mapping is a qualitative data analysis method in which the researcher creates a graphic representation of students’ knowledge connections. The completed flow maps fell into two distinct groups distinguished by number and type of knowledge connections. Integrative analysis found that students who verbalized a greater number of knowledge connections during the interview had higher HOT scores and a deeper understanding of principles underlying nursing interventions than did students who verbalized fewer connections. Knowledge connections and HOT appear to be associated, as predicted by meaningful learning theory. Additional research is needed to investigate CBT’s effect on this relationship.
Dedication

To my husband, Steve, who has been a constant source of support and encouragement.
Acknowledgements

I wish to extend heartfelt gratitude to all who inspired and supported my journey. To my colleagues - those at Good Samaritan College of Nursing and Health Science, those from 14CD at Good Samaritan Hospital, and those from the University of Cincinnati doctoral program. Thank you for our conversations; they stimulated my thinking.

To the administrative staff at Good Samaritan College; thank you for offering flexible hours to accommodate my academic schedule. To the many students who have touched my life, further increased my passion for teaching, and from whom I continue to learn every day. I’m grateful our paths have crossed.

To the members of my dissertation committee, Dr. Terry Beery, Dr. Yin Xu, and Dr. Beth O’Brien; your thought-provoking questions and feedback have nurtured my growth as a novice researcher. Thank you for your guidance.

To my family members who applauded when I enrolled in the doctoral program, and cheered when I completed. To my parents, Jim and June Getha, whose values and encouragement have enriched my life and strengthened me for this journey. And to my daughters, Adrianne and Kristyn – thank you for having the interest (and courage!) to ask me how my study was progressing, and the strength to keep your eyes from glazing when I told you. I love you.

This study was funded, in part, by a research grant from

the University of Cincinnati’s Beta Iota Chapter of Sigma Theta Tau International
Preface

This work was completed using a manuscript dissertation format. The documents that follow include the first three chapters in standard dissertation form, followed by three manuscripts written for publication.

The first chapter provides an introduction to the study problem, and support for the research investigation. Chapter Two contains a synthesis of the literature, and provides the theoretical foundation on which the study is based. The third chapter provides a detailed description of the methods used to conduct the study.

The decision to use a manuscript format for this work was based on findings from the literature review. Findings from the literature review indicate that much patient care is being provided in a manner that is neither safe nor effective. This is of concern not only to nurses and nurse educators, but also to the general public.

Meaningful learning in pre-licensure education is essential for nurses to provide safe and effective patient care. In order for nurse educators to implement measures that promote meaningful learning, they must first receive information about what meaningful learning is, and how it can be fostered in students. The three manuscripts are a means of disseminating this information. Each manuscript was developed in alignment with the submission guidelines for a specific nursing journal.

The manuscripts follow the chapters. The first manuscript provides a description of the theory underlying meaningful learning, and an innovative pedagogy based on meaningful learning concepts and principles. The second describes a method of assessing and analyzing students’ meaningful learning. The third manuscript provides a succinct description of the study, its findings, conclusions, and implications for practice.
Table of Contents

Chapter I: The problem
Introduction of the problem ........................................... 1
  Introduction to meaningful learning ................................ 2
  Meaningful learning and higher order thinking .................... 2
  Meaningful learning and clinical judgment ......................... 3
  Pedagogies that facilitate meaningful learning .................... 6
  Evaluating new pedagogies ........................................... 7
Purpose of the study ..................................................... 8
  Quantitative strand .................................................... 9
  Qualitative strand .................................................... 9
Rationale for conducting the study ................................... 10
  Traditional nursing pedagogy and learning outcomes ............. 10
  National nurse licensing trends ...................................... 12
  Evidence from nurse managers and novice nurses ................. 13
  Findings from current nursing education research ................ 14
  Factors inhibiting implementation of newer pedagogies .......... 15
  Innovation of the proposed study .................................. 17
Specific Aims & research questions .................................. 18
  Specific Aims ....................................................... 18
  Quantitative questions ............................................. 19
  Qualitative question ................................................ 20
  Integrated questions ............................................... 21
Summary ........................................................................... 22

Chapter II: Background
Introduction ................................................................. 23
Overview of chapter II sections ........................................ 24
Learning paradigms: Overview .......................................... 27

Constructivism: Underlying philosophy and key theorists ....... 28
  Early constructivist theorists ....................................... 29
    John Dewey ......................................................... 29
    Jean Piaget ......................................................... 30
  Jerome Bruner ........................................................ 31
  David Ausubel’s theory of meaningful learning .................. 32
    Meaningful versus rote learning ................................ 33
    The role of cognitive structure in meaningful learning ....... 34
    The processes involved in meaningful learning ............... 34
    Progressive differentiation ....................................... 35
    Subsumption/assimilation ....................................... 35
    Integrative reconciliation ....................................... 36
    Formation of arbitrary connections ............................. 36
    Advance organizers in meaningful learning .................... 37
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contemporary view of constructivism &amp; Ausubel’s theory</td>
<td>37</td>
</tr>
<tr>
<td>Depth versus breadth of content</td>
<td>38</td>
</tr>
<tr>
<td>Addressing learners’ underlying knowledge</td>
<td>39</td>
</tr>
<tr>
<td>Cognitive engagement</td>
<td>40</td>
</tr>
<tr>
<td>Summary</td>
<td>40</td>
</tr>
<tr>
<td>Strategies to facilitate meaningful learning</td>
<td>40</td>
</tr>
<tr>
<td>Scaffolding learning</td>
<td>41</td>
</tr>
<tr>
<td>Concept-based teaching</td>
<td>42</td>
</tr>
<tr>
<td>Contemporary view of meaningful learning as knowledge integration</td>
<td>44</td>
</tr>
<tr>
<td>Knowledge integration and decision-making</td>
<td>44</td>
</tr>
<tr>
<td>The role of memory in learning</td>
<td>45</td>
</tr>
<tr>
<td>Short-term memory and learning</td>
<td>46</td>
</tr>
<tr>
<td>Short-term memory: Seminal research</td>
<td>46</td>
</tr>
<tr>
<td>Rote memorization &amp; learning</td>
<td>48</td>
</tr>
<tr>
<td>Memory &amp; constructivist-based learning: Neuroscience evidence</td>
<td>50</td>
</tr>
<tr>
<td>Brain structure &amp; finite short-term memory</td>
<td>50</td>
</tr>
<tr>
<td>Brain activity during learning</td>
<td>50</td>
</tr>
<tr>
<td>Brain structural changes during conceptual learning</td>
<td>51</td>
</tr>
<tr>
<td>Summary</td>
<td>52</td>
</tr>
<tr>
<td>Meaningful learning and higher order thinking</td>
<td>52</td>
</tr>
<tr>
<td>The cognitive domain in the original Bloom’s taxonomy</td>
<td>53</td>
</tr>
<tr>
<td>The revised two-dimensional Taxonomy</td>
<td>54</td>
</tr>
<tr>
<td>Higher order thinking in the revised Taxonomy</td>
<td>54</td>
</tr>
<tr>
<td>Higher order thinking and knowledge transfer</td>
<td>55</td>
</tr>
<tr>
<td>Summary</td>
<td>57</td>
</tr>
<tr>
<td>The instructional learning paradigm</td>
<td>57</td>
</tr>
<tr>
<td>Underlying assumptions and principles</td>
<td>57</td>
</tr>
<tr>
<td>Outcomes of instructionism</td>
<td>58</td>
</tr>
<tr>
<td>Meaningful learning in an instructionist environment</td>
<td>59</td>
</tr>
<tr>
<td>Barriers to implementation of meaningful learning strategies in nursing education</td>
<td>60</td>
</tr>
<tr>
<td>Foundation of contemporary nursing education practices</td>
<td>60</td>
</tr>
<tr>
<td>Faulty implementations of newer pedagogies in nursing</td>
<td>61</td>
</tr>
<tr>
<td>Lack of nursing-specific cognitive research</td>
<td>62</td>
</tr>
<tr>
<td>The value of pedagogies promoting meaningful learning</td>
<td>64</td>
</tr>
<tr>
<td>Support for development of meaningful learning strategies</td>
<td>65</td>
</tr>
<tr>
<td>Concept-based teaching to promote meaningful learning</td>
<td>67</td>
</tr>
<tr>
<td>Concept-based teaching: Outcomes</td>
<td>67</td>
</tr>
<tr>
<td>Concept-based teaching: Process</td>
<td>69</td>
</tr>
<tr>
<td>Strategies to enrich concept-based teaching</td>
<td>71</td>
</tr>
<tr>
<td>Active learning</td>
<td>72</td>
</tr>
<tr>
<td>Application of principles from the cognitive and learning sciences</td>
<td>74</td>
</tr>
<tr>
<td>Topic</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Post-education measurement</td>
<td>112</td>
</tr>
<tr>
<td>Pre and post-test comparison</td>
<td>116</td>
</tr>
<tr>
<td>Dependent variable: Level of measurement</td>
<td>117</td>
</tr>
<tr>
<td>Co-variables</td>
<td>117</td>
</tr>
<tr>
<td>Age</td>
<td>117</td>
</tr>
<tr>
<td>Gender</td>
<td>118</td>
</tr>
<tr>
<td>Previous science learning</td>
<td>118</td>
</tr>
<tr>
<td>Learning approach</td>
<td>119</td>
</tr>
<tr>
<td>Data recording</td>
<td>120</td>
</tr>
<tr>
<td>Setting</td>
<td>121</td>
</tr>
<tr>
<td>Sampling</td>
<td>122</td>
</tr>
<tr>
<td>Selection of participants</td>
<td>122</td>
</tr>
<tr>
<td>Inclusion and exclusion criteria</td>
<td>122</td>
</tr>
<tr>
<td>Recruitment</td>
<td>122</td>
</tr>
<tr>
<td>Data analysis and management</td>
<td>124</td>
</tr>
<tr>
<td>Power analysis</td>
<td>124</td>
</tr>
<tr>
<td>Selection of significance level</td>
<td>125</td>
</tr>
<tr>
<td>Effect size</td>
<td>126</td>
</tr>
<tr>
<td>Analysis of data</td>
<td>127</td>
</tr>
<tr>
<td>Significance testing</td>
<td>129</td>
</tr>
<tr>
<td>Multiple regression</td>
<td>129</td>
</tr>
<tr>
<td>Rigor</td>
<td>131</td>
</tr>
<tr>
<td>Qualitative strand: Detailed description of methods</td>
<td>133</td>
</tr>
<tr>
<td>Specific aim</td>
<td>133</td>
</tr>
<tr>
<td>Research question</td>
<td>133</td>
</tr>
<tr>
<td>Design</td>
<td>133</td>
</tr>
<tr>
<td>Procedures</td>
<td>134</td>
</tr>
<tr>
<td>Setting</td>
<td>134</td>
</tr>
<tr>
<td>Sampling</td>
<td>134</td>
</tr>
<tr>
<td>Participant selection</td>
<td>135</td>
</tr>
<tr>
<td>Inclusion and exclusion criteria</td>
<td>136</td>
</tr>
<tr>
<td>Recruitment</td>
<td>136</td>
</tr>
<tr>
<td>Sample size</td>
<td>137</td>
</tr>
<tr>
<td>Instrument</td>
<td>138</td>
</tr>
<tr>
<td>Semi-structured interview</td>
<td>138</td>
</tr>
<tr>
<td>Advantages and disadvantages of semi-structured interviews</td>
<td>141</td>
</tr>
<tr>
<td>Interview procedure</td>
<td>141</td>
</tr>
<tr>
<td>Measures to control bias</td>
<td>143</td>
</tr>
<tr>
<td>Description of the case study</td>
<td>143</td>
</tr>
<tr>
<td>Development of the case study</td>
<td>145</td>
</tr>
<tr>
<td>Development of the interview guidelines</td>
<td>148</td>
</tr>
<tr>
<td>Data analysis and management</td>
<td>149</td>
</tr>
<tr>
<td>Flow mapping: Overview</td>
<td>150</td>
</tr>
<tr>
<td>Flow mapping: Procedure</td>
<td>151</td>
</tr>
<tr>
<td>Flow mapping: Analysis</td>
<td>153</td>
</tr>
<tr>
<td>Integration of quantitative and qualitative strands</td>
<td>153</td>
</tr>
</tbody>
</table>
Rigor .................................................................................................................. 154
Pilot study ........................................................................................................ 154
Protection of human subjects ........................................................................ 159
  Quantitative strand ...................................................................................... 160
  Qualitative strand ....................................................................................... 162
Scope and limitations ..................................................................................... 166
  Limitations related to quantitative strand .................................................. 166
  Limitations related to qualitative strand ..................................................... 168

Tables
Table 1: Summary Comparison of the Two Curricula ....................................... 169
Table 2: Summary Descriptions of ATI Critical Thinking & Fundamentals Assessments .......................................................... 171
Table 3: Comparison of ATI Critical Thinking Assessment and Nursing Fundamentals Assessment to Bloom’s Taxonomy of Higher Order Thinking .................................................. 173
Table 4: Summary of Cohorts Based on Preliminary Analysis ....................... 175
Table 5: Summary Plan for Analysis ................................................................ 177

References ...................................................................................................... 179

Appendices
Appendix A: Relationship Between Purpose, Aims, Questions, & Hypotheses .......... 210
Appendix B: Relationship Between Meaningful Learning, Deep Understanding, and Higher Order Thinking .......................................................... 212
Appendix C: Invitation to Participate in Quantitative Strand .......................... 214
Appendix D: Invitation to Participate in Qualitative Strand ............................ 216
Appendix E: Confidentiality Agreement ............................................................ 218
Appendix F: Case Study and Interview Guidelines ......................................... 220
Appendix G: Flow Map Diagram .................................................................... 225

Manuscripts
Manuscript #1: Meaningful Learning: Theoretical Support for Concept-Based Teaching . . 227
Manuscript #2: Flow Mapping to Assess Student Learning .......................... 250
Manuscript #3: Nursing Student Learning Outcomes in Response to Learner-Centered Pedagogy .......................................................... 258
Concept-Based Teaching & Meaningful Learning in Associate Degree Nursing Students

Chapter I: The Problem

Introduction of the Problem

Safety of patient care in the United States has been under close scrutiny over the past decade, following the Institute of Medicine’s (IOM) report, *To Err is Human: Building a Safer Health System* (IOM, 2000). The report cited an “epidemic” of potentially preventable medical errors committed by health care providers, including nurses (IOM, 2000, p. 1). These errors account for an estimated 98,000 patient deaths annually (IOM, 2000). The report identified deficiencies in healthcare practitioner education as one of several factors contributing to the prevalence of medical errors, and called for an “overhaul” of healthcare provider education (Greiner & Knebel, 2003, p. 1).

Members of the nursing profession have responded to the IOM report on medical errors, expressing support for a change in nursing education (e.g. Benner, Sutphen, Leonard, & Day, 2010). Specifically, a call for change in nursing pedagogy has been made, one that will ensure preparation of students who will become safe practitioners capable of making sound clinical decisions. Many nurse experts contend that teaching and learning strategies that facilitate greater understanding of classroom material and its application to the practice setting will best address this need (e.g., Benner et al., 2010; Candela, Dalley, & Benzel-Lindley, 2006; Durham & Sherwood, 2008; Finkelman & Kenner, 2009; Sherwood & Drenkard, 2007), and will help narrow what is commonly referred to as the “theory-practice gap” (Newton, Billett, Jolly, & Ockerby, 2009, p. 315).

Teaching and learning strategies that promote meaningful learning (Ausubel, 1963, p. 22) are the key to effective transfer of knowledge from the classroom to real world situations,
particularly when knowledge is applied to solve problems and make decisions (Ausubel, 1963; Novak, 2010). Meaningful learning occurs when learners connect new information “in a nonarbitrary and substantive (nonverbatim) fashion” (Ausubel, 1968, pp. 37-38) to their pre-existing knowledge. The end result is a hierarchical organization of knowledge in the learner’s mind, referred to as “cognitive structure”, and a deeper understanding of both pre-existing and new knowledge (Ausubel, 1968, p. 38). The theory of meaningful learning, as posited by David Ausubel, provided the framework for this study.

**Introduction to meaningful learning.**

Meaningful learning allows the learner to organize knowledge into a coherent whole. It is this coherence that allows significant relationships between new information and the pre-existing knowledge to be recognized, and the principles governing those relationships to emerge (Carver, 2006; Entwistle, 2000; Erickson, 2007; Marton & Säljö, 1976a; Novak, 2010).

Recognizing knowledge relationships and the principles integral to those relationships generates a deep understanding in learners (Ausubel, 1968; Novak, 2010). Deep understanding produces usable conceptual knowledge, as opposed to inert factual knowledge (Anderson et al., 2001), that learners can transfer to real world problem solving and decision-making (Erickson, 2007).

**Meaningful learning and higher order thinking.**

Knowledge transfer is evident when learners demonstrate more complex cognitive processes (Anderson et al., 2001), commonly referred to as higher order thinking. Complex cognitive processes fall under the categories of understanding, applying, analyzing, evaluating, and creating knowledge. These processes include practices such as inferring logical conclusions, differentiating relevant from irrelevant information, and generating alternative hypotheses
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

(Anderson et al., 2001). The ultimate test of knowledge transfer is a learner’s ability to apply theoretical knowledge toward understanding an unfamiliar situation or solving a novel problem (Bransford, Brown, & Cocking, 2000).

Experts possess a wealth of discipline-specific conceptual knowledge (Drucker, 1998), and are adept at utilizing complex thinking processes and applying knowledge to novel situations (Anderson et al., 2001; Bransford et al., 2000). Nurse experts, for example, integrate conceptual knowledge and complex thinking when relationships between observations and underlying nursing knowledge are recognized, when principles that guide interpretation of observations and provide a framework for responding appropriately are used, and when patient assessment findings are synthesized to discern patterns that become the basis for evaluating patient health status (Banning, 2008; Benner et al., 2009). These processes are most evident in the practice of clinical judgment and decision-making (Thompson & Dowding, 2009).

**Meaningful learning and clinical judgment.**

Clinical judgment “involves integration of information about a person . . . to reach an evaluation or assessment of their state or condition” (Thompson & Dowding, 2009, p. 3), whereas decision-making is focused on determining the best course of action to take in response to the judgment made (Thompson & Dowding, 2009). Both clinical judgment and decision making require higher order thinking and are, therefore, a consequence of meaningful learning.

The higher order thinking processes involved in judgment and decision-making include interpretation of data, differentiation of relevant from irrelevant data, generation of hypotheses to account for observations made, and development of a plan for intervention or action (Anderson et al., 2001). A specific example of how nurses might use cognitively connected knowledge to form clinical judgments and make clinical decisions follows.
Nurses collect information related to the patient’s vital signs, appearance, and level of consciousness during patient assessment. This information is then integrated, or synthesized, to reach a conclusion, or judgment, regarding the patient’s overall condition (Thompson & Dowding, 2009). The judgment becomes the basis for determining whether or not intervention is needed and, if so, what the appropriate course of action might be. Once an action (or inaction) is implemented, the process begins with a re-assessment of the patient’s condition. The re-assessment requires that incoming information be considered in the context of underlying knowledge (Thompson & Dowding, 2009).

The processes of clinical judgment and clinical decision-making, as described in the preceding example, are dependent upon the nurse’s ability to recall pre-existing knowledge, to manipulate and connect underlying knowledge and new information, and to transfer underlying knowledge in an appropriate manner to the clinical situation (Thompson & Dowding, 2009). An individual’s capacity for recall, manipulation, and transfer; according to Ausubel’s theory of meaningful learning (Ausubel, 1963, 1968; Ausubel, Novak, & Hanesian, 1978), are influenced by the individual’s knowledge organization and number of connections in the cognitive structure.

Strength and number of knowledge connections have been found to be significant factors in nurse performance. Specifically, decreases in both strength and number of connections negatively influence the nurse’s ability to attend to relevant data (Benner et al., 2010). In the absence of significant pre-existing cognitive connections, nurses find it difficult to determine what information might be most pertinent to the current clinical situation. As a result, essential patient assessment data are likely to be missed, and patient safety and effective care jeopardized.

Many novice nurses have difficulty recognizing relationships among patient assessment data or making connections between the data and the corresponding nursing implications learned
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

during pre-licensure education (Ebright, Carter Kookan, Moody, & Latif Hassan, 2006; Ebright, Urden, Patterson, & Chalko, 2004). Inability to recognize relationships results in near-miss safety events, defined as “an act of commission or omission that could have harmed the patient but did not cause harm as a result of chance, prevention, or mitigation” (IOM, 2004, p. 227). More importantly, the novice’s inability to recognize relationships and patterns is one of the most common causes of adverse patient outcomes that cause patient harm or death (Ebright et al., 2004).

A synthesis of the preceding information suggests that novice nurses’ inability to discern knowledge connections precludes the provision of safe and effective nursing care. Therefore, teaching methods that increase an awareness of how knowledge is connected in pre-licensure nurses could, potentially, improve the patient care provided by novice nurses. A deep understanding of knowledge relationships occurs through the process of meaningful learning (Ausubel, 1968). It follows that nursing education must be implemented in a manner that promotes meaningful learning in order to increase the safety and effectiveness of care provided by novice nurses.

The overall purpose of this mixed methods study was to evaluate the effects of a nursing curriculum designed to promote meaningful learning. Specifically, this study: (1) investigated learning outcomes of nursing students who participated in an innovative curriculum known to promote meaningful learning in other disciplines, (2) compared the learning outcomes of nursing students from the innovative curriculum to outcomes of nursing students from a traditional nursing curriculum, (3) identified thinking patterns of students from the innovative curriculum following an interview requiring knowledge transfer, and, (4) used the identified patterns to explain differences in learning outcomes of students who received the innovative curriculum.
Pedagogies that facilitate meaningful learning.

Evidence from the cognitive and learning sciences has transformed the way many educators view teaching and learning. The end result has been a paradigm shift from a teacher to a learner-centered approach to education. This metamorphosis, and the teaching strategies associated with it, has been found to increase students’ meaningful learning, development of complex cognitive processes, and usable knowledge. This is because learner-centered strategies are based on principles that facilitate knowledge connections (Bransford et al., 2000).

Benner et al. (2010) assert that a learner-centered approach is essential in nursing education, and that the approach must be focused on meaningful learning to improve patient care. This is because meaningful learning experiences prepare nurses who have a greater understanding of relationships between core patient care concepts and the principles underlying patient care decisions (Candela et al., 2006). A greater understanding of how knowledge is connected promotes complex cognition, such as the higher order thinking processes of applying, analyzing, and evaluating information (L. W. Anderson et al., 2001). Novice nurses who have an affinity for complex thinking are better able to transfer classroom knowledge when making clinical judgments. This translates to safe and effective patient care in the clinical setting (Ironside, 2004, 2005).

Concept-based teaching is one strategy that has been found to promote students’ meaningful learning and resultant higher order thinking in science-related, non-nursing disciplines (e.g., Morse & Jutras, 2008; Novak, 2005). Concept-based teaching provides anchoring concepts that assist learners in interpreting new information and organizing their cognitive structure, and creates a foundation on which learners can build subsequent knowledge
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

(Ausubel, 1968; Erickson, 2007; Novak, 2010). Concept-based teaching, then, has the potential to facilitate meaningful learning and higher order thinking in nursing students.

**Evaluating new pedagogies.**

It is essential that student learning outcomes associated with newer pedagogies, such as concept-based teaching, be compared to those of traditional teaching modalities, such as presentation of discrete, disconnected topics (Brown, Kirkpatrick, Greer, Matthias, & Swanson, 2009; Ironside & Valiga, 2007). Outcome assessment provides a measure of teaching effectiveness and, subsequently, guides faculty in their selection of teaching methods.

This study used a quantitative approach to compare meaningful learning outcomes of nursing students participating in a concept-based learning curriculum to those participating in a more traditional curriculum. The purpose of this approach was to assess the effectiveness of concept-based teaching in promoting students’ meaningful learning outcomes, and to compare the outcomes of concept-based teaching to those of the more traditional pedagogy.

Student cognition is an essential component of the learning process and, thus, must be considered when student learning is evaluated (Entwistle & Ramsden, 1983). This study included a strand of qualitative inquiry in order to explore student cognition and gain a better understanding of the meaningful learning process following concept-based teaching. The quantitative and qualitative information were then synthesized to provide a more complex understanding of meaningful learning in nursing students.

Several systematic reviews of nursing education literature (Cant & Cooper, 2010; Kaakinen & Arwood, 2009; Spector, 2006; Wiechula & Rochmawati, 2010) were examined during preparation for this study. The purpose of the examination was to determine the state of the science of nursing education, and this study’s potential contribution. The examination
revealed a paucity of nursing research on the relationship between human cognition, learning theory, nursing pedagogies, and learning outcomes. The literature specific to concept-based teaching in nursing was likewise sparse, particularly empirical research underpinned by cognitive or learning science theory.

Due to the scarcity of nursing education research underpinned by evidence from the cognitive and learning sciences, nurse experts suggest that nurse educators look to research from other disciplines to determine effective teaching strategies, specifically, strategies that are evidence based and incorporate what is known about learning and cognition (Emerson & Records, 2008; Tanner, 2008b). Teaching strategies that have been found effective can then be tested in a nursing context and, if successful, implemented to improve student learning outcomes and, ultimately, patient care.

This study implemented the previously described recommendations. An innovative approach to education found to be effective in other disciplines was applied in a nursing education setting. The approach was developed in alignment with principles drawn from learning and cognitive science evidence, and student learning outcomes were evaluated to test its effectiveness.

**Purpose of the Study**

The innovative teaching approach consisted of a curriculum revision. The revision integrated concept-based teaching and active learning strategies, and was designed to enhance students’ meaningful learning. The overarching purpose of this mixed methods study was to evaluate the effect of the curriculum revision on nursing students’ meaningful learning. This was accomplished by: (1) comparing before and after measures of meaningful learning collected from archived data of students in the concept-based teaching (CBT) group, (2) comparing archived...
records of outcome measurements from the CBT group to those of a comparison group receiving traditional teaching, (3) exploring patterns of thought in students from the CBT group, and, (4) using the identified thought patterns to help explain differences in students’ meaningful learning outcomes.

This study used a quantitative-dominant, explanatory sequential design (Creswell & Plano Clark, 2011), and consisted of a quantitative strand followed by a qualitative strand. The quantitative approach was used to investigate the effect of concept-based teaching.

**Quantitative strand.**

The ultimate purpose of the quantitative strand of this study was to provide empirical evidence of an innovative teaching modality’s effectiveness or ineffectiveness in promoting meaningful learning. This evidence was collected not only to evaluate the teaching approach, but also to inform the practice of nurse educators and nurse researchers, and the science of nursing education.

The specific aim of the quantitative component was to investigate and compare meaningful learning outcomes in students who were taught with traditional nursing pedagogy or concept-based teaching. This strand was informed by Ausubel’s (1963, 1965, 1968) theory of meaningful learning, and examined the effect of teaching anchored by fundamental nursing concepts on students’ meaningful learning. Meaningful learning was measured by students’ ability to respond correctly to test questions measuring higher order thinking.

**Qualitative strand.**

This study also examined student thinking which, when considered from a constructivist viewpoint, is integral to the study of learning. Due to the subjective nature of cognition, and to the fact that this area of study is relatively unexplored in nursing students, a qualitative method
of inquiry was an appropriate means of study for this aspect of the phenomenon. Qualitative data were collected to add richness to the quantitative data (Creswell & Plano Clark, 2011), and to provide a better understanding of nursing students’ thinking and learning after receiving concept-based teaching. The specific aim for the qualitative strand of this study was to gain a greater understanding of the mechanisms underlying meaningful learning in associate degree nursing students who were taught using concept-based teaching.

The quantitative and qualitative data were integrated to provide a more complex understanding of student outcomes in response to concept-based teaching. This mixed methods approach capitalized on the strengths of both quantitative and qualitative methods, and provided balance by allowing the strengths of each method to offset the weaknesses of the other (Creswell & Plano Clark, 2011).

**Rationale for Conducting the Study**

A review of current nursing education literature indicated a gap exists in investigation of student cognition. A gap was likewise identified concerning educational practices that will best support meaningful learning. Other factors signaling a need for research of innovative pedagogies included less than optimal learning outcomes associated with traditional pedagogies, downward trends in national nurse licensure examination pass rates, and evidence from nurse managers and new nurse graduates indicating a need for better pre-licensure preparation.

**Traditional nursing pedagogy and learning outcomes.**

Nursing practice is a complex endeavor, requiring rapid and accurate decision-making in order to promote patient health and prevent complications, disability, or death. The ability for accurate and rapid clinical judgment and decision-making requires practicing nurses to quickly
and easily retrieve, manipulate, and connect information stored in their memories in order to transfer knowledge from one context to another (Ebright et al., 2006; Simmons, 2010).

Unfortunately, the current approach to teaching and learning in many nursing preparation programs is not conducive to future nurses’ ability to retain, retrieve, manipulate, or connect information (Levett-Jones et al., 2010). This is because much of the information communicated to nurses during their formative years as nursing students is done so using traditional teaching techniques. Traditional techniques typically include presentation of discrete factual knowledge through a lecture style format. These techniques and format allow the learner to assume a passive role in the educational process. Passive education methods produce primarily surface learning of memorized facts, rather than a deep understanding of underlying principles and concepts or how they are related to one another (Carver, 2006).

Deep understanding is the result of meaningful learning (Ausubel, 1968). Meaningful learning occurs when learners connect new information to information already present in their minds (Ausubel, 1968). It is characterized by the ability to apply information in new and novel ways (Novak, 2010). Novel situations occur regularly in a nurse’s workday, due to the complex and dynamic nature of human beings. Nurses, therefore, must have a deep understanding of discipline specific knowledge in order to apply that knowledge from the context of one patient to the context of another, and to the changing context of the individual patient as that patient’s condition evolves. Learner-centered pedagogies are one means of facilitating knowledge integration and deep understanding in student nurses. Concept-based teaching implemented with active learning strategies is a prime example of learner-centered pedagogy.

The argument can be made that traditional pedagogies used in nursing education have been effective. As of 2004 there were more than two million registered nurses licensed in the
United States (U.S. Department of Health and Human Services, 2004), most of whom were educated through traditional means. All of these nurses were successful in passing the national licensure examination, and most are currently providing patient care (U.S. Department of Health and Human Services, 2004). However, data from a national study by the IOM (2000) indicate the care being provided is often neither safe nor effective, as evidenced by an increased number of errors in patient care and increased mortality rates. Statistics from national nursing organizations support the IOM’s findings (i.e., Kenward & Zhong, 2004; Smith & Crawford, 2004).

**National nurse licensing trends.**

The purpose of an entry-level registered nurse program is to prepare students to function as competent nurses. Competent nursing practice is viewed as the ability to provide safe and effective patient care (Brazen, 2008). Registered nurse graduates in the United States are required to pass the NCLEX-RN licensure examination, which serves as a measure of minimal competency for registered nurse practice (Wendt & Marks, 2007).

The NCLEX-RN examination is practice-based and its development is founded on interviews and observations of nurse graduates during their first year of practice. The purpose of these observations and interviews is to provide practice-based evidence of the knowledge novice nurses must possess in order to provide safe and competent nursing care (Wendt & Marks, 2007).

Data from the National Council of State Boards of Nursing (2009a) show declining NCLEX first-attempt pass rates, and a 45% or lower pass rate on succeeding attempts for 2009. This is a disheartening statistic in itself, but is alarming when considered in reference to the fact that the NCLEX-RN measures only *minimal* competency.
The NCLEX-RN blueprint has changed in recent years, with the inclusion of a greater number of questions that assess higher order thinking (Wendt & Harmes, 2009). The format of the NCLEX-RN has changed as well, with the addition of innovative test items in place of an all-multiple choice question format (Wendt & Harmes, 2009). It is possible these changes might be responsible, in part, for lower first-time pass rates.

It is likewise possible that traditional nursing pedagogies have contributed to lower NCLEX-RN pass rates. Traditional pedagogies (i.e., lecture style format that encourages passive learning and presentation of discrete topics that hinders integration of knowledge) do not foster development of conceptual knowledge or higher order thinking processes and, as a result, might not provide adequate preparation for the revised NCLEX-RN format (Benner et al., 2010; Carrick, 2011).

**Evidence from nurse managers and novice nurses.**

Evidence from national surveys of nurse managers (Smith & Crawford, 2004) and new graduates (Kenward & Zhong, 2004) indicate that new graduates do not have adequate knowledge to assume their role as registered nurses. The National Council of State Boards of Nursing (NCSBN) Employer Survey reports nurse manager perceptions regarding adequacy of new graduates’ educational preparation for their role as a nurse. The NCSBN 2004 study indicated that only 41% of managers surveyed believed new nurse graduates were adequately prepared to provide safe and effective patient care (Smith & Crawford, 2004).

The NCSB (Kenward & Zhong, 2004) survey of new registered nurse graduates indicates that new nurses do, in fact, experience difficulty transferring theoretical knowledge to practice. Only 50% of the new nurses surveyed reported feeling capable of synthesizing data from multiple sources in order to make appropriate patient care decisions. More recently, assessment
of new nurse graduates’ clinical reasoning found that 70% of new graduates tested scored at an unsafe level (del Bueno, 2005). These statistics indicate deficiencies in new nurses’ ability to synthesize information to formulate sound clinical decisions. This is a factor that contributes to patient care errors (Kenward & Zhong, 2004).

The preceding evidence (e.g., Kenward & Zhong, 2004; Smith & Crawford, 2004) can be summarized as follows. The purpose of an entry level nursing program is to prepare a competent, beginning level practitioner. However, many new graduates are failing their initial licensure exam in spite of the fact that the exam measures only minimal competency (Wendt & Marks, 2007). A majority of nurse managers reported that new nurse graduates who have passed the licensure exam, and are therefore assumed to have at least minimal competency for nursing practice, are perceived as being unable to provide safe and effective patient care (Smith & Crawford, 2004). More importantly, a majority of new graduates described themselves as being unprepared to make clinical decisions (Kenward & Zhong, 2004).

This evidence supports the argument for a change in nursing pedagogy. Specifically, there is a need for learner-centered pedagogies that have been shown to be effective in promoting meaningful learning and fostering the higher order thinking needed to make safe and effective patient care decisions.

**Findings from current nursing education research.**

A multiyear study of professional education funded by The Carnegie Foundation for the Advancement of Teaching Support further supports the argument that a change in nursing pedagogy is needed. The purpose of the Carnegie study was to investigate the process of professionals’ educational preparation for practice, one of which was nursing (Benner et al., 2010). A primary finding of the study was that nurses are not adequately prepared for the
demands of practice in the current healthcare arena (Benner et al., 2010). The researchers concluded that continued use of traditional pedagogies is a primary factor contributing to inadequately prepared nurses.

In order for learner-centered pedagogies, such as concept-based teaching, to be adopted in institutions where teaching-centered approaches have been used for decades, the new teaching and learning strategies must be shown to be effective. The National League for Nursing’s (NLN) Nursing Education Advisory Council (NEAC) insists that nursing pedagogy must be evidence-based, and research must determine best educational practices (Ironside & Speziale, 2006).

Evidence of best education practices, including the efficacy of concept-based teaching, is available. The bulk of these studies have come from the field of educational research, primarily in the area of science learning (e.g., Aydin, Aydemir, Boz, Cetin-Dindar, & Bektas, 2009; Machin, Varleys, & Loxley, 2004; Moreira, 1977; Morse & Jutras, 2008; Novak, 2005).

The findings from many of these studies indicate that concept-based teaching significantly improves learners’ understanding of key concepts and principles in science education. Nursing is an applied science, with a strong bioscience foundation (Akinsanya, 1987, 2002; Gresty & Cotton, 2003; McVicar & Clancy, 2001; McVicar, Clancy, & Mayes, 2010). It follows, then, that concept-based teaching for nursing students might promote depth of understanding of the concepts and principles guiding patient care and clinical decision making.

Factors inhibiting implementation of newer pedagogies.

Despite evidence showing positive learning outcomes of cognitive-based, newer pedagogies in other fields, many nurse educators continue to teach as they were taught, using traditional approaches (National League for Nursing, 2006a). The scarcity of research-based evidence specific to cognitive-based educational practices and student learning in nursing
education is one possible barrier to nurse educators’ implementation of evidence-based practices, such as concept-based teaching.

The majority of previous nursing education studies have focused on the phenomena of attitudes or perceptions related to learning, psychomotor performance, or knowledge outcomes. Studies measuring knowledge outcomes have focused primarily on lower order thinking, i.e., learners’ ability to recognize or recall information, rather than on the higher order thinking so essential to safe and effective nursing practice. Nursing literature related specifically to concept-based teaching is sparse and has been primarily anecdotal (e.g., Brady et al., 2008; Giddens, 2007; Giddens et al., 2008; Heims & Boyd, 1990; Kantor, 2010; Kelly & Colby, 2003; Nielsen, 2009; Vacek, 2009). Only one research study related to concept-based teaching was found in the nursing literature. This study investigated clinical judgment (Lasater & Nielsen, 2009).

The Lasater and Nielsen study (2009) found a significant change in clinical judgment scores during simulation for students receiving a concept-based teaching intervention. Change in individual students’ cognition resulting from the intervention was difficult to assess. This was due to the fact that clinical judgment was evaluated during dyad or triad group participation in a simulation experience, rather than during individual student performance. Clearly, the relationship between concept-based teaching and individual student nurse learning outcomes requires further study and exploration.

As described above, several factors exist that might limit nurse educators’ use of newer pedagogies, such as concept-based teaching. Nursing-specific empirical studies on this topic are relatively non-existent. Empirical studies from other disciplines are available, but have been published predominantly in education journals. This poses a potential barrier to nurse educators’
acquisition of this information, as nurse educators are perhaps more likely to access nursing publications when seeking evidence to guide educational practice decisions.

This study provides nursing-specific evidence of the effectiveness or ineffectiveness of concept-based teaching. The findings will be disseminated via an accepted nursing forum. It is expected that the nursing-specific context and dissemination of findings will increase nurse educators’ interest in innovative pedagogies.

**Innovation of the proposed study.**

National organizations have recommended that learner-centered pedagogies be instituted to improve student learning (IOM, 2000; NCSBN, 2006a, 2006b, 2009b, 2009c). Concept-based teaching is one type of learner-centered pedagogy.

Previous research on student learning outcomes in response to concept-based teaching has been conducted in the field of science education, but has been relatively absent in the field of nursing education. Most studies conducted in the field of nursing education have been primarily descriptive, have not been based on learning theory, or have not considered the cognitive factors involved in learning.

The innovative pedagogy of interest to this study, that of concept-based teaching in conjunction with active learning, is evidence-based, has been found to support meaningful learning (Daley & Torre, 2010), and is supported by what is currently known about cognition and learning (Bransford et al., 1999, 2000; Nesbit & Adescope, 2006; Novak, 2010).

This study was unique from most other research in nursing education, in that it was theoretically underpinned by established learning theory. The study proceeded from the well-established learning theory of David Ausubel, and the results provide a better understanding of nursing students’ learning outcomes in response to concept-based teaching. The mixed methods
approach of this study was likewise innovative, in that it provided subjective as well as objective data, thus leading to a richer understanding of meaningful learning in nursing students.

**Specific Aims & Research Questions**

This mixed methods study was conducted using a quantitative-dominant, explanatory sequential design (Creswell & Plano Clark, 2011). This approach to data collection and data analysis and interpretation provided a more thorough understanding of student learning in response to the cognitive-based, learner-centered pedagogy. The quantitative strand of this study supplied data from which learning outcomes following traditional teaching could be compared to those following concept-based teaching.

The central phenomenon for this study was student learning, with a specific focus on meaningful learning and its relationship to higher order thinking and knowledge transfer in first semester, associate degree nursing students. The specific aims of both the quantitative and qualitative strands of this study were related to the overarching purpose of the study. The overarching purpose was to evaluate the effects of a nursing curriculum revision, that of concept-based teaching, on meaningful learning in nursing students.

**Specific aims.**

There were two specific aims for this study, one that directed the quantitative strand of inquiry, and one that directed the qualitative strand. The quantitative and qualitative aims were, respectively: (1) to investigate and compare meaningful learning outcomes in students who received either traditional nursing pedagogy or concept-based teaching, and, (2) to gain a greater understanding of the mechanisms underlying meaningful learning in associate degree nursing students who received concept-based teaching.
The specific aims assumed a critical role in this study. This is typical of a mixed methods “bottom-up” approach, in which the specific aims are the driving force behind all planning decisions, including the development of specific research questions (Creswell & Tashakkori, 2007, p. 306). Accordingly, specific questions related to each of the two aims were formulated to direct this study’s design and methods (Creswell & Plano Clark, 2011; Johnson & Onwuegbuzie, 2004). A description of these questions follows.

**Quantitative questions.**

This study incorporated a quantitative strand to investigate the effect of the teaching innovation. This strand was designed to address this study’s first specific aim by answering the following questions:

1. Do learners exhibit a significant increase in meaningful learning, as measured by higher order thinking scores, after receiving concept-based teaching, and,

2. Is there a significant difference in meaningful learning outcomes, as measured by higher order thinking scores, when outcomes of learners who received the concept-based teaching intervention are compared to those who received traditional nursing pedagogy?

An experimental design is the gold standard for investigating the effect of a change in practice, but is not always the most appropriate choice when other factors are considered (Creswell, 2011). This is particularly applicable when investigating phenomenon occurring in naturalistic settings, such as the educational classroom, or when research questions are not amenable to quantitative methods (Creswell, 2011).

The setting for this study was the naturalistic setting of a college level educational institution, and the study’s purpose was to evaluate learning outcomes following a curriculum
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

revision. The quantitative data were collected from archived student records. The use of archived data allowed for comparison of outcome measures from students who received the traditional curriculum immediately preceding the revised curriculum, to those of students in the revised curriculum. For these reasons, an experimental design was neither appropriate nor feasible.

This study investigated not only quantitative learning outcomes, but also student nurses’ cognitive processes. An exploration of cognition, or thought processes, was undertaken to better understand the meaningful learning process. For this reason, this study incorporated qualitative inquiry, which is the best approach for investigating the unique nature of human thought processes (Southerland, Smith, & Cummins, 2005).

Qualitative question.

Nursing education and student learning take place in the naturalistic settings of the classroom and clinical unit. These phenomena are appropriately investigated using methods other than pure experiment, in order to allow for the complexities that accompany natural human experiences (Guba & Lincoln, 1997). Due to this study’s naturalistic setting, the subjective nature of cognition, and the fact that this area of study has been relatively unexplored in nursing students, the addition of a qualitative method of inquiry was appropriate to the study of this particular phenomenon (Creswell & Plano Clark, 2011).

The qualitative data for this study were collected through semi-structured interviews. A patient case study provided the point of discussion during the interview. The purpose of the semi-structured interviews was to gather information to address the specific aim for the qualitative strand of the study. The specific aim was: to gain a greater understanding of the mechanisms underlying meaningful learning in associate degree nursing students who received concept-based teaching. The qualitative data were collected from students whose
higher order thinking scores were from the uppermost or lowermost quartile of the quantitative post-test. The purpose of this sampling approach was to gain a greater understanding of meaningful learning.

The specific question for this strand of the study was: **What overall patterns emerge during discussion of a novel patient case study related to the concept of oxygenation, when the thinking of nursing students who received CBT is analyzed?**

The format and sequencing of research questions must be related to the tradition of scientific inquiry used in a research study, and to the study design (Creswell & Plano Clark, 2011). The sequence of the specific questions for this explanatory sequential study was quantitative followed by qualitative. The quantitative strand used a deductive process to evaluate the knowledge claims for this study, through hypothesis testing, whereas induction was used during the qualitative strand to discover nursing students’ thinking patterns.

**Integrated questions.**

The qualitative data, collected from CBT group participants with extreme scores on the quantitative measure, were used to help explain differences in the quantitative data. This process, referred to as *abduction* (Johnson & Onwuegbuluzie, 2004), provided a deeper understanding of the quantitative results, and addressed the integrated questions for this study: **(1) Does thinking qualitatively differ between students achieving scores from the uppermost quartile vs. the lowermost quartile on the quantitative post-test higher order thinking measure?, and, (2) How do the patterns identified through analysis and interpretation of the CBT group’s qualitative data help explain the CBT group’s quantitative findings?**
Summary

The purpose of this chapter was to present evidence supporting a need for change in nursing pedagogy, specifically, a change expected to increase nursing students’ transfer of knowledge from the classroom to the patient bedside. Research from national organizations such as the Institute of Medicine (2000), The National Council of State Boards of Nursing (Smith & Crawford, 2004; Kenward & Zhong, 2004), and the Carnegie Foundation for the Advancement of Teaching Support (Benner et al., 2010) suggest that traditional pedagogies are not successful in facilitating the knowledge transfer needed for successful performance by new nurse graduates. The evidence includes increases in patient care errors committed by nurses, declining NCLEX-RN pass rates, nurse manager surveys indicating concern about new nurse competency, and surveys from novice nurses who report feeling unprepared for practice.

Effective knowledge transfer is needed for sound decision-making and safe patient care. Therefore, it is imperative that nurse educators consider teaching strategies other than those traditionally employed. Evidence from the learning sciences supports teaching strategies that promote meaningful learning as a means to improve learners’ ability for knowledge transfer. These strategies are based on what is currently known about cognition and learning. One such strategy is concept-based teaching.

Chapter II provides additional background information regarding the framework and logic underlying this study, as well as support for the predicted efficacy of concept-based teaching in improving learning outcomes in nursing students. Specifically, Chapter II synthesizes Ausubel’s theory of meaningful learning, which provided the theoretical underpinning for this study, with relevant research related to learning, cognition, and pedagogy.
Chapter II: Background

Introduction

Student learning was the phenomenon of interest for this study, the overall purpose of which was to evaluate the effects of a nursing curriculum revision. The goal of this chapter is to provide background information and evidence supporting the need for: (1) a change in nursing pedagogy, (2) the use of meaningful learning principles in designing and effecting that change, and, (3) the potential efficacy of concept-based learning in improving learning outcomes following the change.

The background information and evidence presented in this chapter is organized in the following manner:

• Overview of the chapter sections and their relationship to one another
• Overview of learning paradigms
• Constructivist learning paradigm: Underlying philosophy & key constructivist theorists
• Ausubel’s constructivist-based theory of meaningful learning
• Contemporary constructivism & research findings supporting Ausubel’s theory
• Strategies to facilitate meaningful learning
• The contemporary view of meaningful learning as knowledge integration
• The role of memory in learning and decision-making
• Neuroscience evidence supporting constructivism and meaningful learning
• The relationship between meaningful learning and higher order thinking
• Instructional learning paradigm
• Barriers to implementation of meaningful learning strategies
• The value of pedagogies promoting meaningful learning
Overview of Chapter II Sections

The phenomenon of interest for this study was nursing students’ meaningful learning after receiving either a traditional or concept-based nursing curriculum. The revised curriculum was developed in alignment with learning principles known to create a deep understanding in learners. The revised curriculum was based on fundamental nursing concepts that provided a foundation for subsequent learning. This approach is referred to as concept-based teaching and learning, a strategy known to facilitate meaningful learning (Erickson, 2007).

In order to begin an exploration of meaningful learning, it is essential to first define learning. One’s definition of learning, however, is dependent upon the paradigm from which one operates (Sawyer, 2006). The paradigm from which one views learning is an outcome of one’s philosophy regarding epistemology, or the nature of knowledge (Sawyer, 2006). This chapter will present a summary of two predominant, yet competing, teaching and learning paradigms: constructivism and instructionism (Sawyer, 2006).

This chapter begins with an overview of learning, followed by a discussion of constructivism, the paradigm from which this study originated. The discussion will include an historical perspective of constructivist learning theories, in order to provide context for the information that will follow.

The information following the historical background will begin with a description of David Ausubel’s theory of meaningful learning (1968), which provided the theoretical framework for this study. The description will include a discussion of the primary concepts and
principles of Ausubel’s theory. The principles are based on the premise that an individual’s knowledge development is a building process unique to each learner (Ausubel, 1963; 1965; 1968; 2000). The concepts and principles clarify the specific processes whereby knowledge building and meaningful learning occur.

The National Research Council developed a report recognizing the value of a knowledge building approach to teaching and learning (Bransford et al., 2000). The report summarizes more than 30 years of research from the fields of cognitive and social psychology, neuroscience, and human development. Many of the learning principles published in the report are in direct alignment with Ausubel’s principles of meaningful learning. Consequently, those principles will be presented in this chapter.

Many contemporary educators apply the principles of meaningful learning as a means of developing and assessing teaching strategies to promote students’ knowledge building (e.g., Linn, 1995, 2000, 2006; Linn, Clark, & Slotta, 2003; Linn & Hsi, 2000; Linn, Lee, Tinker, Husic, & Chiu, 2006). These educators focus on how learners add new knowledge to their repertoire of pre-existing knowledge, and refer to the process as knowledge integration (Linn, 2006, p. 243). This chapter will provide a discussion of knowledge integration in order to illustrate meaningful learning principles as applied in contemporary practice.

Meaningful learning is most evident when higher order thinking is manifested (Ausubel, 1968), such as that which occurs when classroom knowledge is applied, or transferred, to the world of work (Erickson, 2007; Novak, 2010). Preparing students who are able to transfer knowledge from classroom to practice is the purpose of higher education (Krathwohl, 2002), and is particularly important in the education of nursing students (Benner et al., 2010).
Knowledge transfer from classroom to practice is critical to the processes of problem solving and decision-making, which occur continuously in the day-to-day cognitive work of nurses (Benner, 2001). These processes are imperative to provision of safe and effective patient care (Benner, 2001; Benner, Tanner, & Chesla, 2009; Thompson & Dowding, 2009). The discussion of meaningful learning will, therefore, include a description of the relationship between meaningful learning and higher order thinking, with an emphasis on the higher order thinking required for sound decision-making. The purpose of this description will be to illustrate how meaningful learning can positively impact nursing students’ provision of patient care.

The discussion of meaningful learning and higher order thinking will be followed by a presentation of information about human memory, which is an integral component of both learning (Dehn, 2008) and the decision-making process (Rolls, 2009). The objective of this presentation will be to demonstrate how meaningful learning and memory interact to improve cognition during higher order thinking and decision-making.

The limits of human memory impose restrictions on the quantity of information that can be processed, remembered, and manipulated by learners at any one time. This is especially true when teaching and learning are conducted from a traditional, or instructionist, approach (Bransford et al., 2000; Papert & Harel, 1991). This chapter will present a description of instructionism and its relationship to human cognition, particularly as it relates to memory. The purpose of this presentation will be to provide support for a change in pedagogy, from the currently practiced teacher-driven instructionist model to a constructivist-based, learner-centered approach.

This chapter’s literature review will conclude with a presentation of constructivist-grounded research that supports Ausubel’s theory and identifies factors that impact meaningful
learning. Emphasis will be placed on research specific to concept-based teaching, which was the pedagogical innovation evaluated by this study.

The information in this chapter is provided to facilitate a deeper understanding of both traditional and more contemporary pedagogical practices, and their correspondence to best practices as identified by current research findings. This chapter will close with a summary and conclusion of the relationships between research-based evidence and educational practice.

**Learning Paradigms: Overview**

Learning can occur in a variety of ways (Bransford et al., 2000). The most familiar means of acquiring knowledge are through formal classroom experiences or through the informal learning that occurs during natural life experiences, such as the acquisition of language (Bransford et al., 2000).

The thesis of this study was concerned primarily with the phenomenon of formal classroom learning. Classroom learning encompasses planned learning experiences, both inside and outside the classroom, in a formal education setting. This does not mean, however, that informal learning was irrelevant to this study. Scientists’ observations of the seemingly effortless knowledge acquisition that occurs during informal learning have been influential in the development of fundamental learning principles (Bransford et al., 2000). Several of these principles were particularly relevant to this study, and reference will be made to them when appropriate.

Learning principles are inextricably bound to the theory and philosophy from which they emanate. Theories regarding learning have evolved over the years, as have philosophies of teaching and learning (Sawyer, 2006). The discussion that follows will focus on the
constructivist philosophy, the viewpoint from which this study proceeds, as well as associated theories and learning principles.

**Constructivism: Underlying Philosophy and Key Theorists**

The basic tenet of constructivism is that learning is an active process, one in which a learner constructs her or his own knowledge as she or he attempts to make meaning of the world (Kafai & Resnick, 1996). Constructivists believe learning begins with the learner’s development of abstract ideas, which form the foundation for future knowledge building.

Constructivism is based on the premise that teaching and learning are collaborative processes, and learning is the sole responsibility of the learner (Sawyer, 2006). The purpose of teaching, from a constructivist perspective, is to facilitate learning by providing an appropriate environment and relevant experiences that will assist learners with knowledge construction (Bransford et al., 2000).

The focus in constructivist-based formal education is on the learner. The goal in a constructivist-based learning environment is for the learner to acquire a deep understanding not only of facts and procedures, but also of how facts and procedures are related (Fosnot, 2005; Larochelle, Bednarz, & Garrison, 2009). Success in this type of learning environment is evaluated through the learner’s ability to use knowledge in order to gain a better understanding of, and to function within, the world.

Contemporary educational and cognitive research studies provide evidence of the effectiveness of constructivist learning principles (e.g., Bransford et al., 2000). Numerous books have recently been authored to assist educators in implementation of this approach to teaching and learning (e.g., Fosnot, 2005; Larochelle et al., 2009; Pritchard & Wollard, 2010). Constructivism, however, is not a new teaching and learning philosophy.
The philosophy and primary principles of constructivism are evident in the work of well-known educational theorists from the early 1900’s. These theorists include John Dewey, Jean Piaget, and Jerome Bruner. A brief synopsis of the ideas held by Dewey, Piaget, and Bruner follows. The ideas of these educational theorists were predecessors of those posited by David Ausubel whose theory frames this study.

**Early constructivist theorists.**

**John Dewey.**

John Dewey (1859-1952) is credited with initiating the constructivist movement. He contended that a learner’s past experience is fundamental to her or his interpretation of new experiences and ability to infer logical conclusions (Dewey, 1910). Dewey viewed the learner’s environment as an essential component of this process. He proposed that the individual’s interaction with the environment produces change in both the individual and the environment.

Interaction between the learner and the environment, however, is not sufficient for the development of knowledge (Dewey, 1910). Learners must also reflect on their thinking in order to create continuity of thought. Without interaction, the learner doesn’t change and, without continuity, learning is random and no different from trial and error (Dewey, 1910).

Dewey argued that for learning to be most effective, the learner must be an active participant in the process and the learner’s prior knowledge must be considered as a foundation for future learning (Dewey, 1902). Dewey viewed this principle as being applicable to all learners, regardless of their age:

“Even when a child (or a grownup) has a problem, to urge him to think when he has no prior experiences involving some of the same conditions, is wholly futile” (Dewey, 1910, p. 10).
In informal learning, which Dewey referred to as “normal growth” (Dewey, 1910, p. 112), learners acquire abstract knowledge, or “properties”. The development of abstract knowledge occurs when learners recognize connections among events and objects discovered during everyday life experiences. The learner’s recognition of connections results in the formation of concepts, which are general ideas that can be applied to understand new cases (Dewey, 1910).

The application of a concept to understand a new case (i.e., example) of the concept produces synthesis. Synthesis occurs when a new case is not merely added to the collection of cases already existing in the learner’s mind, but when the new case is integrated meaningfully into the network of related knowledge, “to bring other cases into line” (Dewey, 1910, p. 129).

**Jean Piaget.**

Jean Piaget (1896-1980) also believed that learners construct their own knowledge. He theorized that knowledge construction occurs through interaction between the self and what is being learned (Piaget, 1952, 1960). Piaget, however, proposed that the cognitive ability to construct knowledge is age-related. Specifically, learners’ ability to construct knowledge is dictated by chronological age and occurs on a continuum from concrete to abstract operations (Piaget, 1952).

Piaget, whose work focused on informal learning during early childhood, is credited with adding much to the foundation of constructivism. He proposed that children internalize information gained from life experiences and, through the processes of assimilation and accommodation, construct new knowledge situated in an age-related cognitive structure (Piaget, 1952, 1960). This proposition contradicted prevailing notions of the time by focusing on the role of the learner, rather than the teacher.
Piaget held two additional ideas about learning that conflicted with other constructivists of his time. He believed knowledge acquisition has a specific, age-related trajectory, and construction of new knowledge does not change the learner’s pre-existing cognitive framework (Piaget, 1952).

**Jerome Bruner.**

Jerome Bruner’s (1915- ) early work focused on symbols and language learning in young children. He likewise contributed to early constructivist theory. Bruner suggests that the cognitive methods employed by individuals to acquire knowledge are the same, regardless of the individual’s age. This was in contrast to the ideas held by Piaget.

As contended by Dewey and Piaget, Bruner likewise proposes that learners construct their own knowledge. He suggests this process occurs as the learner transforms incoming information through the lens of her or his pre-existing knowledge base (Bruner, 1960, 1963). Bruner states that transformation of incoming information occurs when teachers enable students to generate their own thinking. This is best accomplished by providing activities that allow students to independently discover important principles (Bruner, 1960, 1963).

Bruner proposes that what is learned is not as important as how knowledge is used and acquired, and a student’s ability to use knowledge requires that underlying concepts and ideas be deeply understood. Bruner refers to this as “generic” learning, which he views as the essence of “thinking” (Bruner, 1959, p. 192). According to Bruner, the key to generic learning lies in the learner’s organization and manipulation of information so that content is no longer context bound.

Manipulation and organization of knowledge, which occurs when the learner establishes connections among pieces of information, allow learners to “recognize the new problems [they]
encounter as exemplars of old principles [they] have mastered” (Bruner, 1959, p. 184). This idea is similar to Dewey’s conception of cases.

Bruner recommends that educators implement teaching methods based on his learning theory. These methods include assessment of students’ readiness to learn, structuring of material in a form that can easily be grasped by the learner, pacing and sequencing material to meet the needs of the learner, and using a “spiral curriculum” in which key ideas are revisited until the learner has attained a clear understanding (Bruner, 1960, p. 52).

Bruner re-emphasizes the role of key ideas in the learning process in his references to domain- and discipline-specific knowledge. He asserts that “fundamental ideas of a discipline” exist (Bruner, 1960, p. 3), as does a specific “structure” of various subjects. Bruner asserts that attention to key ideas and the structure of a subject is particularly important to assist students who seem to struggle academically.

David Ausubel’s theory of meaningful learning.

David Ausubel’s (1918-2008) ideas concerning epistemology likewise emanated from a constructivist viewpoint. The principles of his theory have much in common with the ideas of Dewey, Piaget, and Bruner. The commonalities among these theorists include the assumptions that an interrelationship exists between a learner’s pre-existing and new knowledge, and that formation of abstract concepts are crucial for future knowledge building (Ausubel, 1968).

Ausubel’s initial work referred to his theory as a subsumption theory of meaningful learning (Ausubel, 1962, p. 312). A later collaborative work (Ausubel et al., 1978, p. 159) labeled Ausubel’s theory as an assimilation theory of learning. The title of the theory continued to evolve, and Ausubel’s solo work in 2000 (p. 1) described the theory as an assimilation theory.
of meaningful learning and retention. In both the initial and later works, emphasis was placed on the meaning learners attribute to new and pre-existing knowledge.

**Meaningful versus rote learning.**

According to Ausubel, meaningful learning occurs when learners incorporate new information into their network of pre-existing knowledge in a substantive manner (Ausubel, 1968). By substantive, Ausubel was referring to the unique knowledge created when learners translate new information into a format that makes sense, or has meaning, to them. Substantive integration also requires that the new information be connected to related pre-existing concepts or ideas in the learner’s mind (Ausubel, 1968).

Ausubel’s theory was in contrast to ideas held by many other educational theorists of the time. Many of Ausubel’s contemporaries based their premises on the prevailing principles of behaviorism, and viewed learning from a positivistic perspective (Novak, 1992). Learning, from a behaviorist viewpoint, is defined as a change in performance, such as the student’s ability to memorize and repeat teacher-delivered facts verbatim. Ausubel referred to this process as *rote learning* (Ausubel et al., 1978, p. 103).

The difference between the behaviorist conceptualization of learning and Ausubel’s lies in the cognitive processes involved. The rote memorization associated with behaviorism requires only that new information be remembered. Meaningful learning, on the other hand, requires that new information be deeply understood (Ausubel, 1963). Deep understanding occurs when the learner actively uses pre-existing knowledge to make sense of new information, and then links the new information to the related pre-existing knowledge (Ausubel, 1963).

According to Ausubel, the learner’s ability to recognize connections between new information and underlying concepts and principles is what makes knowledge usable across a
variety of situations (Ausubel, 1968). The notion that information can be learned in one context yet applied in another is similar to Bruner’s (1959) idea of generic learning.

The role of cognitive structure in meaningful learning.

Ausubel’s theory of meaningful learning evolved from his observations of learners in the naturalistic setting of the classroom. He envisioned knowledge as an integrated and organized system of information in the learner’s mind, and referred to this integrated and hierarchically organized system as cognitive structure (Ausubel, 1968, p. 217). Ausbel’s theory is concerned primarily with explaining how learners integrate large quantities of new information into their cognitive structure to create new, usable knowledge.

Ausubel’s theory is based on the premise that learners must have anchoring concepts present in their cognitive structure before related information can be understood. Anchoring concepts are fundamental ideas at a high level of abstraction that serve as a foundation for the integration of new ideas and concepts (Ausubel, 1963, 1968). These are referred to as superordinate concepts (Ausubel, 1965, p. 420). As more and more ideas are integrated into the learner’s cognitive structure, the learner develops a more nuanced understanding not only of the anchoring concept, but also of all other ideas and concepts connected to the anchor (Ausubel, 1963, 1968; Novak, 2010). The learner’s pre-existing knowledge thus becomes modified every time new, related knowledge is added.

The processes involved in meaningful learning.

Ausubel described three processes by which new information becomes integrated into the learner’s cognitive structure. These processes are progressive differentiation, subsumption or assimilation, and integrative reconciliation (Ausubel, 1965; Ausubel et al., 1978).
Progressive differentiation.

Progressive differentiation is both a process and a description of the learner’s cognitive structure. The cognitive structure, as previously stated, is hierarchically organized and can be visualized as an interconnected network. Ideas or concepts at a high level of abstraction are located as a higher level of the structure than are less inclusive ideas or concepts. When new ideas are connected to related but more abstract ideas, the entire network of related ideas becomes increasingly more distinguished (Ausubel, 1965).

The more examples a learner recognizes and relates to a general concept, the greater the learner’s facility for recognizing future related examples (Ausubel et al., 1978). This idea is similar to Dewey’s description of cases that “bring other cases into line” (Dewey, 1910, p. 129).

Subsumption/assimilation.

Subsumption is a term Ausubel used in his initial work to describe the process whereby learners integrate less abstract ideas or concepts into their cognitive structure (Ausubel, 1963). In later works, Ausubel referred to this process as assimilation (Ausubel et al., 1978).

In subsumption/assimilation, the learner recognizes a new, less inclusive idea or concept as a more specific example of a more inclusive concept or idea that is located at a higher level in the cognitive structure (Ausubel, 1963, 1965, 1968; Ausubel et al., 1978). The learner creates a cognitive connection between the two ideas or concepts, incorporating the less inclusive idea into a position below the more inclusive idea. The less inclusive idea becomes contained, or subsumed/assimilated, by the more abstract idea or concept.

Subsumption/assimilation is facilitated when “central unifying concepts of a discipline” are introduced to learners (Ausubel, 1968, p. 89), followed by subordinate concepts and
principles (Ausubel, 1968). This is similar to Jerome Bruner’s proposition that each subject or knowledge area has its own unique structure and specific key concepts (Bruner, 1960, 1963).

The process of subsumption/assimilation serves two purposes. The more inclusive idea that pre-exists in the learner’s mind allows the learner to understand the new idea, and the less inclusive idea allows the learner to recognize gradations of the more inclusive concept (Ausubel, 1963, 1965; Ausubel et al., 1978). As a result of subsumption/assimilation, the understanding of both the new information and the pre-existing knowledge are transformed (Ausubel et al., 1978).

*Integrative reconciliation.*

Learning often produces confusion in learners, particularly when new information is received that seems to contradict pre-existing knowledge (Ausubel et al., 1978). The process of integrative reconciliation allows learners to make adjustments in thinking in order to resolve the seemingly contradictory information. This is accomplished by a recombination of ideas in the cognitive structure to create linkages that make sense to the learner (Ausubel et al., 1978).

*Formation of arbitrary connections.*

Connections to pre-existing knowledge are not always made in a meaningful manner. These connections are referred to as arbitrary connections (Ausubel, 1963). Arbitrary connections occur when learners acquire disconnected facts and pieces of information, have no information in their cognitive structure related to the new information, or are unaware of how new and pre-existing knowledge are related (Ausubel, 1963).

Arbitrary connections can be imagined as electrical circuits with no connections to the rest of the network. The lack of connection results in inefficient, or complete lack of, recall of the arbitrarily connected information (Ausubel, 1963, 1968; Ausubel et al., 1978), similar to the interruption of transmission that occurs in a disconnected electrical circuit. Failure to connect
new information in a meaningful manner to pre-existing knowledge produces a disorganized cognitive structure. The lack of organization associated with arbitrarily acquired information is what typically occurs in rote learning.

*Advance organizers in meaningful learning.*

Ausubel is probably best known for devising the concept of advance organizers, which are based on his principles of meaningful learning. Advance organizers are teaching tools or strategies provided in advance of a learning experience. These tools or strategies support the learner in making connection between pre-existing and new knowledge. Advance organizers are capable of serving this function due to the fact that they are at a higher level of abstraction or generality than the information that follows, and are based on what the learner already knows (Ausubel, 1965).

Providing learners with important, discipline-specific concepts is one means of implementing the principles on which advance organizers are based. This is because the concepts provide a context from which new information can be understood, and a means of connecting new information to pre-existing knowledge (Erickson, 2007).

Ausubel’s work does not make specific reference to concept-based teaching. The relationship between Ausubel’s theory of meaningful learning and concept-based teaching, however, is apparent in the synthesis of findings from contemporary research.

**Contemporary View of Constructivism and Ausubel’s Theory**

A recent synthesis of more than three decades of research from the fields of educational and cognitive psychology, neuroscience, and human development resulted in formulation of principles to guide educators in the development of a constructivist-based learning environment (Bransford et al., 2000). The results of this synthesis were made available in a report entitled,
How people learn: Bridging research and practice. This report was published by the National Research Council (NRC) which functions under the auspices of the National Academies comprised of the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), and the Institute of Medicine (IOM) (National Research Council, 2011).

The NRC findings indicate that teaching is most effective when depth rather than breadth of a subject is addressed, when learners’ thinking processes and underlying knowledge are considered during the planning, implementation, and evaluation of learning activities; and when learners are cognitively engaged during the learning process (Bransford et al., 2000). The core learning science principles identified by the NRC are in direct alignment with Ausubel’s theory of meaningful learning, and with its primary constructs. A description of the relationship between Ausubel’s theory and the core learning science principles follows.

**Depth versus breadth of content.**

Ausubel’s theory includes the construct of subsumption (Ausubel, 1963, p. 24), which he later came to refer to as assimilation (Ausubel, 1968, p. 89; Ivie, 1998; Novak, 1992). Subsumption or assimilation is the process whereby learners recognize the subordinate relationship of a concept or principle to a more inclusive pre-existing idea and, as a result, integrate that concept or principle into a lower hierarchical position in their cognitive structure (Ausubel, 1963, 1968). This process helps the learner more fully differentiate the subsuming idea or concept and creates greater depth of understanding. This is because the subsuming, or more abstract concept, acquires greater nuance when related but subordinate concepts or ideas are integrated into the cognitive structure.

A newly integrated concept or principle that becomes linked to a pre-existing idea already established in the learner’s cognitive structure attains stability, and is thus more likely to
be retained over time (Ausubel, 1963, 1968). The connections within the cognitive structure also serve as a network that facilitates information retrieval.

Ausubel’s conception of a linked and hierarchically arranged cognitive structure helps explain why teaching that focuses on depth, rather than breadth, has been found to improve student learning outcomes. This is particularly evident when outcomes related to knowledge transfer are considered. The learner is better able to detect gradations in connected knowledge due to the increasing differentiation that occurs as subordinate concepts and principles are integrated into the structure (Ausubel, 1968). The detection of subtle differences, in turn, enables the learner to select knowledge most relevant to interpreting familiar situations or to understanding similar, yet unfamiliar, situations.

Addressing learners’ underlying knowledge.

Ausubel’s (1968) theory of meaningful learning emphasizes the critical role served by a learner’s underlying knowledge. This is evident in his most well known quote:

“If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him (sic) accordingly.” (p. vi).

The relationship between a learner’s pre-existing knowledge and new learning is further defined by Ausubel’s construct of anchoring ideas or concepts (Ausubel, 1968, p. 132). Anchoring ideas are concepts at a high level of abstraction that serve as linchpins to which related information is connected. In the absence of relevant anchoring ideas from which new information can be understood, meaningful learning does not occur and knowledge retention is hindered (Ausubel, 1961a, 1961b, 1968).
The learner more readily discerns patterns and relationships when pre-existing knowledge is explicitly connected to new information (Ausubel, 1968; Erickson, 2007; Novak, 2010). Learners who discern relationships between concepts and ideas discover principles that allow knowledge to be used in everyday life (Erickson, 2007). A learner’s ability to use knowledge in order to be productive and successful is a primary goal of education (L. W. Anderson et al., 2001), and is one of the public’s greatest expectations of higher education (Higher Learning Commission, 2003).

**Cognitive engagement.**

Ausubel proposed that meaningful learning does not occur unless the learner elects to integrate the new information into her or his pre-existing cognitive structure (Ausubel, 1968). This principle is congruent with that established by the NRC research, which emphasized the important role of cognitive activity in the learner’s development of new knowledge.

**Summary.**

Ausubel’s theory provides theoretical support for the core learning science principles developed by the NRC (Bransford et al., 2000), which were based on a synthesis of 30 years of learning science research. The research findings, in turn, lend credibility to Ausubel’s theory. It is for this reason Ausubel’s theory of meaningful learning was selected as the theoretical framework for this study. The theory integrates the three core learning science principles, and provides a foundation for understanding the relationship between curriculum, pedagogy, and meaningful learning.

**Strategies to Facilitate Meaningful Learning**

The NRC research (Bransford et al., 2000) was summarized into four major findings. The NRC findings can be translated into the following principles that are in direct alignment with the
principles of Ausubel’s theory of meaningful learning: (1) a learner’s underlying knowledge is critical to her or his understanding of new information, (2) a learner’s preconceptions can either enhance or impede future learning, (3) learning is enhanced when learners are provided opportunities to reflect on their own learning, and, (4) in order to apply knowledge, learners must develop a strong base of factual knowledge that is linked conceptually to form ideas, and those facts and ideas must be organized in a manner that expedites their retrieval (Bransford et al., 2000).

The theme that arose most frequently in the NRC’s research synthesis was the importance of a learner’s background and previous experience in their ability to construct future knowledge. Educational environments in which this principle is applied are referred to as learner-centered (Bransford et al., 2000; Quintana, Shin, Norris, & Soloway, 2006). Both scaffolded learning and concept-based teaching make use of this principle to enhance student outcomes.

**Scaffolding learning.**

One hallmark of learner-centered pedagogies is that they facilitate meaningful learning by providing scaffolding to help learners create knowledge connections (Bransford et al., 2000; Linn, 2000; Huber, 2006; Huber & Hutchings, 2004; Humphreys, 2005; National Survey of Student Engagement, 2009). Scaffolding is a term that became popularized when educators began applying Vygotsky’s theory of the Zone of Proximal Development (Quintana et al., 2006). Vygotsky’s theory proposed that learning is enhanced when a more experienced person, such as a mentor, tutor, or educator; actively interacts with the learner to provide assistance tailored to meet the learner’s needs (Vygotsky, 2002).

The concept of a learning coach or mentor who provides scaffolding in a formal learning environment is similar to that of “mediators” who help facilitate informal learning (Sherwood,
Kinzer, Hasselbring, & Bransford, 1987, p. 95). Mediators provide support to the learner by structuring the environment in ways that facilitate learning:

For example, mediators arrange the environment so that children will encounter certain experiences (e.g., toys, books); they help separate relevant from irrelevant information (‘you can eat on this plate even though it is blue rather than red’); they prompt children to anticipate events (e.g., ‘After we get up from our we nap we will do what?’) and they help children connect various parts of their experiences (‘This story mentions a duck. Didn’t we see a duck yesterday in the park?’). (Sherwood et al., 1987, p. 95).

Mediators are most effective when they have an understanding of the child’s previous learning experiences, and structure new experiences to build on the old (Sherwood et al., 1987). Meaningfulness of the learning is facilitated because the mediators provide information about how the new information is related to previous knowledge, and how the new information can be used.

Learning cues are another means to mediate learning. Cues activate prior knowledge that is related to the current information or situation (Bransford & Johnson, 1972), and are similar in theory to advance organizers, a previously mentioned learning tool developed by Ausubel (1968). Cues and advance organizers are analogous in that both serve the purpose of priming subjects for increased comprehension by providing context for new information.

**Concept-based teaching.**

Concept-based teaching is one means of mediating and promoting meaningful learning (Erickson, 2007). In concept-based teaching, foundational and discipline-specific concepts at a high level of abstraction are provided during initial learning experiences (Erickson, 2007). These highly generalizable concepts, described by Ausubel as superordinate concepts (1965), provide
context for future learning and, therefore, increase learners’ ability for comprehension of the information that follows.

Presentation of exemplars is an integral component of concept-based teaching (Erikson, 2007). Exemplars provide various examples of a specific concept and assist the learner in discriminating information through identification of gradations. The idea that exemplars enhance discrimination corresponds to Dewey’s (1910) description of cases that help to define one another, and to the process Ausubel (1968) described as progressive differentiation.

Concept-based knowledge construction occurs naturally during informal learning, as is evident in the acquisition of language by young children (Ausubel, 1968). It is the exposure to various exemplars, and often the presence of mediators, that allow the child to develop a conceptual understanding of the world and how to use language appropriately.

For example, a child might learn to understand the concept of *dog* through repeated exposures to four-legged animals with fur. Concept formation is enhanced through mediator-provided cues, such as, “See the doggie? We saw a big dog like that yesterday, didn’t we?”, and, “No; that’s not a dog; that’s a cat. Dogs say bow-wow.”

It is recommended that principles gained from observations of informal learning processes and outcomes be applied to facilitate the formal learning that occurs in the classroom (Sherwood et al., 1987). This includes providing mediation and multiple exemplars, as well as providing explicit instruction regarding new information is connected to that previously learned.

In informal learning, for example, children are explicitly taught how to use physical tools, such as utensils. This strategy enhances a child’s skill acquisition. Sherwood et al. (1987) propose that explicit instruction regarding the usefulness of cognitive tools, such as concepts and principles, is equally important to meaningful learning and promotes creation of new knowledge.
Contemporary View of Meaningful Learning as Knowledge Integration

Many contemporary educators and educational psychologists refer to the creation of knowledge connections as *knowledge integration* (Linn, 2006, p. 243). The concept of knowledge integration is a contemporary variation on Ausubel’s principles of meaningful learning and his conception of knowledge as having an organized cognitive structure. A comparison of the concept of knowledge integration to the specific principles developed by Ausubel follows to help illustrate the similarities.

Knowledge integration is a dynamic structuring process and consists of organizing information by the processes of linking and distinguishing (Linn, 2000). These processes are similar to Ausubel’s principles of progressive differentiation and subsumption/assimilation.

Knowledge integration occurs when a learner connects new ideas and concepts to knowledge already known (Linn, Clark, & Slotta, 2003). This process allows the learner to assume a more holistic view of the world (Arcario, Eynon, & Clark, 2005; Milligan & Wood, 2010), in the sense of recognizing how ideas and entities are related to, and might interact with, one another (Gale, 2007). Organized knowledge integration, which Ausubel perceived as being hierarchically arranged, is also crucial to knowledge recall and an individual’s ability for knowledge application (Linn, 2006; Linn et al., 2006).

**Knowledge integration and decision-making.**

Knowledge integration is evidenced when learners can identify patterns and disregard irrelevant data (Linn et al., 2003). Learners develop principles as they determine how information pieces are related or unrelated. It is these principles that allow learners to understand or comprehend, and to make predictions about outcomes (Anderson, 1984).
Pattern recognition is particularly important during problem solving and decision-making, and is a characteristic that differentiates experts from novices, including those in nursing practice (Benner, 2001). The ability to identify patterns, or recognize relationships between incoming information and pre-existing knowledge, can be equated to Ausubel’s principle of integrative reconciliation.

The learner’s ability to integrate knowledge in an appropriate manner is essential for meaningful learning to occur. A learner’s capacity for knowledge integration and skill in knowledge application is related to the ability to store, retrieve, and manipulate knowledge (Rolls, 2009). Ability for knowledge storage, retrieval, and manipulation are, in turn, directly related to the learner’s use of memory. A discussion of memory follows, to help illustrate the critical role it assumes in knowledge creation and application.

**The Role of Memory in Learning**

The advent of the internet has greatly affected knowledge development, due to the fact that information can now be shared immediately across the globe. Sharing of information has generated such an abundance of new knowledge over the past several decades, that the phenomenon has been described as a knowledge explosion (Castledine, 2007). The rapid generation of knowledge has been particularly prevalent in the fields of the biological and social sciences (Castledine, 2007), where the exponential growth of information affects not only nurses and nurse educators but also nursing students, as both attempt to retain an overwhelming quantity of facts and ideas (Diekelmann, 2002). Although the amount of information available to be learned has increased greatly, the capacity of the human memory to process new information has not (Thompson & Madigan, 2007).
Short-term memory and learning.

Human memory is not a single entity but, instead, consists of several different types, depending somewhat on the source of the memory and how it is processed (Baddeley, 1997; Dehn, 2008; Medina, 2008). The most commonly described types of memory are short-term, long-term, and working memory (Rolls, 2009; Thompson & Madigan, 2005; Zull, 2002).

Much of what is known about short-term memory originated with the work of George Miller (1956). Miller synthesized the findings of several studies investigating participants’ ability to identify various sensory stimuli based on the stimuli’s defining characteristics (e.g., Beebe-Center, Rogers, & O’Connell, 1955; Garner, 1953; Pollack, 1952).

Short-term memory: Seminal research.

In one study reviewed by Miller, participants were asked to identify auditory stimuli based only on differences in pitch (Pollack, 1952). In a separate study, participants’ ability to identify auditory stimuli based on the characteristic of volume was investigated (Garner, 1953). In both studies, participants were asked to indicate when a sound stimulus was repeated. Overall, participants were able to accurately identify between five and nine stimuli based on their memory of the one distinguishing characteristic of pitch or volume.

Miller theorized it was necessary for each participant to consider the stimuli simultaneously in order to make a comparison. Furthermore, it was essential that the items be available in the participant’s short-term memory in order for the comparison process to occur. Miller synthesized the Pollack (1952) and Garner (1953) findings and concluded that the greatest number of single attribute items (i.e., differing only in pitch or volume) that can be retained in short-term memory is nine (Miller, 1956). However, this limitation was not the case when participants were asked to identify multidimensional stimuli, or those with more than one
defining characteristic (e.g., Eriksen & Hake, 1955; Klemmer & Frick, 1953; Pollack, 1953). Participants in these studies were found to accurately identify, or remember and discriminate among, a greater number of stimuli. These stimuli included a greater number of attributes than the stimuli in the previously described studies. The stimuli in the second Pollack study (1953), for example, included the attributes of both pitch and volume.

Miller used the term *channel capacity* to refer to the finite number of unidimensional items that can be retained simultaneously in short-term memory (Miller, 1956, p. 348). Short-term memory has a channel capacity of approximately seven, plus or minus two, and a span of approximately 30 seconds. In other words, short-term memory allows humans to retain approximately five to nine *bits* or pieces of independent information simultaneously for approximately 30 seconds (Miller, 1956, p. 344).

The 30 second time restriction, in conjunction with limits on the number of pieces of information that can be maintained in short term memory at any one time, negatively impacts learning. This is due to the fact that only seven bits of disconnected information, plus or minus two, can be considered during a 30 second period. As the learner attempts to collect more and more disconnected facts, the capacity to store, recall, and manipulate information in short-term memory eventually is exceeded (Willis, 2007). As a result, the learner is unable to consider all the pieces simultaneously and, therefore, cannot combine them into a meaningful whole.

Miller’s conclusions can be applied to understand factors that influence learning. When arbitrarily connected information is recalled, such as that associated with the rote learning process described by Ausubel (1968), it must be viewed as an independent entity. These disassociated facts are similar to the unidimensional stimuli described by Miller’s work (1956).
The multidimensional stimuli with several distinguishing attributes can be thought analogous to the nuanced concepts that are created during meaningful learning.

**Rote memorization and learning.**

Information can be moved from short-term to long-term memory through consolidation (Alvarez & Squire, 1994). Consolidation of information occurs when a learner connects newly acquired information to the pre-existing organization of knowledge in the learner’s brain (Alvarez & Squire, 1994). This process, which produces memories that are more stable and permanent, is, on the surface, theoretically similar to Ausubel’s (1963, 1968) principle of subsumption/assimilation.

When consolidation occurs in an arbitrary manner, however, efficiency of retrieval suffers. This is because arbitrary connections produce unidimensional entities rather than the multidimensional entities nuanced by connections to related knowledge (Alvarez & Squire, 1994).

When one considers what is known about human memory and what is known about learning, it becomes apparent why rote memorization negatively impacts meaningful learning. Learners who use rote memorization often fail to recognize connections between discrete pieces of information, and can process and manipulate only limited amounts of information simultaneously. Failure to create knowledge connections is particularly detrimental in nursing, where the ability to synchronously consider multiple pieces of information is needed for sound clinical decision-making.

Learning by rote memorization, rather than learning through formation of meaningful knowledge connections, can have a direct impact on nursing students’ learning. The sheer volume of information provided to nursing students (Diekelmann, 2002), in conjunction with the
limitations of short-term memory and learners’ reliance on rote memorization as a learning strategy, can inhibit information processing as students unsuccessfully attempt to store a tremendous quantity of unrelated information in an organized fashion (Ironside, 2005). Eventually, the limits of memorization are reached (Ironside, 2005), and thinking processes are jeopardized (Ironside, 2004).

Most students may be able to recall classroom information in order to perform successfully on academic exams. Many, however, are incapable of retaining the overwhelming number of disconnected facts when they become independently responsible for making decisions that impact patients’ health and lives post-graduation. This is because students who learn primarily through rote memorization do not acquire enough depth of knowledge to gain a deep understanding, and so are unable to effectively apply information (Graff, 2003). The ultimate outcome of this situation is a novice nurse who possesses a great number of disconnected facts that, unfortunately, cannot be recalled quickly enough or integrated well enough to practice the sound decision-making needed to provide safe and effective patient care.

In contrast, the novice nurse with a well-integrated knowledge structure is able to think more abstractly or conceptually (Benner, 2001; Benner et al., 2010), which augments decision-making. Conceptual thinking, moreover, exerts less strain on working memory (Dehn, 2008; Rauk, 2003; Zull, 2002). Evidence exists of physical changes that occur in the brain in correspondence to conceptual knowledge, decision-making, and memory. A description of evidence from selected research follows.
Memory & Constructivist-Based Learning: Neuroscience Evidence.

Recent research in the field of neurobiology has helped uncover physical evidence in support of both Miller’s and Ausubel’s work. A synopsis of select research relevant to this study follows.

**Brain structure and finite short-term memory.**

Migliore, Novara, and Tegolo (2008) conducted research based on the morphology of hippocampal neurons that, although acquired from rats, are similar in morphology to the hippocampal neurons of primates. Hippocampal neurons are located in the pyramid of the hippocampus, and consist of a trunk with dendrites, or branches. Migliore, Novara, and Tegolo’s 2008 findings, based on extensively tested and robust simulation models, suggest there are a preferred number of dendritic branches involved when associations are made between external stimuli and information stored in the brain.

Migliore, Novara, and Tegolo’s work (2008) focused on visual stimuli and human recognition of those stimuli. The resulting model suggested that dendritic branches become activated as a result of visual stimuli. The dendrites are involved in the brain’s associative processes responsible for the visual recognition of persons, places, and objects. The researchers concluded that the anatomical structure of certain dendrites in the hippocampus might help explain the finite number of items (i.e., seven plus or minus two) that humans can store in short-term memory.

**Brain activity during learning.**

In addition to research related to memory, recent neurobiological studies have focused on brain responses during learning and decision-making (e.g., Kumaran, Summerfield, Hassabis, & Maguire, 2009). This research indicates that learning produces structural changes in the brain.
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

itself (Kumaran et al., 2009; Zull, 2002). These changes include modifications of neuronal connections, and interactions between the sensory and motor areas of the cerebral cortex during the learning process (Zull, 2002).

Brain imaging techniques used during neurobiological research show that activity in the brain varies during a learning experience. The sensory area of the learner’s brain is more active when information is being received, such as occurs during reading or exposure to expository-style teaching (Zull, 2002). The motor area of the brain, in contrast, becomes more active when the student is physically active or has the perception of movement, such as occurs when learning progress is achieved (Zull, 2002). This type of brain activity occurs during learning activities that engage the student physically or when action is anticipated, such as that which occurs during planning or decision-making processes.

Neuronal connections are created and expanded upon during every learning experience (Zull, 2002). Neuronal connections are physical manifestations of previous learning, and provide a pathway for information transmission during problem solving or when learners attempt to create meaning from new information (Kumaran et al., 2009; Zull, 2002). The interaction between the brain’s sensory and motor areas provides evidence to support principles posited by constructivist theorists. These findings highlight the importance of student engagement to the learning process.

**Brain structural changes during conceptual learning.**

Brain imaging techniques have been used to investigate the role conceptual knowledge plays in decision-making. The findings from a study by Kumaran et al. (2009) indicate that strong neural connections, created during conceptual thinking, are activated during decision-making, and are particularly active when decision-making occurs in a novel situation. These
findings provide evidence for the existence of a physical network of related information in the human brain, similar to the cognitive structure envisioned by Ausubel, as well as for Ausubel’s premise that conceptually related knowledge is necessary for higher order thinking, such as occurs during problem solving and decision-making (Ausubel et al., 1978).

**Summary.**

The evidence from neurobiology supports the constructivist approach to learning and, specifically, Ausubel’s theory of meaningful learning. Neurobiological research demonstrates that memory recall and learning produce actual structural changes in the brain, manifested as neuronal connections (e.g., Kumaran et al., 2009; Migliore et al., 2008). Early educational theorists who proposed a constructivist approach to learning, such as Ausubel, had intuitive knowledge of this process, which is now supported by empirical evidence.

**Meaningful Learning and Higher Order Thinking**

Educators’ development of teaching plans and assessment of student learning are most frequently evaluated against objectives or outcomes based on Bloom’s Taxonomy (L.W. Anderson et al., 2001). The original Bloom’s Taxonomy was based on three learning domains: cognitive, affective, and manipulative; which educators use as a framework to develop learning objectives (Bloom, 1956).

Objectives developed for the cognitive domain focus on students’ “recall or recognition of knowledge” (Bloom, 1956, p. 7). Objectives developed for the affective domain are based on learning outcomes related to changes in attitudes or values, and objectives in the area of manipulative learning focus on students’ development of psychomotor skills. The domain of interest for this study was cognition. The cognitive domain and its relationship to knowledge are therefore the focus of the subsequent discussion.
The cognitive domain in the original Bloom’s Taxonomy.

The original version of the Taxonomy delineated knowledge as just one of the categories in the cognitive domain, with knowledge being defined as the learner’s ability to recognize or recall information that was taught (Krathwohl, 2002). Objectives for the cognitive domain specify the content to be learned, expressed as a noun, and how the learner will use the content, expressed as a verb (Krathwohl, 2002).

An example of an objective in the cognitive domain for a nursing foundations course might be, “The learner will be able to describe the steps of the Nursing Process”. The content attached to this objective, the noun, would be the Nursing Process steps, and the verb, or expected action following the learning experience, would be the learner’s ability to describe the steps.

The original Taxonomy continues to be widely used and, as a result, many educators judge learners’ knowledge based on lower order thinking, described as the learner’s ability to remember (Anderson et al., 2001). Remembering learned information is described as the ability to recognize the information when it is encountered again or to recall it from long-term memory. These lower order thinking processes (Bloom, 1956, p. 120) are associated with rote memorization (L. W. Anderson et al., 2001).

Recognizing or recalling information serves a purpose in many situations, such as when medical terminology or formulas for mathematical calculations are memorized. The ability to identify or recall information is likewise essential to meaningful learning and higher order thinking, but as “a means to an end, rather than the end itself” (Mayer, 2002, p. 228). The learner’s ability to recognize and recall information, however, does not guarantee the information can be used in a manner other than that in which it was delivered (L. W. Anderson et al., 2001).
The revised two-dimensional Taxonomy.

More recently, the Bloom’s Taxonomy has been revised, dividing knowledge and cognitive process into two separate dimensions (L. W. Anderson et al., 2001). The resulting two-dimensional table provides a framework from which teaching strategies to promote higher order thinking can be developed and learning outcomes appropriately evaluated (Airasian & Miranda, 2002; L. W. Anderson et al., 2001).

The revised Taxonomy includes remember, which is designated as a cognitive process category and is related to knowledge retention (L. W. Anderson et al., 2001). The remaining five cognitive process categories in the Taxonomy relate to knowledge transfer, which is the manifestation of meaningful learning (Anderson et al., 2001). These categories include understand, apply, analyze, evaluate, and create (L. W. Anderson et al., 2001, p. 31).

Higher order thinking in the revised Taxonomy.

Meaningful learning is described as a learner’s deep understanding of knowledge (Ausubel, 1963; Mayer, 2002). According to the Revised Taxonomy, understand is defined as the ability to “construct meaning from instructional messages” (L. W. Anderson et al., 2001, p. 31). When Ausubel’s conception of meaningful learning and the Revised Taxonomy definition of understand are synthesized, it becomes apparent that assessment methods measuring learners’ understanding provide an indication that meaningful learning has transpired.

The cognitive processes associated with the cognitive category understand include: (1) exemplifying, such as when a learner is able to find an example of a general concept or principle, (2) classifying, which occurs when learners categorize or subsume information, (3) summarizing, which includes the processes of abstracting or generalizing, (4) inferring, which is associated with the development of logical conclusions, (5) comparing, in which the learner identifies
similarities and differences between facts and ideas, (6) *applying*, such as when information is used to solve a familiar problem, and, (7) *implementing*, which occurs when information is used to solve an unfamiliar problem (L. W. Anderson et al., 2001).

**Higher order thinking and knowledge transfer.**

Evidence of higher order thinking, such as that present when a learner demonstrates understanding, indicates that knowledge transfer has occurred (L. W. Anderson et al., 2001). Knowledge transfer is defined as the learner’s ability to use knowledge in order to problem-solve, initiate and respond to inquiry, and build future knowledge (Mayer & Wittrock, 1996). These processes are possible when meaningful learning has occurred (L. W. Anderson et al., 2001; Ausubel, 2000). This is because knowledge transfer is facilitated by the learner’s development of conceptual knowledge (Kumaran et al., 2009), which is the cornerstone of meaningful learning.

Most learners do not readily transfer or apply information from one context to another, such as from a biology to a nursing theory classroom or from a nursing theory classroom to the clinical setting (Bransford et al., 2000). Therefore, educators must make explicit relevant theoretical connections before learners can apply the theoretical information to problem solving. A study by Gick and Holyoak (1980) pointed out the important role that explication of relevant information plays in college students’ ability to transfer information from one context to another.

Gick and Holyoak (1980, 1983) conducted a series of experiments to test learners’ knowledge transfer when solving analogous problems. All participant groups received a primary problem to be solved as well as analogous problems. Each group, however, received varying amounts of additional instruction.
The additional instruction concerned how the information from one problem might be used to solve a similar problem from a completely different domain. The problem to be solved was how a physician might best use radiation to treat a malignant tumor while protecting surrounding tissue. The analogies accompanying this problem were stories related to military strategy or fire-fighting.

One group of learners received explicit instruction regarding the information from the analogy that was relevant to the problem solution. The majority of students (90%) in this group were able to successfully solve the analogous problem (Gick & Holyoak, 1980, 1983). Another group was required to independently determine relevant information from the accompanying analogies. A minority of students in this group (20%) was able to develop a problem solution (Gick & Holyoak, 1980, 1983).

The researchers concluded that explication of salient points facilitated learners’ ability for knowledge transfer to the analogous situation. Furthermore, the ability to transfer principles derived from one problem situation to another “disparate” (Gick and Holyoak, 1983, p. 8) but analogous situation is the hallmark of a deep understanding of underlying principles.

In a later study, Gick and Holyoak (1983) found transfer of knowledge to be significantly higher when learners were presented with multiple analogs. Learners were presented with a radiation problem and with either one or two military strategy or fire-fighting analogies. The greater the number of analogs presented, the greater the learners’ ability to consider information at a greater level of abstraction. As ability for abstract thinking increased, learners demonstrated greater facility in transferring principles between similar situations.

Gick and Holyoak’s (1980, 1983) research provides support for Ausubel’s theory of meaningful learning. Ausubel’s theory proposes that ability for higher order thinking is promoted
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

when learners are provided with explicit information about how information is connected and related to prior knowledge (Ausubel, 1963, 1968; Ausubel et al., 1978).

Summary.

As summarized in the preceding sections, evidence from the natural sciences supports Ausubel’s theory that a knowledge building approach to teaching prepares learners to become capable of knowledge transfer. In addition, more than thirty years of learning science research confirms the effectiveness of constructivist principles. Many educators, however, continue to teach as they were taught, utilizing traditional teaching and learning strategies (Scardamalia & Bereiter, 2006). These traditional strategies are referred to as an instructionist approach to teaching and learning (Papert & Heral, 1991).

The Instructional Learning Paradigm

The instructional paradigm is the framework on which traditional teaching and learning are based (Buckley, 2002). Educators operating from this paradigm define learning as the student’s ability to reproduce the teacher’s knowledge or recall facts transmitted from teacher to student (Marton & Säljö, 1997). Prior to the 1970s, the instructional paradigm was the predominant philosophy from which classroom education proceeded, and the associated teaching approaches were referred to as instructionism (Papert & Heral, 1991).

Underlying assumptions and principles.

Instructionism is based on two assumptions: (1) the purpose of formal education is to provide facts and procedures that students will memorize, and, (2) teachers are responsible for student learning (Sawyer, 2006). Instructionists view learning as a one-way relationship: teachers actively provide information, and students passively absorb it. This mechanism for imparting
knowledge has, understandably, been referred to as the transmission method of learning (Sawyer, 2006).

The success of an instructionist-based education can be measured by testing how many facts and procedures learners are able to recall after being taught (Bransford et al., 2000; Sawyer, 2006). This method of educating students was an effective means of preparing people for the world of work during the industrial revolution. Contemporary research, however, indicates this method is no longer effective for our knowledge-rich world in which the ability to navigate through and manipulate knowledge is essential (Sawyer, 2006).

The transmission method, in its most primitive form, can best be described as faculty deliverance of pieces of information, and students’ reception and recording of that information in the same form in which it was delivered (Sawyer, 2006). Students taught with this method do not translate or interpret the information delivered by the teacher. As a result, the students do not ascribe meaning to the new information or connect it to what is already known (Novak, 2010).

Outcomes of instructionism.

Instructionist teaching strategies do not encourage cognitive engagement in students. As a result of passive learning, learners do not acquire enough depth of understanding to transfer knowledge easily from the classroom to the problems encountered in their personal or work lives, and the information is not well retained (Erickson, 2007; Fink, 2003).

The negative outcomes of passive learning are further exacerbated by the manner in which curricular content is organized and delivered. Content in an instructionist environment is organized by topic, with each topic being delivered as a separate entity (Fink, 2003). This manner of organization, in conjunction with the transmission mode of delivery, produces disconnected facts in students’ minds that they attempt to store in memory through the process of
rote memorization (Erickson, 2007). Rote memorization does not produce conceptual connections to underlying knowledge. The lack of connections inhibits the student’s ability to consider multiple pieces of information simultaneously or understand new, related information (Erickson, 2007; Fink, 2003).

Meaningful learning in an instructionist environment.

Change in the learner provides a measure of both the long and short-term success of a learning experience (Bransford et al., 2000). The immediate change that indicates learning has occurred, from an instructional viewpoint, is that of student performance (Fincher, 1998). This belief is based on behaviorist principles, with student performance being viewed as a response to the stimulus of teaching.

More recent research from the learning sciences suggests that, although traditional teaching strategies based on behaviorist principles may produce a change in learner behavior or performance, they do not always produce change in the learner’s understanding and underlying knowledge. Teaching based on behaviorist principles is, therefore, not conducive to meaningful learning (Bransford et al., 2000). These types of teaching and learning strategies hinder students’ meaningful learning and impede their development of higher order thinking. The long-term result is the student’s inability to transfer knowledge from the classroom to practice (Krathwohl, 2002).

Decades of research provide evidence supporting the need for a change in educational practice, in order to facilitate meaningful learning (Bransford et al., 2000; Sawyer, 2006). Meaningful learning promotes the learner’s capacity for future knowledge building and ability to transfer knowledge from the classroom to life situations, including those encountered in professional practice (Erickson, 2007; Novak, 2010). Knowledge building and transfer are
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

essential to competent nursing practice and are, therefore, essential skills to cultivate in nursing students.

**Barriers to Implementation of Meaningful Learning Strategies in Nursing Education**

Teaching centered, traditional nursing curricula and pedagogies, such as delivery of discrete, topic-based content, are not the most effective method for facilitating a deep understanding of nursing knowledge and higher order thinking (Benner et al., 2010; Diekelman, 2002; Tanner, 2008a, 2008b). This is because traditional approaches used in nursing education focus on the delivery of prescribed content over a pre-ordained period of time, with little consideration for how learners assimilate or come to understand the material, or how the material is related to concurrently or previously delivered information or to learners’ underlying knowledge (Diekelman, 2002).

Despite evidence indicating that traditional pedagogies are not the best means of producing meaningful learning, many nurse educators continue to implement instructionist-based teaching strategies. A description of factors that might influence this practice follows.

**Foundation of contemporary nursing education practices.**

Most nursing education programs are based on the Tyler model of education, in which the curriculum is content-laden and teacher-driven, rather than focusing on how learning might best be supported (Dillard & Siktberg, 2009; National League for Nursing, 2004, 2005, 2007; Sauter, Johnson, & Gillespie, 2009). The Tyler model, developed in the 1940’s, was a valuable contribution toward much needed curricular reform at the time, but is not in accordance with contemporary, evidence-based educational principles (National League for Nursing, 2007).

State Boards of Nursing used the Tyler model as a framework to evaluate nursing education programs and grant approval and accreditation (Bevis & Watson, 1989). This resulted
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

in the creation of a legislated list of specific content that nursing education programs are required to address. Many faculty, as a result, tend to focus on the content of education rather than the process.

The objectives-driven approach of the Tyler model is based on summative evaluation of students’ achievement of course objectives, rather than on ongoing assessment of students’ meaningful learning (National League for Nursing, 2007). The model places a primary emphasis on goals the educator is to accomplish, such as content that must be delivered within a specified timeframe. There is much less focus on determining whether or not teaching effectively helps learners create usable knowledge.

**Faulty implementation of newer pedagogies in nursing.**

Many nurse educators strive to encourage learners’ knowledge building by implementing more contemporary, evidence-based educational practices into traditional nursing education programs (Greer, Pokorny, Clay, Brown, & Steele, 2010; Kaakinen & Arwood, 2009). Unfortunately, consideration is not always given to the important role that student cognition plays in the learning process when these newer pedagogies are implemented (Kaakinen & Arwood, 2009). Moreover, the modalities are not always presented in a manner that builds on learners’ pre-existing knowledge or facilitates complex cognitive processes or higher order thinking (Greer et al., 2010).

Research on nurse educator practices indicates that although some educators are utilizing newer teaching strategies, the majority focus on the teaching method itself, rather than on assessment of student learning outcomes (Brown et al., 2009; Schaefer & Zygmont, 2003), and on curricular content, rather than the processes of student cognition and learning (McEwen & Brown, 2002). These findings emphasize the need for both educator support in using innovative
pedagogies (Forbes & Hickey, 2009; Newton et al., 2009), and nursing education research grounded by the cognitive and learning sciences.

A lack of attention to learners’ pre-existing knowledge and the cognitive processes involved in knowledge building has been noted not only in educators’ practices, as indicated above, but also in the phenomenon selected by education researchers as topics for study. This is apparent in the findings from a study conducted by The National Council of State Boards of Nursing’s (NCSBN) Director of Education (Spector, 2006).

**Lack of nursing-specific cognitive research.**

The NCSBN research (Spector, 2006) was based on a systematic review of nursing education studies related to learning outcomes. Most of the studies included in the review focused on learners’ attitudes, perceptions, and feelings (e.g., Babenko-Mould, Andrusyszyn, & Goldenberg, 2004; Buckley, 2003), rather than on the cognitive processes learners use to build nursing knowledge.

A more recent national study, conducted by The Carnegie Foundation for the Advancement of Teaching (Benner et al., 2010), supports the findings of the NCSBN (Spector, 2006). Specifically, the Carnegie study indicates that educators often do not explicate relationships between students’ pre-existing, theoretical knowledge gained through classroom experience and its application to patient care. Nor are the relationships between basic scientific principles learned in pre-requisite science courses, patient condition, and nursing interventions made clear. Insufficient attention to knowledge connections is not unique to nursing education, but is prevalent throughout higher education - individual courses are often presented as discrete entities, and learners are expected to discover the interrelationships between various courses’ content independently (Hutchings, 2007).
The educator’s failure to illustrate connections, or to guide the learner in this process, limits the opportunities for learners’ meaningful learning (Ausubel, 1968). Also compromised are the learner’s ability for future knowledge integration (Ausubel, 1968; Linn, 2006) and transfer of knowledge from the classroom to the work setting (Ausubel, 1968; Erickson, 2007; Novak, 2010).

Knowledge transfer is essential to the processes of problem solving and decision-making in nursing (Benner et al., 2009; Benner et al., 2010). In order to make a substantial difference in nursing students’ meaningful learning and, in turn, increase capacity for knowledge transfer to the practice setting, it is essential that nurse educators develop effective teaching approaches. These approaches must be based on what is known about the cognitive processes learners use to create meaning from their learning experience (Jayasekara, Schultz, & McCutcheon, 2006; Candela et al., 2006).

Nurse educators must apply principles gleaned from the field of cognitive science in order to support students’ knowledge integration. This requires determination not only of what should be taught, but also how teaching should be implemented and its effectiveness evaluated. Emphasis should be placed on evidence-based strategies that facilitate meaningful learning and help nursing students create usable knowledge that can be applied toward provision of safe and effective patient care (Vandeveer, 2009).

According to the National League for Nursing (NLN), approximately 78% of nursing faculty surveyed reported using evidence to support decisions related to teaching and learning (Ironside & Speziale, 2006). The NLN maintains that 78% is inadequate, and states that further work must be done to reflect best practices in nursing education. The question arises regarding whether or not the reported 78% is an accurate measurement; according to Candela, Dalley, and
Benzel-Lindley (2006), nursing faculty have not, in fact, changed pedagogical practices. Instead, faculty members continue to implement teaching-focused, instructionist-styled curricula by rearranging or re-packaging content (Bevis & Watson, 1989; NLN, 2004).

Nurse educators must be encouraged to implement newer pedagogies that facilitate meaningful learning. This is necessary to improve student learning outcomes including the ability to transfer classroom knowledge to the patient bedside. In order for this to occur, educators must first be made aware of the value of pedagogies that promote meaningful learning, and how they might be implemented.

**The Value of Pedagogies Promoting Meaningful Learning**

Curriculum and content delivery in nursing education has, traditionally, been not only content-laden (Diekelman, 2002), but also linear and topic directed (Ebright et al., 2006). A content-laden curriculum, unfortunately, does not allow students the cognitive processing time needed to integrate new information. Time constraints in conjunction with the linear approach prevent learners from recognizing how new information relates to their pre-existing ideas (Giddens et al., 2008).

The amount of classroom time available for processing new information is expected to dwindle even more due to the rapidly proliferating quantity of new knowledge being produced, instant electronic accessibility to that knowledge, and faculty desire to present all prescribed content as well as related newer information (Facione, Sanchez, Facione, & Gainen, 1995). Therefore, it is imperative that nursing educators identify and address information that is the most essential to safe and effective nursing practice (Benner et al., 2010; Finkelman & Kenner, 2009).
Nurse educators’ presentation of only the most essential nursing knowledge will allow adequate time for student processing of information. Student learning will be enhanced even further if teaching of essential content is implemented in a manner that allows learners to integrate new information, and achieve a deep understanding of basic knowledge they can apply in practice (Bevis & Watson, 1989).

The characteristics of the healthcare environment itself demand that nurses achieve knowledge integration of adequate depth to promote knowledge transfer. These characteristics include the unpredictable nature of patient responses and outcomes, as well as the constantly changing healthcare system (NLN, 2004).

**Support for development of meaningful learning strategies.**

Both national nursing organizations and national educational organizations recognize the importance of teaching approaches that promote knowledge integration. The Carnegie Foundation for the Advancement of Teaching provides several key exhibit essays to support the essential need for integration through curriculum, pedagogy, assessment, and faculty development (e.g., Gale, 2007; Huber, 2006; Hutchings, 2007; Miller, 2007).

The need to support pedagogies that enhance knowledge integration in higher education is so critical to successful learning that the Association of American Colleges and Universities developed a campaign entitled *Liberal Education and America’s Promise: Excellence for Everyone as a Nation Goes to College*. The campaign emphasized the need to develop students’ knowledge integration, and described it being the hallmark of a high quality undergraduate education and essential for workplace success (Humphreys, 2005):
“. . . in most arenas outside the academy – from the workplace to scientific discovery to medicine to world and national affairs - multilayered, unscripted problems routinely require an integrative approach” (Humphreys, p. 30).

Leaders in the business world have likewise requested that institutions of higher education invest in development and implementation of pedagogies that promote knowledge integration. This request was made in the early 1990’s in the U.S. Department of Labor SCANS (Secretary’s Commission on Achieving Necessary Skills, 1991) Report.

Education leaders support the call for a change in teaching and learning, referring to a paradigm shift that must occur in order to improve student learning outcomes. These leaders state it is imperative for educators and educational administrators to change from an instructionist to a constructivist approach to education.

The new paradigm has been described as a transition from a teaching-centered to a learner-centered approach to education (Buckley, 2002; Gardiner, 1994; Harris & Cullen, 2010; Sawyer, 2006). This approach stems from a constructivist epistemology, and is based on the premise that learners construct their own knowledge rather than receive it intact and unchanged from others (Brandon & All, 2010; diSessa, 2006).

The time for innovation is now, as a “perfect storm” (Harris & Cullen, p. 13) of conditions currently exists, creating an ideal opportunity for a paradigm shift in higher education. These conditions include the extensive volume of knowledge being generated at a rapid pace, research supporting application of new pedagogies, changes in perception related to accountability and public expectations of higher learning institutions, demographic changes such as greater numbers of non-traditional students and changes in work patterns of both students and faculty, industry and market changes related to higher expectations of employers of new
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

graduates, and emerging needs of students who strive to be lifelong learners (Harris & Cullen, 2010).

The Higher Learning Commission (HLC), which is the Midwest’s regional agency that accredits the highest number of higher education institutions (Harris & Cullen, 2010), supports the need for change. According to the HLC, transformation must occur not only in what students are being taught, but also in how faculty share information with learners and assess student outcomes (HLC, 2003). Decisions must be evidence-based, and consider factors known to enhance or impede learning (Sawyer, 2006).

**Concept-Based Teaching to Promote Meaningful Learning**

Concept-based teaching is one evidence-based approach to teaching and learning found to facilitate meaningful learning. This is accomplished through strategies that support learners’ knowledge integration. Although concept-based teaching is not yet widely practiced in nursing education, it is a pedagogy used successfully in other disciplines such as teacher preparation and science education. A summary of research describing the outcomes of concept-based teaching follows.

**Concept-based teaching: Outcomes.**

Concept-based teaching has been found to significantly improve student’s meaningful learning in disciplines such as medicine (e.g., González, Palencia, Umaña, Galindo, & Villafrade, 2008) and teacher education (e.g., Gliessman, Pugh, & Bielat, 1979). Research indicates it improves college students’ understanding of science (e.g., Halme, Khodor, Mitchell, & Walker, 2006; Morse & Jutras, 2008; Teichert & Stacy, 2002) and junior high students’ understanding of mathematics (Espindola, 2010). The success of concept-based teaching in other
science-based disciplines suggests that, perhaps, concept-based teaching might be an effective means of improving meaningful learning in nursing students as well.

A review of the published nursing literature from the past decade revealed several articles on the subject of concept-based teaching (Berbiglia & Saenz, 2002; Daley, 1996; Giddens, 2009, 2010; Giddens & Brady, 2007; Giddens et al., 2008; Kantor, 2010; Katz et al., 2008; Kelly & Colby, 2003; Lasater & Nielsen, 2009; Nielsen, 2009). The vast majority of the literature was either anecdotal or descriptive in nature. The sole article that reported empirical findings (Lasater & Nielsen, 2009) focused on the effect of concept-based teaching on nursing students’ development of clinical judgment.

The Lasater and Nielsen study (2009) found a significant change in clinical judgment scores for students receiving a concept-based teaching intervention. However, as previously noted, clinical judgment was evaluated during dyad or triad group participation in a simulation experience, thereby precluding assessment of individual student performance and learning outcomes.

The Tanner Clinical Judgment Model (Tanner, 2006) provided the primary framework for the Lasater and Nielsen (2009) study. The model emphasizes the importance of nursing knowledge in the formation of sound clinical judgments. The model is based on five conclusions that were made following decades of research. The first conclusion is, “Clinical judgments are more influenced by what the nurse brings to the situation than the objective data about the situation at hand” (Tanner, 2006, p. 205). According to Tanner, knowledge is one of the items the nurse brings to the patient care situation.

Tanner references knowledge not only in the conclusions associated with her model, but also in the model’s phases. Noticing, Interpreting, Responding, and Reflecting (Tanner, 2006, p. 205).
208) comprise the four phases of Tanner’s Clinical Judgment Model. Noticing refers to what the nurse expects from the patient situation, which is influenced, in part, by the nurse’s underlying knowledge. The concept-based teaching group in the Lasater and Nielsen study was found to demonstrate the greatest effect size for this particular phase of clinical judgment.

Although both Tanner’s original research and the subsequent Lasater and Nielsen (2009) study make reference to cognition and learning (i.e., nurse thinking and knowledge), established learning theory was not used to inform either study. Furthermore, no reference was made to evidence from the cognitive or learning sciences that might support the studies’ findings.

Tanner’s Model, however, posits that nurses’ underlying knowledge is a key factor both in their ability to recognize relevant patient data, and in clinical judgment performance (Tanner, 2006). These findings are in alignment with cognitive and learning science principles and Ausubel’s theory of meaningful learning. Specifically, teaching strategies that enhance depth of understanding, by building on pre-existing knowledge, improve learners’ transfer of classroom learning to real world situations.

**Concept-based teaching: Process.**

Concept-based teaching provides a means of enhancing learners’ depth of knowledge by building on a pre-established knowledge base. Concept-based teaching operates from the premise that learners must have an accurate understanding of basic anchoring (Erickson, 2007), or threshold (Entwistle, 2004), concepts in order to construct new knowledge and achieve meaningful learning (Erickson, 2007). Concept-based teaching differs from traditional pedagogies not only by the content presented, but also in how the content is delivered and sequenced (Giddens et al., 2008).
Content, when presented through traditional teaching techniques, is delivered in a manner that requires little activity on the part of the learner (i.e., lecture format) and is, typically, organized by topic. Content in nursing courses, for example, is most often organized by body system (Sohn, 1991). This presentation of discrete topics requires that the learner independently recognize how content is interrelated, a process many learners find difficult to achieve (Entwistle & Ramsden, 1983; Erickson, 2007).

The sequencing of concept-based teaching, in contrast, begins with the introduction of anchoring concepts (Erickson, 2007). Anchoring concepts are ideas at a high level of abstraction. These abstract ideas assume a superior position in one’s hierarchical cognitive structure, and provide a foundation to which related, but less generalizable, ideas can be connected (Ausubel, 1968). Anchoring concepts provide a frame of reference the learner uses to gain a better understanding of new, related information (Ausubel, 1968; Erickson, 2007).

The presentation of anchoring concepts is followed by introduction of related concepts, and subsequent presentation of multiple examples, or exemplars, of how the concepts are manifested (Erickson, 2007). The introduction of each concept and exemplar is accompanied by an explicit description of how the concepts and exemplars are related to one another. In a nursing curriculum, for example, the concept of homeostasis learned during a prerequisite science course might be explicitly related to the concept of fluid balance during a medical-surgical nursing course, with congestive heart failure and hypovolemic shock serving as exemplars.

Homeostasis, as a highly abstract concept with which the learner is already familiar, serves as the anchoring concept in the preceding example. Knowledge about homeostasis provides the learner with a context from which understanding of the new, related concept of fluid balance can proceed. Explicit references made by the educator as to how the two concepts are
related allow the learner to link the two concepts, thus achieving understanding of the new information related to fluid balance, while also acquiring a greater depth of understanding regarding homeostasis.

The exemplars of congestive heart failure and shock further differentiate the concepts of both homeostasis and fluid balance, creating a network of information in the learner’s cognitive structure (Ausubel, 1968). It is this explicit connection of new information (i.e., the exemplars) to the learner’s pre-existing knowledge base (i.e., the anchoring concept) that contributes to meaningful learning.

**Strategies to enrich concept-based teaching.**

Concept-based teaching not only provides the major concepts on which learners can build their knowledge, but also incorporates clear explanations of the linkages between related ideas (Erickson, 2007; Novak, 2010). This information is necessary but not sufficient for meaningful learning to occur. In order to facilitate student learning, concept-based content must be delivered in a manner that allows the learner to be an active participant in the learning process (Sawyer, 2006). Opportunities must be provided for learners to build their own knowledge. These opportunities must incorporate active processing of new information in order for meaningful learning to occur.

Learners who are active participants, as opposed to being passive recipients of teacher-presented material, are better able to apply classroom-acquired information to real world problem solving, and to transfer knowledge to novel situations (Alfaro-LeFevre, 2009; Bransford et al., 2000). Teaching methods that help facilitate learners’ knowledge construction through learners’ active participation in the process, are referred to as *active learning* strategies (Bransford et al., 2000, p. 12).
Active learning.

The phrase active learning was initially introduced in the 1980’s, and was popularized in a 1991 report for the Association for the Study of Higher Education (Bonwell & Eison, 1991). The earliest conceptions of active learning were associated with discovery learning, in which active referred to the learner’s behavioral or physical activity. The performance of physical activity was thought to enhance the learning process. More recent work by cognitive scientists suggests that cognitive, rather than physical, activity must be emphasized in learning designs (Mayer, 2004). For this study, active learning referred to the learner’s cognitive activity, or engagement.

A variety of active learning strategies have been implemented and evaluated in nursing education. These strategies include concept mapping (Hicks-Moore & Pastirik, 2006; Veo, 2010; Wilgis & McConnell, 2008), case studies (Chau, Chang, Lee, Ip, & Wootton, 2001), problem-based learning (Applin, 2008; Williams & Beattie, 2008), group learning (Hoke & Robbins, 2005), narrative pedagogy (Ironside, 2006), simulation (McCaughey & Traynor, 2010; Zavertnik, Huff, & Munro, 2010), and reflective learning (Lindahl, Dagborn, & Nilsson, 2009). Although much of the active learning literature has been anecdotal (e.g., Lindahl, et al, 2009), or has been descriptive or qualitative research (e.g., Hicks-Moore et al., 2006; Hoke & Robbins, 2005; Ironside, 2006; McCaughey & Traynor, 2010; Veo, 2010; Wilgis & McConnell, 2008), some studies have found that active learning strategies produce statistically significant gains in student learning (e.g., Zavertnik et al., 2010), whereas others have not (e.g., Applin, 2008; Chau et al., 2001).

Active learning strategies, such as those previously described, are based on similar learning principles. They are not, however, equivalent. Some strategies, such as simulation, are
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

typically implemented as collaborative activities, whereas others, such as reflective learning, are often solo learning events. These, and other diverse characteristics of active learning strategies, introduce additional variables into the learning experience that possibly account for disparate learning outcomes (Bonwell & Eison, 1991). A meta-analysis of previous nursing research studies of specific active learning strategies would provide more conclusive evidence of their efficacy or ineffectivity in producing positive outcomes in nursing students. However, no meta-analytic studies are available.

Findings from systematic reviews of nursing education studies have, overall, been inconclusive regarding the effect of active learning strategies, such as problem-based learning (Wiechula & Rochmawati, 2010), reflective journaling (Epp, 2008), or simulation (Cant & Cooper, 2010), on nurses’ and nursing students’ learning outcomes. The discrepancy between research findings is, perhaps, due to the fact that active learning strategies often are not implemented in accordance with learning science principles. It is also possible the mixed findings reflect variations in how learning outcomes are measured.

Kaakinen and Arwood (2009), for example, conducted a systematic review of one active learning strategy (simulation), for the purpose of determining whether or not learning theory was applied in the planning and implementation of simulation experiences. The researchers concluded that although simulation is an active learning strategy, it is often presented as a teaching modality with little to no emphasis on the cognitive aspects of student learning. It is, perhaps, the lack of attention to cognitive processes and its impact on learning outcomes that has contributed to the overall inconclusive results of these and other studies investigating the efficacy of active learning in nursing education.
Application of principles from the cognitive and learning sciences.

Kaakinen and Arwood’s work (2009) underscores an important principle related to student learning: the most effective learning experiences consider not only the content and instructional method used to deliver that content, i.e. the *what* and *how* of teaching, but also the processes used by learners to cognitively makes sense of the experience, and the methods used by educators to assess that learning, i.e. the *how* and *what* of learning (Quintana et al., 2006). Educators must attend to all of these facets, in order to help learners organize their knowledge in a manner that makes sense to them (Hounsell, 1984). It is this active process of organizing and sense-making that leads to deep understanding and the ability to transfer knowledge from one context to another (Ausubel, 1968; Bruner, 1959; Hounsell, 1984).

It is imperative that educators who wish to nurture students’ meaningful learning consider these variables when designing learning experiences. A description of factors that have been found to have an impact on learning in general, and on meaningful learning in particular, follows.

**Variables Affecting Meaningful Learning**

A student’s learning experience in the classroom setting can be influenced by a number of factors. These include attributes both external and internal to the learner that can impact the learning process. Elements external to the learner include factors such as engagement of the educator (Himangshu, 2006), the physical learning environment, time on task, and the type of teaching method employed (Bransford et al., 2000).

Intrinsic factors include learner characteristics such as gender (Halpern, 2006), culture (Martin, 2006), the learner’s engagement in the learning process (Blumenfeld, Kempler, & Krajcik, 2006), level of motivation (Anderman & Wolters, 2006), previous learning experience
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

(Bransford et al., 2000; Kost, Pollock, & Finkelstein, 2009), pre-existing knowledge (Ausubel, 1963; Serafino, 1998), learning style or approach (Marton & Säljö, 1997), and level of intellectual development (viz., Perry’s 1970 work describing learner’s movement from having an authority-driven, static and dualistic perception of the world, including the belief that knowledge is either right or wrong, toward a perception that is more dynamic and variable in response to context) (Perry, 1999).

Meaningful learning has been found to be greatly influenced by teaching approach, both in the content presented and in the teaching strategies used, and by the learner’s engagement in the learning process, underlying knowledge (González et al., 2008; Gülpinar & Yeğen, 2005; Gurlitt & Renkl, 2010; Teichert & Stacy, 2002), and learning style or approach (Entwistle, Hanley, & Ratcliffe, 1979; Marton & Säljö, 1976a, 1976b). A more detailed description of these factors follows.

Teaching approach.

When content is provided in depth with emphasis on important concepts and principles, and sequenced in a manner that proceeds from general, abstract ideas to specific exemplars, meaningful learning is fostered (González et al., 2008). Meaningful learning is likewise enhanced when teaching and learning methods provide for cognitive engagement of learners, and when learners’ underlying knowledge is used as a foundation for knowledge building (Teichert & Stacy, 2002). These principles were applied during development of the curriculum that was evaluated by this study.

Learning approach.

Learning approach can be thought of in terms of the learner’s preferred learning modality, such as an inclination toward visual learning materials rather than auditory or tactile,
or in terms of the approach taken by learners during studying and learning (Becta, 2005).

Research regarding the relationship between learning style and meaningful learning has focused on the latter (Entwistle, Hanley, & Ratcliffe, 1979; Marton & Säljö, 1976a, 1976b; Mitchell & Liu, 1995; Mitchell, Regan-Smith, Fischer, Knox, & Lambert, 2009), and will be referenced in the discussion that follows.

Some learners automatically search for connections between ideas and concepts, and attempt to discern underlying principles implicit to classroom content when learning and studying (Entwistle et al., 1979; Marton & Säljö, 1976a; Mitchell & Liu, 1995; Mitchell et al., 2009). This approach to studying and learning has been found to increase knowledge acquisition (Angel, Duffy, & Belyea, 2000), depth of understanding and knowledge retention (Entwistle & Ramsden, 1983), and performance on higher order thinking assessments (Dahlgren, 1997).

Other students employ either a surface or strategic approach. Rote memorization is used during surface learning, whereas a combination of rote memorization and deep learning are applied in strategic learning. The method of choice in the strategic approach depends on which strategy the learner perceives will be more useful to the particular situation and achievement of academic success (Entwistle et al., 1979; Marton & Säljö, 1976a; Mitchell & Liu, 1995; Mitchell et al., 2009).

**Learner’s age.**

A positive relationship between learner age and meaningful learning, as demonstrated by conceptual understanding, was found in early studies investigating meaningful learning in children (Berlyne, 1957). A more recent study, however, found age to be inconsequential to conceptual learning, even in learners as young as age six. The study’s results, however, indicated that performance in knowledge transfer activities improved with age (Lawton, 1977). In light of
these contradictory results, data regarding participant age were collected for this study and control for this variable was applied during the data analysis process.

**Learner’s gender.**

Gender differences have been found to be associated with learners’ deep conceptual understanding, or meaningful learning, of science concepts. The findings, however, have been inconsistent. Gerstner and Bogner (2009) found the performance of females to exceed that of males when concept maps were used as a measure of meaningful learning, whereas Kost, Pollock, & Finkelstein (2009) found males to outperform females on a test of conceptual understanding. The difference in the latter study appeared to be due to males’ previous science education, rather than gender itself (Kost et al., 2009). Moreover, the male students’ positive attitudes toward science were found to be a factor contributing to their performance (Kost et al., 2009).

In view of the conflicting results described above, and due to the fact that the sample for this study was comprised of very few males, participant gender data were collected for the purpose of describing the sample but were not included in calculation of the inferential statistics.

**Previous science learning.**

Meaningful learning in a current science course, such as the applied science of nursing (McVicar et al., 2010), is positively influenced by participation in previous science courses (Kost et al., 2009). Nursing is considered to be a bioscience (McVicar, Clancy, & Mayes, 2010), and the bioscience foundation of nursing is apparent in many of the North American Nursing Diagnosis Association (NANDA) accepted nursing diagnoses (Clancy, McVicar, & Bird, 2000), such as *impaired gas exchange* (Herdman, 2009, p. 85) and *excess fluid volume* (Herdman, 2009,
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

p. 112). For this reason, data regarding participants’ previous science learning were collected as a covariate for this study. Operationalization of this variable is discussed in Chapter III.

**Underlying misconceptions.**

Learners’ misconceptions resulting from previous learning experiences have been found to negatively impact conceptual understanding of science (Teichert & Stacy, 2002). It is possible correction of misconceptions might be an indirect consequence of concept-based teaching. This result would be expected due to the explicit teaching on anchoring concepts and their relationship to specific patient conditions and nursing interventions that occurs in concept-based teaching. Although learners’ misconceptions were not a focus of this study, it was anticipated that information regarding students’ conceptual misunderstandings would be revealed during this study’s qualitative strand.

**Summary.**

In summary, concept-based teaching is an approach to content delivery that can support learners’ meaningful learning by emphasizing depth of knowledge, providing anchoring concepts on which to build future related knowledge, and aiding learners in their organization of cognitive structure (Erickson, 2007; Novak, 2010). However, concept-based teaching, as with any other learner-centered pedagogy, must be implemented in a manner that facilitates learning. Active learning strategies are one means to promote meaningful learning (Mayer, 2004).

Concept-based teaching in conjunction with active learning strategies has been found to improve meaningful learning in other disciplines, as evidenced by knowledge transfer. Enhanced knowledge transfer is manifested by activities requiring higher order thinking (L. W. Anderson et al., 2001), such as improved problem solving, as found in medical physiology students.
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

(González, et al, 2008), and refined clinical decision-making, as exhibited by medical students (Daley & Torre, 2010).

This evidence suggests that concept-based teaching, coupled with active learning, might also prove effective in enhancing nursing students’ meaningful learning and application of knowledge through higher order thinking, such as that needed for clinical judgment and decision-making. The purpose of this study was to test this premise. The next chapter presents the methods used to accomplish that goal.
Chapter III: Methods

Introduction

This chapter provides a brief recapitulation of the theoretical framework and major constructs underpinning this study, as well as a detailed description of the study’s data collection and analysis plan. A summary of the study’s purpose, specific aims, and research questions will be presented first, as they provide direction to the methods. A chart summarizing the relationships between these elements and the study’s hypotheses, and the research methods can be found in Appendix A.

A mixed methods approach was used to conduct this study. Mixed methods research incorporates both quantitative and qualitative methods to collect and analyze data, and integrates findings from both methods of inquiry in order to more fully address specific types of research questions (Creswell & Plano Clark, 2011).

The use of contradictory worldviews in the same research program, such as the postpositivist and constructivist stances used to develop and implement a mixed methods study, has not always been an acceptable practice (Walker & Evers, 1997). Contemporary research experts, however, contend that a shift between philosophical assumptions is suitable, provided the stance is appropriate to the research questions being asked, and the researcher provides support for the decisions made regarding data collection and analysis or interpretation (Creswell & Plano Clark, 2011; Shavelson & Towne, 2002; Tashakkori & Teddlie, 2003).

This chapter will provide the rationale for selecting a mixed methods approach to answer the questions prompting this study. The chapter is separated according to method of inquiry (i.e., quantitative or qualitative), when appropriate. The separation is meant to enhance clarity of the
information, and facilitate an understanding of the mixed methods approach as it applied to this study.

Theoretical Framework: Ausubel’s Theory of Meaningful Learning

David Ausubel’s theory of meaningful learning (Ausubel, 1963, 1968, 2000) informed this study. A brief recapitulation of this theory and its relationship to this study follows, in order to present the logic underlying the study questions and knowledge claims, and to provide the rationale for decisions made regarding the methods of inquiry and instruments selected to address each question.

Ausubel’s theory provided a framework for understanding this study’s teaching innovation, and served as a model to predict the innovation’s outcomes and answer the study’s questions. Cognitive structure, or organization of one’s knowledge, is an essential feature of this theory (Ausubel, 1963). Meaningful learning requires that foundational, or anchoring, concepts exist in the learner’s cognitive structure prior to learning new, related information (Ausubel, 1963).

According to Ausubel’s theory, meaningful learning occurs when learners make substantive connections between anchoring concepts and knowledge facts, and recognize underlying principles resulting from those knowledge connections (Ausubel, 1963, 1968, 2000). Recognition of relationships between pre-existing ideas and new information, and an awareness of the principles integral to those relationships, generates a deep understanding in learners (Ausubel, 1963, 1968, 2000; Novak, 2010). Deep understanding produces usable conceptual knowledge that learners can transfer to real world problem solving and decision-making (Erickson, 2007).
Knowledge transfer is evident when learners demonstrate more complex cognitive processes (L. W. Anderson et al., 2001), commonly referred to as higher order thinking. If meaningful learning results in an increased ability for knowledge transfer in learners (Erickson, 2007), and if knowledge transfer enhances higher order thinking (L. W. Anderson et al.), then higher order thinking is an indirect measure of meaningful learning.

Higher order thinking includes cognitive processes such as inferring logical conclusions, differentiating relevant from irrelevant information, and generating alternative hypotheses (L. W. Anderson et al., 2001). These types of processes are intrinsic to problem solving and clinical decision-making, both of which are integral to safe and effective nursing care (Benner et al., 2010). It follows, then, that meaningful learning and the resultant higher order thinking are a necessary outcome of nursing education.

Meaningful learning is facilitated when learners possess knowledge of important concepts from which future knowledge can be understood and created, and when learners are actively engaged in constructing their knowledge (Ausubel, 1968). The teaching innovation evaluated by this study was concept-based teaching in conjunction with active learning strategies. The innovation provided learners with anchoring, discipline-specific concepts as well as opportunities for learners’ active cognitive engagement (Erickson, 2007). Based on Ausubel’s theory, it was predicted that the innovation would produce an increase in nursing students’ meaningful learning as measured by higher order thinking outcomes.

The higher order thinking scores analyzed during the quantitative strand of this study provided a measure of meaningful learning outcomes in response to concept-based teaching, and allowed comparison of the concept-based teaching to the comparison group. They did not, however, provide information about the meaningful learning process in response to concept-
based teaching. In order to obtain a more complete understanding of the relationship between concept-based teaching and meaningful learning, a qualitative approach was used for the second strand of this study.

Purpose, Specific Aims, and Questions

The primary purpose of this study was to evaluate the effects of a nursing curriculum revision on nursing students’ meaningful learning. This purpose was accomplished by: (1) investigating the relationship between concept-based teaching coupled with active learning strategies and nursing students’ learning outcomes, (2) comparing the outcomes of students who received concept-based teaching (CBT) to outcomes of a comparison group receiving traditional nursing education, and, (3) investigating the processes underlying meaningful learning in students who received the concept-based curriculum.

Quantitative strand.

The specific aim for the quantitative component, or strand, of this study was to investigate and compare meaningful learning outcomes in students who received either traditional or concept-based teaching. The questions related to this specific aim were:

(1) Do learners exhibit a significant increase in meaningful learning, as measured by higher order thinking scores, after receiving concept-based teaching, and,

(2) Is there a significant difference in meaningful learning outcomes, as measured by higher order thinking scores, when outcomes of learners who received the concept-based teaching intervention are compared to those who received traditional nursing pedagogy?
Qualitative strand.

There was one specific aim for this study’s qualitative strand. That aim was to gain a greater understanding of the mechanisms underlying meaningful learning in associate degree nursing students who received concept-based teaching. Of particular interest was the type of knowledge connections made between nursing specific concepts and the principles needed to understand a novel patient situation and recommend appropriate nursing interventions. This aim was accomplished by exploring students’ thoughts expressed during interview discussions of a patient case study, and identifying knowledge connection patterns.

There was one question to guide the inquiry related to this specific aim. This question was: What overall patterns emerge during discussion of a novel patient case study related to the concept of oxygenation, when the thinking of nursing students who received CBT is analyzed?

Integration of quantitative and qualitative strands.

Integration of the quantitative and qualitative data in this mixed methods study occurred at two points. The first point of integration occurred following the quantitative analysis at which time the qualitative sample was selected based on the quantitative findings. Details concerning the selection process are presented in the qualitative Selection of Participants section of this chapter.

The second point of integration occurred when information gained from the qualitative analysis was used to help explain the quantitative findings. The data integration and relevant theoretical information were incorporated to answer the integrated questions. The integrated questions were:
(1) Does thinking qualitatively differ between students achieving scores from the uppermost quartile vs. the lowermost quartile on the quantitative post-test higher order thinking measure?, and,

(2) How do the patterns identified through analysis and interpretation of the CBT group’s qualitative data help explain the CBT group’s quantitative findings?

Quantitative Inquiry: Rationale

Student learning is most often evaluated through quantitative measures (Kirkpatrick & DeWitt, 2009; Novak, Mintzes, & Wandersee, 2005). Quantitative assessments, such as multiple-choice or true/false examinations, are easy to administer and score and provide an objective measure of what students might know (Kirkpatrick & DeWitt, 2009; Novak, Mintzes, & Wandersee, 2005; Sadler, 2005).

Quantitative methods of inquiry incorporate quantitative measurements, such as the objective style tests previously mentioned, and use the deductive process to uncover a universal truth about reality (Polit & Beck, 2010). Quantitative methods proceed from a postpositivist perspective, and are viewed as necessary when the intent of a study is to investigate correlation or causal relationships, or test knowledge claims (Polit & Beck, 2010).

The specific aim and questions for the quantitative strand of this study required that the relationship between concept-based teaching and meaningful learning be determined. Therefore, a quantitative approach was taken during the initial strand of this study in order to meet the specific aim, answer the quantitative questions, test the research hypotheses, and contribute to the accomplishment of the study’s purpose.

Quantitative assessments of learning are considered to be dualistic, in that a learner’s response is evaluated as being either correct or incorrect (Perry, 1999). Although these types of
assessments provide a general, objective measure of what students might know (Dahlgren, 1997), they are not the best means of understanding how students learn, or how cognition is involved in meaningful learning (Novak et al., 2005). Qualitative inquiry is better suited to this purpose (Novak et al., 2005).

**Qualitative Inquiry: Rationale**

Qualitative methods of inquiry emanate from a constructivist or interpretivist viewpoint and emphasize subjective experience and multiple realities (Creswell, 2006). The constructivist philosophy proceeds from the belief that examination of subjective data provides a greater understanding of complex phenomenon (Lincoln & Guba, 2000). This is because subjective data allow the nuances or idiosyncrasies of a phenomenon to emerge.

Qualitative inquiry uses the process of induction, which proceeds from the specific to the general, in order to enrich the researcher’s understanding of subjective human experiences (Creswell & Plano Clark, 2011). In this process, information is gathered from the perspective of individual participants in an attempt to gain a more general understanding of why and how a phenomenon occurs.

A qualitative approach is appropriate when a researcher seeks to understand underlying processes involved in subjective phenomenon (Capaldi & Proctor, 2005), such as that which occurs when individual learners construct their own knowledge as they attempt to understand the world (Ausubel, 1968; Novak, 2010). The knowledge construction process that occurs as knowledge connections are made (Ausubel, 1963, 1968, 2000) is unique to each learner and is, therefore, best understood through collection of subjective data (Novak et al., 2005; Shavelson & Towne, 2002).
The specific aim for the qualitative strand of this study was to gain a greater understanding of the mechanisms underlying meaningful learning in associate degree nursing students who were taught using concept-based methods. Qualitative inquiry, such as interviewing, can help to achieve this purpose by providing subjective data related to an individual’s knowledge structure (Novak, 2010; Novak & Gowin, 1996).

As previously discussed, meaningful learning enhances learners’ ability to transfer knowledge. The ultimate test of knowledge transfer is the ability to apply knowledge toward understanding a novel situation (Benner, 2001). In order to understand meaningful learning in the context of nursing education, the participants in the qualitative strand of this study were presented with a novel patient case study. The case study provided a point of reference from which the interview proceeded.

The purpose of the interview was to explore participants’ thinking as they described their understanding of the case study, and developed responses to questions requiring deep understanding of the clinical situation. Each interview was conducted with the intent to investigate the student’s thinking regarding key nursing concepts, and to examine the connections the student made between concepts and principles related to the patient case study.

**Mixed Methods Study Design**

A quantitative-dominant, explanatory sequential design was used to plan, implement, and evaluate this mixed methods study. The purpose of an explanatory sequential design is to expand upon quantitative findings through the collection and interpretation of pertinent qualitative data (Creswell & Plano Clark, 2011). The study consisted of two distinct phases, or strands, in which different approaches to data collection and analysis were employed.
Quantitative strand: Purpose.

A quantitative approach was used for the initial strand of this study. This approach was used to compare student outcomes following concept-based teaching to outcomes following traditional nursing education and to investigate the relationship between concept-based teaching and meaningful learning.

Student outcomes in response to the two different pedagogies were compared through a between-subjects design. There were two groups, one of which was the innovation group whose members received concept-based teaching, and the second of which received traditional nursing pedagogy. The independent variable for the study was type of pedagogical approach, either traditional or concept-based teaching. A more detailed description of the two levels of this variable is provided in the Procedures section of this chapter.

The study also included a within-subjects design, which investigated the relationship between concept-based teaching and meaningful learning. Meaningful learning outcomes in both the between-subjects and within-subjects components of this study were evaluated by measuring higher order thinking scores in students prior to and following exposure to the respective pedagogy.

The findings from the within-subjects component of the quantitative strand were used for purposeful selection of participants for the qualitative strand of the study. Specifically, higher order thinking scores of students who received the concept-based teaching provided the selection criteria for the qualitative strand.

Purposeful sampling of the participants who received concept-based teaching was conducted using a maximal variation strategy (Creswell, 2011; Teddlie & Yu, 2007). Maximal variation sampling is conducted by purposefully selecting participants who represent diverse
perspectives on the phenomenon of interest. Diversity of perspective was gained by choosing participants whose post-test higher order thinking scores were either in the upper or lower quartile. This strategy enabled patterns that emerged to be compared to the quantitative findings. This comparison was made during the integrated strand of the study, thereby providing a more complex view of meaningful learning (Creswell, 2011).

**Qualitative strand: Purpose.**

Qualitative data were collected through semi-structured interviews, and student responses to a patient case study were analyzed to determine cognitive trends or patterns. It was anticipated that a comparison of trends or patterns identified in the two groups would contribute to a greater understanding of the mechanisms underlying the measured quantitative outcome (Creswell & Plano Clark, 2011). The quantitative outcome was meaningful learning as demonstrated by higher order thinking.

A more specific description of how each method of inquiry was implemented for this study follows. The quantitative strand of the study will be described first, followed by the qualitative strand. This section will conclude with a description of how the two methods were integrated.

**Quantitative Strand: Detailed Description of Methods**

**Specific aim.**

The specific aim of the quantitative strand of this study was to investigate and compare meaningful learning outcomes in students receiving either traditional or concept-based teaching.

**Questions.**

Two specific questions were formulated to provide more precise direction to the inquiry into the relationship between concept-based teaching and student learning outcomes. These
specific questions were related to the study’s purpose and to the specific aim for this strand of the study.

The specific questions guiding this aspect of the investigation were:

(1) Do learners exhibit a significant increase in meaningful learning, as measured by higher order thinking scores, after receiving concept-based teaching, and,

(2) Is there a significant difference in meaningful learning outcomes, as measured by higher order thinking scores, when outcomes of learners who received the concept-based teaching intervention are compared to those who received the traditional nursing pedagogy?

Knowledge claims.

A synthesis of Ausubel’s theory and previous research in the area of student learning, as summarized in Chapter II, led to the development of two knowledge claims for the quantitative strand of this study. The knowledge claims being made were: (1) concept-based teaching provided in a learner-centered environment will produce a significant increase in individual nursing student’s meaningful learning, and, (2) meaningful learning will be significantly greater in students who received the concept-based teaching intervention than in students who received traditional nursing education. This study evaluated the knowledge claims by developing and testing two quantitative hypotheses.

A quantitative approach is appropriate when empirical evidence is being sought to support or refute a knowledge claim (Creswell, 2011; Creswell & Plano Clark, 2011), such as those stated in the preceding paragraph. A quantitative approach was, therefore, appropriate for the initial strand of this study.
Rationale for study design.

The purpose of this study was to investigate the effects of a curriculum revision on nursing students’ meaningful learning outcomes. Pure experiment, such as a randomized controlled trial, is considered to be the ultimate standard for investigating cause and effect relationships (Polit & Beck, 2010). This study did not follow the design of a pure experiment. This was primarily because the purpose of the study was to assess student outcomes following a curriculum revision. The fact that the curriculum revision had been implemented prior to initiation of the study required that student outcome data be collected from archived records.

Two other factors supported the use of a non-experimental design for this study. These factors were ethical issues related to educational research, and the naturalistic setting of the study. Educational researchers often consider it unethical to apply random assignment during education research (Creswell, 2011). This is because it is assumed students assigned to a treatment group will receive an unfair advantage over students assigned to a control group, thus violating the ethical principles of justice and beneficence.

Pure experiment is conducted under controlled conditions. Controlled conditions are often not appropriate for the educational setting (Creswell, 2011). A pure experiment does not allow for the multiple factors that can influence educational outcomes, such as interactions among students, quality of the instructor, workload, and time on task (Lim & Morris, 2009). The findings of a pure experiment, consequently, produce a less than accurate reflection of processes as they occur in naturalistic settings such as the classroom (Polit & Beck, 2010).

A college level educational institution was the setting for this study. It was therefore determined that an experimental design would have provided a less than authentic assessment of the relationship between the pedagogies and the students’ learning outcomes. Although this
study did not use an experimental design, several components of a randomized controlled trial were present. These components strengthened the study’s rigor.

Research with a pure experimental design, such as a randomized controlled trial, must meet the following criteria: (1) deliberate manipulation of an independent variable, (2) application of controls, including use of a control or comparison group, and, (3) random selection of participants from the population of interest, and random assignment of those participants to either an intervention or control group in order to limit sources of variance between groups that might influence outcomes and, therefore, bias the results (Polit & Beck, 2010). A description of these components and their applicability to this study follows.

**Criterion #1: Variable manipulation.**

The independent variable for the quantitative strand of this study was nursing pedagogy. This variable was not manipulated for the purpose of this study, but had been modified at the institution for the purpose of improving student learning.

This study was initiated during the beginning implementation phases of the revised curriculum, and archived data were collected from students who received either the initial or the modified level of the pedagogy. The initial level, which in experimental terms would be referred to as *usual care* (Polit & Beck, 2010), was a traditional approach to nursing education consisting of lecture style teaching of discrete topical content, organized by body system function.

The second level of the independent variable was concept-based teaching in conjunction with active learning principles. This level was created through a very deliberate curriculum revision process. The *Procedures* section of this chapter provides specific details about the two levels of the independent variable.
**Criterion #2: Application of controls.**

This study did not include deliberate application of controls. However, data were collected from a comparison group. A comparison group provided a counterfactual or approximation of the outcome had the concept-based teaching group members received both levels of the independent variable simultaneously (Polit & Beck, 2010). This approximation of outcome without the innovation was used to provide a more compelling case for the existence or non-existence of a cause and effect relationship between the innovation and the observed outcome (Polit & Beck, 2010).

**Criterion #3: Randomization.**

Random selection of participants and random assignment to groups are processes used in pure experiment to decrease variability between groups and increase the probability that the groups will adequately represent the population of interest (Polit & Beck, 2010). This study did not use random selection of participants or random assignment to groups. Random selection and assignment were not possible due to the fact that the data were collected from archived student records of students who had received either the traditional curriculum or the revised curriculum. Instead, a non-equivalent group design was applied.

**Rationale for non-equivalent groups design.**

Non-equivalent comparison group before-after design is frequently used to investigate cause and effect (Polit & Beck, 2010). The underlying assumption in a non-equivalent groups design is that the intervention and comparison group differ prior to implementation of the intervention. The difference is due to naturally occurring variations among members of a population that have not been controlled for by random assignment to groups (Trochim, 2006). Pre- and post-test data are collected from members of both the intervention and comparison
groups in a study utilizing a non-equivalent before-after group design, in order to assess baseline group differences. Principles related to non-equivalent group design were applied in this study, by collecting pre- and post-education measures from both the traditional and concept-based teaching groups.

The use of non-equivalent groups in a study using pre/post-test measures poses a potential threat to internal validity. This is due to the fact that pre-test measurement error can be compounded by baseline group differences (Trochim, 2006). This potential threat was addressed in this study by collecting pertinent baseline data to assess similarity or dissimilarity of group characteristics. The variables selected for baseline data collection were based on previous research. Statistical controls were planned for the data analysis component of this study to adjust for significant baseline differences that might have existed.

The use of a pre-test in addition to the post-test measure provided some compensation for the non-equivalent groups design and, thus, for the absence of random assignment to groups (Trochim, 2006). Compensation was accomplished during the data analysis process when the pre-test measure was used as a covariate in relation to the post-test, or outcome, measure. This procedure controlled for variation caused by possible confounding variables on the study outcome (Trochim, 2006).

Causation is difficult to support when a design other than pure experiment is used, and generalizability of the findings are limited when random selection or assignment are not applied (Trochim, 2006). The results, however, are often of more practical value due to data being collected in the naturalistic setting in which the phenomena occur (Creswell, 2011). Practical results are particularly important when the goal is to improve educational practice (Johnson & Onwuegbuzie, 2004).
Conclusions following analysis of non-experimental studies that investigate relationships between independent and dependent variables typically are based on the plausibility of outcomes following the intervention. Particular attention to alternative explanations is crucial, in order to suggest the existence of a possible cause-and-effect relationship (Guba & Lincoln, 1997). This technique was applied when forming conclusions regarding this study’s outcomes, and when developing implications for practice.

**Procedures.**

Operationalization is the process of defining a variable and how it will be measured (Trochim, 2006). This process increases the precision of a study and the robustness of the study’s design (Polit & Beck, 2010), and determines the appropriate statistical method for analyzing relationships between variables (Tabachnick & Fidell, 2006). A description of how this study’s variables were operationalized follows.

**Independent variable: Nursing pedagogy.**

The independent variable for this study was nursing pedagogy. *Pedagogy* refers to “the art, science, and profession of teaching” (Merriam-Webster, 2011). Some nurse education experts (e.g., Vandeveer, 2009), however, prefer the term *andragogy* be used when referring to education of nursing students.

The term *andragogy* was introduced by Malcolm Knowles (1968) to refer specifically to the education of adults. Knowles developed a set of assumptions to guide the planning of adult education experiences. These assumptions referred to the differences between adult and child learners, most notably those related to motivating factors and the role life experiences play in learning (Knowles, 1968).
Pedagogy and andragogy, as initially described by Knowles (1968), represent two completely different educational paradigms. Pedagogy is a teacher-directed approach necessary for educating dependent, passive learners such as children, and andragogy consists of more learner-centered techniques relevant to the needs of adult learners (Ozuah, 2005).

There are some who object to Knowles’ use of the term andragogy to describe adult learners, due to its sexist connotation. The root of the term is *anher*, which refers specifically to the adult male (Mohring, 1990). Experts in the field of adult education find fault not only with Knowles’ terminology, but also with his model. They contend the principles associated with andragogy are not applicable to all adult learners and, moreover, can be applied to some child learners (Brookfield, 1991).

Knowles, in a later collaborative work, described pedagogy and andragogy as representing opposite ends of an education continuum (Knowles, Holton, & Swanson, 2005). This revised model indicates that principles associated with each of the teaching approaches can be changed, depending on the characteristics of the learner and regardless of age (Knowles et al., 2005).

There has been much controversy over the years regarding the correct terminology to use when describing education of adult learners (e.g., Mohring, 1990; Ozuah, 2005; Savicevic, 2008). The term used throughout several contemporary compendiums of educational research (e.g., Alexander & Winne, 2006; Bransford et al., 2000; Sawyer, 2006), however, is *pedagogy*. That term was used in this study to refer to the practice of teaching, which encompasses both curriculum and instruction, even though the population of interest for this study was adult learners.
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

The initial level of the independent variable for this study was traditional style pedagogy, consisting of a teacher-driven didactic component, clinical laboratory, and a clinical practicum. The second level of the variable, which provided the educational innovation in this study, was a concept-based teaching and learning approach incorporating active learning strategies.

The number of course hours devoted to the didactic component of the course was the same for both the traditional curriculum and the revised, concept-based curriculum. Both levels of the variable were developed in alignment with the mission of the college and the philosophy of the nursing program, the National League for Nursing Associate Degree in Nursing core components and competencies, and the Ohio Board of Nursing standards. A description of the course in which the innovation was implemented follows, as well as a detailed description of each level of the pedagogy variable. A summary of this information can be found in Table 1.

*Overview of the course.*

The course in which the intervention was implemented was the first nursing course of an associate degree program. A team approach was used for the didactic and clinical components of this course. The team approach consisted of all course faculty participating in course planning, implementation, and evaluation. All faculty members provided both didactic and clinical instruction.

The course faculty was comprised of six nurse educators, all of whom were masters prepared. The faculty was consistent throughout the time period of interest to this study, with the exception of three members. One member, with more than 20 years experience at the college, participated in educating students from both the first and third cohorts for this study, but was absent for the time period in which the second and fourth cohorts participated in the course. This
faculty member participated in educating one cohort from the traditional curriculum, and one cohort from the revised curriculum.

A second faculty member, who had more than five years of experience at the college, provided clinical education for one clinical group in the first cohort. A third faculty member, new to the college, provided didactic and clinical instruction for the second cohort students, and continued as an educator for both cohorts in the revised curriculum.

First level of the variable: Traditional pedagogy.

The initial level of the independent variable, a traditional style nursing pedagogy, centered around a framework based on the roles of the nurse, the nursing process, the eight human functions, the wellness-illness continuum, and the concept of adaptation. The theory was content-laden and the teaching style was teacher-driven. The large volume of content was presented primarily through a knowledge transmission approach, by way of faculty lecture.

The didactic component for the traditional-style nursing course included theoretical presentation of nursing fundamentals content, organized by body function. These body functions included sensory-perceptual, fluid-gas transport, nutrition, elimination, comfort/rest/mobility, protective, growth and development, and psychosocial/cultural/spiritual.

Lecture accompanied by PowerPoint® was the primary means of presenting theory content. Classroom assessment techniques were occasionally embedded in the lecture presentations. Classroom assessment techniques include strategies such as requesting students to submit a brief comment or question regarding the most difficult material for that day’s lecture, or asking students to submit ideas for test questions. The purpose of these strategies was to formatively assess student learning, in order to address any misconceptions or need for additional clarification of content.
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

The clinical laboratory component included faculty demonstration of basic nursing skills, such as bathing, feeding, dressing, and vital sign measurement; followed by student practice and return demonstration. Clinical laboratory time also incorporated high fidelity human patient simulation experience. The course included an introduction to adult physical assessment, with an emphasis on normal findings, and an introduction to administration of oral medications.

Direct patient care was provided during the clinical practicum component. Direct care focused on provision of basic nursing skills, such as assisting the patient to perform activities of daily living. Patient assignments typically were aligned with the theory content or the laboratory skill for the week.

Organization of the course was communicated to students through an extensive course outline, which consisted of a chronological listing of course content and its associated reading assignments and teaching methods. Assessment of learning consisted of strategies to evaluate student achievement of learning objectives. These consisted of objective, multiple-choice examinations for the theory component of the course, and subjective faculty evaluation of student performance for the laboratory and clinical practicum components.

Second level of the variable: Concept-based teaching.

The nursing faculty at the college identified a need to improve student learning outcomes. This need was identified during a discussion by the entire nursing faculty, in which concerns were expressed regarding increases in number of students having difficulty meeting course outcomes, increasing complexity of the nursing courses due to content overload, negative student feedback regarding content overload, and declining first-time pass rates for new graduates. As a result, a task force was developed in the spring of 2007. The task force consisted of the academic dean, who is a masters-prepared nurse, and nursing faculty representing all nursing courses. The
The task force was charged with reviewing the current curriculum, and investigating possible strategies to meet the identified need.

The task force conducted an extensive literature review and recommended a revision of the curriculum. The nursing faculty agreed to this recommendation, and an investigation was initiated to explore options for a less content-laden curriculum that would provide appropriate preparation for a beginning nurse generalist. The investigation consisted of further literature review, analysis of the college’s current curriculum by a nursing education consultant, and attendance at national nursing education conferences by several nursing faculty. The findings from these activities were synthesized and presented to the entire nursing faculty. The faculty selected a concept-based curriculum as the most appropriate framework for the revised curriculum.

The entire nursing faculty, department chairs, and academic dean began meeting on a monthly basis to develop the revised curriculum. Work groups were created, consisting of members from each of the four nursing courses, and each group participated in development of course descriptions, selection of concepts and exemplars for the entire nursing program, course outcomes, and a matrix identifying the course in which each concept and exemplar would be introduced. The task force remained active, providing guidance to faculty throughout the curriculum revision process, summarizing the outcomes of each group’s work, and synthesizing the various groups’ work products.

The concept-based approach was applied to the didactic, clinical laboratory, and clinical practicum components. The purpose of a concept-based approach was to provide learners with general ideas, or concepts, at a high level of abstraction. The high level of abstraction provided a foundation on which students could build subsequent knowledge (Ausubel, 1963, 1968, 2000).
The essential concepts of patient, nursing profession, and health care system provided the framework for the curriculum. More specific concepts related to each of the essential concepts were selected and used as the focus for teaching and learning activities. These specific concepts were chosen for their currency in contemporary nursing practice.

Resources for selection of appropriate concepts included Quality and Safety Education for Nurses (QSEN) (Cronenwett et al., 2007), the Institute of Medicine (2004) report on patient safety, Healthy People 2010 (U.S. Department of Health and Human Services, 2000), the Joint Commission National Patient Safety Goals (The Joint Commission on Accreditation of Healthcare Organizations, 2007), and the NCLEX-RN Examination test plan (National Council of State Boards of Nursing, 2009c.) Perfusion, oxygenation, and safety are examples of just three of the concepts selected.

The nursing program consists of five nursing courses, typically completed over four semesters. The concepts are carried through each nursing course in the four-semester curriculum. Exemplars are introduced in each nursing course to illustrate the concepts, with exemplars proceeding from basic to more complex in subsequent courses. The concept of oxygenation, for example, is introduced in the first nursing course through the exemplars of *fundamentals of oxygenation* and *atelectasis*, followed by the exemplars of *asthma* and *chronic obstructive pulmonary disease* in the second nursing course.

The concepts are communicated to students through Learning Focused Guides. The Guides are written tools that provide an overview of the concept, and present the associated exemplar(s) and learning outcomes related to each exemplar. Each Guide also includes a list of learning resources, in addition to textbook reading assignments, and describes the active learning strategies employed to facilitate student learning. Learning Focused Guides in subsequent
courses are identified by the relevant concept, and provide a brief explanation of how the more complex exemplars build upon exemplars learned in previous courses.

The didactic portion of the course incorporates active learning experiences and traditional teaching methods, such as PowerPoint® presentations, which focus on the concept and exemplars scheduled for that class session. Assessment of student learning is accomplished through the integration of active learning strategies with more conventional methods, such as multiple-choice testing.

Examples of active learning techniques for the didactic component include student small group discussion and application of the concept of the day to a clinical issue, student-developed small group presentations, and student electronic responses to critical thinking questions embedded throughout the theory presentation. These activities not only facilitate learning by requiring independent knowledge building, but also provide a means of ongoing formative assessment of learning (Bransford et al., 2000).

The clinical practicum likewise is centered on the concept and exemplars most recently presented and discussed in the classroom. Students provide direct patient care, as with the traditional curriculum, but patient assignments are made in alignment with the concept under current discussion. For example, if the concept presented during the didactic component for the week was oxygenation, students would be assigned a patient experiencing an alteration in oxygenation.

Additional concept-based learning activities, completed in the clinical setting, are interspersed throughout the course. The activities include a component in which students apply the concept during direct patient interaction, and a component for which written work must be submitted. The written component requires that students respond to question prompts and engage
in reflective journaling following the concept-based experience. These activities require that students have a deep understanding of the concept, in order to respond correctly to the higher order thinking prompts.

The curriculum revision was provided to intact cohorts based on semester of enrollment. The curriculum was implemented one course at a time, beginning with first semester nursing students in the fall of 2010. The rationale for this decision follows.

The curriculum revision was based on a learner-centered paradigm. This paradigm was completely different from the teacher-centered paradigm of the previous curriculum and, as such, required significant changes in thinking for both students and faculty.

A decision was made to continue the curriculum implementation in subsequent courses as the first cohort progressed through the program, rather than implementing the revision college-wide with students in all courses simultaneously. This decision was based on the fact that, had the revised curriculum been implemented college-wide, a paradigm shift would have been required for currently enrolled students who began their course of study with the initial, traditional-style curriculum. Faculty believed that requiring students to shift from a teacher-centered to a learner-centered educational approach in the midst of the program would have been detrimental to student learning.

The paradigm shift required that significant changes be made in course materials, course content, sequencing of content, implementation of the clinical practicum, teaching and learning strategies, and methods of evaluating student outcomes. For this reason, the revision was implemented course-wide, as opposed to offering the previous and revised curricula simultaneously in each course. This plan permitted best use of college resources.
The decision to implement the revised curriculum course-wide, incidentally, prevented contamination bias or diffusion effect from influencing the outcome of this study. Contamination bias or diffusion effect occurs when members of a control or comparison group are inadvertently exposed to a research intervention (Keogh-Brown et al., 2007). The potential result of contamination is equalized outcomes, rather than a true measure of intervention effect.

Implementation of the revised curriculum to intact cohorts also prevented effects of compensatory rivalry or resentful demoralization from influencing the study outcomes. Compensatory rivalry or resentful demoralization occur when comparison group members either attempt to improve performance or exhibit performance decline, respectively (Trochim, 2006). Rivalry can produce equalized outcomes, whereas demoralization can lead to falsely inflated group differences. Both situations introduce bias to study results and are, therefore, best avoided (Trochim, 2006).

**Intervention fidelity.**

Intervention fidelity refers to the consistency in which an intervention is implemented (Polit & Beck, 2010). For this study, consistency of the teaching approach for both the traditional and revised curricula was protected through participation of all course faculty members in the development, implementation, and evaluation of the course in each of the curricula. There were no faculty members who were not active participants in this process. In addition, all course faculty members were present during the weekly didactic sessions of the concept-based curriculum. This strategy allowed faculty to observe one another’s presentations, assist with implementation of the active learning strategies, and develop a clear understanding of concepts and principles presented during the theory presentations in order to facilitate students’ application of the information in the clinical setting.
Independent variable: Level of measurement.

The independent variable for this study was nursing pedagogy, as previously described. This variable had two levels, described as either a traditional, teacher-centered approach or a concept-based approach with embedded active learning. These two classifications have no numerical relationship to one another and, as such, are described as categorical data (Bruce, Pope, & Stanistreet, 2008). Categorical data can be coded using a dummy dichotomous variable that can be analyzed using analytic methods based on linear regression (Tabachnick & Fidell, 2006).

Dependent variable: Meaningful learning.

Theoretical definition: Meaningful learning.

The effect, or dependent variable, being investigated in this study’s quantitative strand was meaningful learning. The process of meaningful learning occurs when the learner’s prior knowledge is activated, and the learner integrates new information into her or his underlying cognitive structure in a congruous manner (Ausubel, 1963, 1968, 2000). The end result is the learner’s creation of more deeply understood and useable knowledge that can be transferred across contexts, such as from the context of the classroom to the context of real world situations (Ausubel, 1963, 1968; Erickson, 2007; Novak, 2010). Transfer of learning is evident when learners demonstrate higher order cognitive processes, including understanding, applying, analyzing, evaluating, and creating (Ausubel, 1968). A graphic illustrating the relationship between meaningful learning, deep understanding, and higher order thinking can be found in Appendix B.
**Operational definition: Meaningful learning.**

**Meaningful learning** was operationalized as participants’ pre- and post-education higher order thinking scores, as measured by the Assessment Technologies Institute (ATI) Critical Thinking Assessment and Fundamentals Assessment, respectively. A description of the relationship between higher order thinking and the instruments used to measure this construct prior to and following students’ receipt of the pedagogy follows.

**Instruments.**

Instruments used for the collection of quantitative data must be both reliable and valid in order to produce information that is of high quality, and from which credible conclusions can be drawn (Creswell & Plano Clark, 2011). The next four subsections will describe reliability and validity as they relate to each of the instruments for this study. A summary comparison of the instruments can be found in Table 2.

**Rationale for selection of pre/post instruments.**

Pre- and post-tests measuring a specific construct typically consist of identical instruments (Polit & Beck, 2010). The use of identical instruments can, potentially, decrease variation due to the fact that there are no discrepancies between the instruments themselves. Variation due to error, however, can be compounded when identical instruments are employed due to test-retest, or practice, effects on outcomes. This is particularly true when learning outcomes are being measured (Willett, 1997).

Two different instruments to measure higher order thinking were used in this study, one to measure students’ higher order thinking prior to receipt of the traditional or concept-based teaching, and one to measure higher order thinking post-education. The use of different
instruments to collect pre- and post-measurements is acceptable, assuming the instruments have demonstrated reliability, and are valid measures of the same construct (Trochim, 2006).

Validity of an educational test is evaluated based on evidence of the content being sampled, the criterion against which the test outcomes are assessed, and the construct or quality the test proposes to measure (Twigg, 2009). Tests typically are identified as a valid measure of the same quality when the content being sampled on each test corresponds.

The pre- and post-test measures for this study did not meet the content validity standard. This was because the pre-test instrument provided a generic measure of higher order thinking, whereas the post-test instrument measured higher order thinking specific to nursing knowledge. The use of different instruments for pre- and post-test measures was considered to be an acceptable approach in this study due to the fact that higher order thinking was the primary construct of interest in the quantitative strand, rather than specific content knowledge. Moreover, the participants were students in their first nursing course and, as such, were predicted to have little to no nursing content knowledge that could have been measured prior to the traditional or concept-based teaching experience.

The pre- and post-test instruments for this study have demonstrated criterion-related validity. Previous research found that both instruments correlate to NCLEX-RN performance (Carl, 2007; Vendenhouten, 2008), which is the national licensing examination for graduates of registered nursing programs. No research data were available regarding direct correlation between the ATI CTA and the Fundamentals Assessment during the time period in which this study was conducted (M. Dunham, ATI psychometrician, personal communication, July 12, 2011).
Construct-related validity of the pre- and post-test instruments is exemplified by several factors related to the development process for both instruments. The Assessment Technologies Institute staff, including a masters or doctoral-prepared psychometrician, in association with registered nurses holding masters or doctoral degrees in nursing, developed both instruments. The development panel used the same criteria to determine the cognitive labels for the test items on each of the two instruments, including those measuring higher order thinking (ATI, 2001).

The use of two different instruments to measure the same construct prior to and following an intervention can confound results by producing false inflation or deflation of gain (Trochim, 2006), such as gain or loss in higher order thinking scores for the participants in this study. This can be due to changes in score as a result of test differences, rather than change in the attribute being measured.

Score changes from pre- to post-testing time periods provide a measure of observed change, and are not necessarily a reflection of actual change in an attribute (Polit & Beck, 2010) or, as was expected for this study, true growth in higher order thinking. This possibility created a potential limitation to this study. However, if score changes were due to instrument differences rather than to change in the value of the higher order thinking attribute, it was assumed that post-test scores would be more likely to be falsely deflated rather than inflated. This would be due to the fact that the post test provided a measure of higher order thinking specific to new nursing knowledge, rather than the generic measure provided by the pre-test (ATI, 2001).

*Pre-education measurement.*

The quantitative strand of this study included a pre-education measure of participants’ higher order thinking. The pre-test measure was the ATI Critical Thinking Assessment (CTA) developed by Assessment Technologies Institute (ATI, 2001).
The CTA was developed by critical thinking content experts and field-base consultants in nursing education (ATI, 2001), and is based on six competencies identified in the American Philosophical Association’s Delphi Research Report on Critical Thinking (Facione, 1990). The six competencies, described as the cognitive skills central to critical thinking, are interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 1990). A comparison of the critical thinking skills measured by the CTA to the cognitive processes of Bloom’s Taxonomy (Krathwohl, 2002) is in Table 3. The CTA, while based on constructs developed by the Delphi study evidence, is unique in that it is specific to the discipline of nursing (ATI, 2001).

Development of the CTA included incorporation of educational outcome criteria as identified by nursing academic credentialing bodies, and included a feasibility study followed by a literature review. The review was conducted by critical thinking content experts who developed a topic outline, objectives, content matrix, and outcome criteria for the assessment (ATI, 2001).

An advisory board was formed which consisted of education and test construction experts who reviewed the content matrix. National item writers and nursing faculty developed test items based on the approved matrix. Each item was reviewed for bias, reading level, and grammatical errors; and revisions were made as needed (ATI, 2001).

The instrument was field-tested over a six-month period by nursing students representing 18 nursing programs. An item analysis was performed on the data provided by the field-testing, and the analysis was reviewed by psychometricians (ATI, 2001).

The CTA test items were modified as recommended, and field-testing was again conducted. The second round of field-testing was administered to 1,630 students representing 44 nursing programs. The data from this second field test were likewise subjected to item analysis.
Item analysis is used to assess how well individual test items, or questions, differentiate learners from non-learners, and is considered to be a measure of a test’s effectiveness in assessing student learning (McDonald, 2007; Twigg, 2009). Two statistics calculated during item analysis are the item difficulty and item discrimination indices.

The item difficulty index is a measure of how difficult the item is, and shows the percentage of students who chose the correct response to that item. The recommended range for the item difficulty index of a norm-referenced test, such as the CTA, is between .30 and .80 (Kehoe, 1995), with a recommended average of .70 to .80 (McDonald, 2007). The data resulting from the second field test of the CTA produced a mean item difficulty index of .6735 (ATI, 2001).

A test item’s ability to discriminate among students is the true measure of its value for multiple-choice tests. Point biserial correlation is one method of evaluating an item’s discriminatory ability. The point biserial is the correlation between a student’s performance on a specific item, and that student’s overall test performance (Twigg, 2009). It is recommended that the point biserial value for any item exceed .15 (Varma, n.d.). The mean point biserial index for the CTA was found to be .411, with a standard error of measurement of 2.486 (ATI, 2001).

The ATI CTA is a timed power test, rather than a speed test (ATI, 2001). A speed test contains a large number of questions of limited scope, and the methods needed to respond appropriately are apparent. The purpose of a speed test is to determine how many items can be answered correctly in a fixed period of time (Helmbold & Rammsayer, 2006).

A power test, in contrast, is concerned with more complex items for which the method needed to respond correctly is unclear. The primary intent of a power test is to assess the degree of difficulty of test items that can be mastered without undue time pressure. The number of
items on a power test, due to the emphasis on content mastery rather than mental agility or speed, is less than those on a speed test (Helmbold & Rammsayer, 2006). The power attribute of the CTA is in alignment with the test’s purpose, which is assessment of complex thinking skills, a skill that reflects content mastery.

The ATI CTA is norm-referenced rather than criterion-referenced test (ATI, 2001). Norm-referenced tests compare an individual’s score to that of a reference group. A criterion-referenced test, in contrast, does not compare the performance of individual test takers to one another, but instead relates an individual’s performance to a measure of competence in the area being tested. Criterion-referenced tests typically are administered for the purpose of licensing or certification examinations, such as the NCLEX-RN (Trigg, 2009).

The purpose of the CTA is to determine critical and higher order thinking of nursing students as they enter or progress through the nursing program. As such, this test is appropriately norm- rather than criterion-referenced.

The CTA is an electronically administered, timed and proctored assessment, consisting of 40 multiple choice format items (ATI, 2001). The cognitive skills measured by the CTA are described as higher order thinking, with the skills of interpretation, analysis, and inference having a hierarchical relationship (ATI, 2001).

Global alpha for the CTA is .694 for all 40 of the test items (ATI, 2001). This calculation was based on computation of internal consistency, as indicated by Cronbach alpha and compared to the Guttman split-half coefficient. Test reliability coefficients between .7 and .8 are considered to be ideal (Twigg, 2009). The reliability coefficient may be lower, however, if all students do not have adequate time to complete all test items, or if the items are of varying levels of difficulty (Twigg, 2009). The CTA is a timed test, with the majority of the items measuring
higher order thinking. This factor could, perhaps, account for the test’s reliability coefficient being less than .7.

Post-education measurement.

The dependent variable for this study was meaningful learning, as measured by multiple-choice questions designed to measure higher order thinking. The assessment of higher order thinking measured by the CTA is continued in the ATI content mastery assessments, including the nursing Fundamentals Assessment (ATI, 2001). The Fundamentals Assessment, a standardized assessment administered at the completion of the first nursing semester, provided the post-test measure for this study.

The Fundamentals Assessment is an electronically administered, timed, proctored, 60-item assessment of student’s basic comprehension and mastery of fundamental nursing principles. Test items are labeled according to cognitive level required to provide the correct item response, and are divided into two categories: (1) basic knowledge as related to recognition and recall (35 items), and, (2) content mastery as related to higher order thinking (25 items) (ATI, 2001). The cognitive labels are in alignment with those of the NCLEX-RN test items (ATI, 2001; National Council of State Boards of Nursing, 2011), and, as with the CTA, are based on six competencies identified in the American Philosophical Association’s Delphi Research Report on Critical Thinking (Facione, 1990).

The ATI Fundamentals Assessment has two forms, Form A and Form B. The test matrix for each form is identical, and is based on topics as identified by nurse education experts familiar with the content for a beginning level nursing student. The topics are in alignment with content areas identified by National Council of State Boards of Nursing in development of the NCLEX-RN test plan (M. Dunham, ATI psychometrician, personal communication, December 23, 2010).
Individual items for the Fundamentals Assessment were written by registered nurse educators, reviewed by content experts for content validity, and subjected to review by a panel consisting of two registered nurse educators, a psychometrician, and a production specialist (M. Dunham, ATI psychometrician, personal communication, December 23, 2010). The registered nurse members of the panel hold masters or doctoral degrees in nursing, and teaching or practice experience in the content area. The psychometrician members hold masters or doctoral degrees in statistics and educational or psychological measurement, and the production specialists hold degrees in English, journalism, or related fields (M. Dunham, ATI psychometrician, personal communication, December 23, 2010). A description of the review process follows.

Each item was displayed on a video screen for panel discussion. Input was solicited from the registered nurse members regarding suitability of the item in meeting the test specifications, which are based on the NCLEX-RN test plan (M. Dunham, ATI psychometrician, personal communication, December 23, 2010). The purpose of a table of test specifications, also referred to as a blueprint, test plan, or grid; is to define the learning outcomes and content to be evaluated through administration of the test (Twigg, 2009).

Each item on the Fundamentals Assessment was classified in reference to the categories on the table of specifications. These categories included the level of thinking skill required to correctly respond to the item, the step of the nursing process demonstrated by the question, and the clinical topic outcome being assessed. The final step in the process was a review of pertinent nursing textbooks in order to provide a supporting rationale for each item’s correct response (M. Dunham, ATI psychometrician, personal communication, December 23, 2010).

Two nurse educators and a psychometrician reviewed the draft form of each test, and comments were written as needed related to item content or technical issues. The nurse educators
responded to each test item and responses from the two educators were compared for discrepancies (M. Dunham, ATI psychometrician, personal communication, December 23, 2010).

The test panel reviewed and revised any items for which the nurse and psychometrician reviewers made comments, or for which response discrepancies occurred. The revised items were subjected to the same process as the original draft form of the test. Items for which no written comments were received and for which correct responses were provided by both educators were included in the test item bank, and both forms of the test were beta tested for appearance and functionality (M. Dunham, ATI psychometrician, personal communication, December 23, 2010).

The beta versions of the tests were delivered through the ATI portal, and completed by two nurse educators. Revisions to each form of the test were made based on feedback following beta testing (M. Dunham, ATI psychometrician, personal communication, December 23, 2010).

The total number of items on the Fundamentals Assessment was determined based on a judgment of how many items were needed to adequately address the required content, while maintaining an acceptable length of testing time. The NCLEX-RN was used as a blueprint to determine the number of items dedicated to each content area (M. Dunham, ATI psychometrician, personal communication, December, 10, 2010).

Cronbach’s alpha was calculated to provide a measure of reliability for the Fundamentals Assessment. Test reliability is an indication of a test’s quality, and refers to testers’ consistency of performance on a particular test (McDonald, 2007; Twigg, 2009). Reliability for the Fundamentals Assessment, measured using an alpha correlation statistic, is .630 for Form A and .667 for Form B (ATI, 2008).
Form B of the Assessment was administered to the student sample for this study. The reliability coefficient of .667 for Form B is considered to be acceptable for a timed test with items of varying degrees of difficulty (Twigg, 2009), both of which are the case with the Fundamentals Assessment.

Item difficulty and point biserial indices were calculated for the Fundamentals Assessment. The mean values for these indices, based on an N of 7,951, were found to be .71 and .20, respectively (ATI, 2008), both of which are acceptable for a test of this type (Twigg, 2009).

The items on the Fundamentals Assessment are scrambled with each test delivery, and a total of five different scrambles are available. Scrambling is one means of providing alternate forms of a test, and is a measure taken to protect test reliability and validity by preventing student cheating (McDonald, 2007; Twigg, 2009).

The ATI Fundamentals Assessment is a power test, and is both criterion- and norm-referenced (ATI, 2001; M. Dunham, ATI psychometrician, personal communication, December 21, 2010). As with the ATI CTA, the function of the Fundamentals Assessment is to assess mastery rather than mental agility of testers, and to provide a measure of how testers compare to their peers. Peer comparison provides a basis for determining whether or not remediation is necessary as the student progresses through the nursing program.

The criterion-referenced characteristic of the ATI Fundamentals consists of classifications developed by experts in nursing education from across the United States. The classifications were created through a national standard setting process, and resulted in establishment of three proficiency levels (ATI, n.d.b).
The ATI proficiency levels consist of level 1, level 2, and level 3. Student scores associated with each level are considered, respectively, “to meet the absolute minimum expectations”, “exceed the minimum expectations”, or, “exceed most expectations for performance” on items of varying difficulty testing knowledge related to nursing fundamentals (ATI, n.d.b).

*Pre- and post-test comparison.*

Pre-test data are often collected to establish a baseline on an attribute of interest (Willett, 1997). Baseline data are important to determine between-subjects differences that may exist due to lack of randomization to groups. This study did not include randomization to groups. Pre-education data, therefore, were collected for both the intervention and comparison groups. Pre-testing data were also collected to measure change (Trochim, 2006). Pre- and post-test data were then compared to assess change in the measured attribute over time.

Some researchers consider pre- and post-testing to be an unreliable measure of learning growth (Bereiter, 1963). Others, however, believe pre and post-test measures provide a reasonable estimate of change (Willett, 1997). Pre- and post-test differences were used in this study to determine within-subjects change in higher order thinking over the course of one semester.

Archived ATI CTA and Fundamentals Assessment test results were available for the students in each of the six cohorts used as this study’s sample. The assessments served as pre- and post-test measures of higher order thinking for this study, and provided a measure of change in students’ higher order thinking over time and a means of comparing the meaningful learning outcomes of the innovation (concept-based teaching) group to those of the comparison (traditional curriculum) group.
The time interval between pre- and post-testing can influence outcomes, due to maturation or other factors to which a learner is exposed during the intervening time (Polit & Beck, 2010). It is assumed that influencing factors are similar when identical time intervals are maintained for all participants between pre- and post-testing (Trochim, 2006).

The time interval between pre- and post-testing for the participants in this study varied. For this reason, time lag data were collected, and controls were planned for statistically significant differences that were identified.

**Dependent variable: Level of measurement.**

Scores from the CTA and Nursing Fundamentals Assessment are reported as percentages (ATI, 2001), which reflect the number of test items to which a tester responds correctly, divided by the total number of items on the test. Calculation of a test score produces a whole number that, technically, does not qualify as an interval variable (Tabachnick & Fidell, 2006). Test scores, however, are considered to be a measurement of an underlying continuous variable and, therefore, can be treated as interval data during data analysis (Tabachnick & Fidell, 2006).

The pre- and post-test measures for this study did not contain the same number of test items. For this reason, the scores were standardized prior to data analysis.

**Co-variables.**

There were several potential co-variables for this study, as extrapolated from previous research. Co-variables included age, gender, previous science learning, and learning approach. A description of how these variables were addressed follows.

**Age.**

**Participant age** (AGE) was defined as chronological age, and was operationalized by subtracting the participants’ date of birth, as reported on the nursing program application, from
the date at completion of the first nursing semester. This calculation produced a ratio level variable. Ratio level variables can be statistically analyzed by the same methods as those used to analyze interval data (Polit & Beck, 2010), such as those representing other covariates for this study.

_Gender._

_Gender_ was defined as male or female, two attributes that have no numerical correspondence to one another (Bruce et al., 2008). This characteristic distinguishes gender as categorical, or nominal, data (Tabachnick & Fidell, 2006). These data, however, can be coded using a dummy variable, thus transforming the measurement into a dichotomous variable that can be analyzed using linear regression methods (Tabachnick & Fidell, 2006).

It was unlikely that gender would contribute significantly to the variation in this study’s findings, due to the low percentage of male participants comprising both the innovation and comparison groups. For this reason, and due to the fact that previous research found gender insignificant to meaningful learning when previous science coursework was considered (e.g., Kost et al., 2009), gender was used to describe the sample, rather than analyzed as a covariate in this study.

_Previous science learning._

_Previous science learning_ for this study was operationalized as the number of high school and/or college level natural and physical science course credits awarded to a participant prior to beginning the first semester nursing course. Courses were selected as meeting the criteria for a natural or physical science course based on descriptions developed by the National Education Association (1894), with the addition of more contemporary courses described by The College Board (2011).
All course credits were converted to the equivalence of a college semester hour, based on a formula developed by the Carnegie Foundation for the Advancement of Teaching (Harris, 2002; Shedd, 2003). This variable was collected as interval level data.

Based on previous research, it was predicted that learners’ previous science learning experience was the variable most likely to confound the data analysis. Statistical measures were planned to control for the possible confounding influence of this variable on the dependent variable of higher order thinking (Polit & Beck, 2010).

If data characteristics did not allow for statistical analysis of covariance, matching of participants by potential confounding variables was planned to provide comparable groups for comparison of outcomes. The characteristic to be matched was that of previous science learning, as measured by the number of life and physical science courses successfully completed prior to beginning the first nursing course. If analysis of matched pairs was performed, results would be compared to findings from the unmatched analysis.

Learning approach.

The data for the quantitative analysis of this study were collected from archived records that did not, unfortunately, include a specific measure of learning approach. There is some correspondence, however, between learning approach and higher order thinking. This is apparent in two commonly used measures of learning approach, the Approaches and Study Skills Inventory for Students (ASSIST) (Entwistle, Tait, & McCune, 2000), and the Learning Style Inventory (LSI) (Kolb & Kolb, 2005).

Characteristics of higher order thinking are encompassed in a subscale of the ASSIST (Entwistle, Tait, & McCune, 2000). These characteristics, which include seeking meaning,
relating ideas, and using evidence; are similar to the higher order thinking constructs of *understand*, *analyze*, and *evaluate* from the revised Bloom’s Taxonomy (Krathwohl, 2002).

Characteristics of higher order thinking are likewise apparent in constructs represented in the LSI (Kolb & Kolb, 2005). The types of learning styles identified by the LSI are based on stages of a learning cycle that include abstract conceptualization and reflective observation (Kolb & Kolb, 2005). Both modes of learning provide a means of cognitively transforming experience into knowledge. These modes can be related to the higher order thinking constructs of *understand* and *analyze* (Krathwohl, 2002).

Although this study did not include a measure of learning approach, some speculation might be made regarding participants’ learning approach as extrapolated from this study’s pre- and post-test measures of higher order thinking. This extrapolation would represent conjecture only.

*Data recording.*

A researcher-designed Excel® file was created to record the demographic variables of age, gender, and previous science learning. The raw data for these variables were available in archived records for all participants, which had been collected during normal educational practice.

The level of the independent variable to which each participant had been exposed, post-test data, the unique identifier for each participant, results of the pre-test measure, and time interval between pre- and post-testing were likewise be entered to the Excel® file. Influence of the covariates of age, pre-test measure, pre- and post-test gap, and previous science learning on meaningful learning were controlled statistically during the data analysis.
Setting.

The quantitative data were collected from archived records of students attending a private college of nursing. The college is a subsidiary of a private health care system. It is adjacent to a 470-bed hospital that is a teaching facility and provides specialty services, such as heart and vascular, orthopedic, maternity, and intensive care for infants and adults.

The college, with an approximate enrollment of 250, is a private, not-for-profit institution located in a mid-western city with a population of approximately 330,000. The college is approved by the Ohio Board of Nursing and the Ohio Board of Regents, and is accredited by the Higher Learning Commission and the National League for Nursing Accrediting Commission, Inc.

The college’s associate degree nursing program is two years in length, and graduates are awarded an associate of applied science in nursing (AASN) degree. Graduates of the college are eligible to take the state registered nurse licensing examination.

The nursing program consists of four semesters. The first semester course provides foundational information as an introduction to nursing practice. A medical-surgical nursing course is offered in the second semester, followed by a course emphasizing maternal-child and family care in the third semester. The two terminal courses in the program include one in which the focus is care of individuals and groups with complex health care needs, and one that prepares learners for the transition from student to professional nurse.

The college’s sole focus during the time in which the study was conducted was nursing education, rather than having a multidisciplinary health sciences focus. The college also provides general education courses as a core foundation for the nursing education program.
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

Sampling.

Selection of participants.

The quantitative strand of this study was based on data obtained from a convenience sample of 346 records from nursing students in their first semester of the AASN program. The total sample was comprised of approximately 57 records from each of six consecutive, intact cohorts.

The concept-based teaching group data were drawn from archived records of students in the first three semesters in which the revised curriculum was implemented. It consisted of 170 students. The comparison group data were collected from archived records of students who were enrolled in the first semester nursing course during the three semesters immediately preceding initiation of the revised curriculum. This group was comprised of 176 students. A summary of the two groups can be found in Table 4.

Inclusion and exclusion criteria.

Inclusion criteria included: (1) completion of the ATI CTA pre-test measurement, and, (2) completion of the ATI Fundamentals Assessment post-test. Pre- and post-test data from students repeating the course were reviewed in order to identify information that might supplement the study’s findings, or indicate an area requiring further investigation through future research. These data, however, were not included in the group data analysis due to the potential confounding influence of repeat exposure to the course content on student outcomes. The sole exclusion criterion was failure to complete both the pre- and post-test measures.

Recruitment.

An invitation to participate in the quantitative strand was issued verbally to all students currently enrolled in the college (Appendix C). The invitation was extended in the classroom
setting during the spring 2012 semester at a time when faculty were not present. The PI, who was not responsible for assigning grades for any of the students, extended the invitation.

The PI presented a verbal summary of the study and of the informed consent document. A copy of the document was provided to all students and time was provided to read it. The PI then provided an opportunity for students to raise questions about the study or study participation.

The PI instructed students to return a copy of the consent document, regardless of their intent to participate or decline participation. Students who wished to decline were instructed to return an unsigned consent document. A ballot style box was provided for the document returns. All students consented to participation. A copy of the informed consent document with both the participant’s and the PI’s signature was returned to each student. This document included contact information for the PI.

The student’s signature on the consent document indicated consent to participate for all currently enrolled students. A waiver of consent was requested from the IRB for students from the cohorts of interest who were no longer enrolled at the college. The rationale for requesting a waiver of consent follows.

The data for the quantitative strand of this study were extracted from archived student records collected for non-research purposes during the course of standard educational practice. Not all persons whose records comprised the six cohorts of interest were still enrolled as students at the study site. This was because of students’ graduation or withdrawal from the college.

The data from previous students’ records were needed to provide a sample of sufficient size to detect a difference between the outcomes of the CBT and traditional curriculum students, should a difference exist. It was anticipated that contacting previous students would have been
impractical. This was due to the fact that current contact information was unavailable for the majority of persons no longer enrolled at the college.

**Data analysis and management.**

The purpose of data analysis in this study was to determine whether or not a correlation existed between the independent variables and dependent variable and, if so, whether or not that correlation was statistically significant. Data analysis provides the means for testing a hypothesis or knowledge claim (Bruce et al., 2008). For this study, this translated to: (1) whether or not a difference existed between individual students’ pre- and post-education higher order thinking scores, or between the mean scores of the concept-based teaching and traditional curriculum groups, (2) whether or not this study was able to detect those differences if they existed, and, (3) whether or not any differences detected were statistically significant. In order to accurately address these items, a study must be adequately powered (Lipsey, 1998).

**Power analysis.**

The power of a study refers to the probability that the hypothesis test will successfully result in rejection of a false null hypothesis. This requires that the study be sensitive enough to detect an intervention effect that actually exists and is statistically significant (Lipsey, 1998). An adequately powered study allows the researcher to infer that a difference in outcome between an intervention and comparison group is due to the intervention and not to random chance (Bruce et al., 2008; Cohen, 1992).

Both a study’s power and the assigned level of significance influence conclusions drawn from a study’s findings (Lipsey, 1998). An appropriately assigned level of significance decreases the probability of a Type I error being made, whereas an adequately powered study decreases the probability of a Type II error (Lipsey, 1998).
Error can likewise be decreased by use of reliable and valid instruments, thus increasing a study’s power (Cohen, 1992). The ATI CTA and Fundamentals Assessments, serving as this study’s pre- and post-test measures, respectively, have been found to be both reliable and valid (ATI, 2001).

Power analysis is based on the mathematical relationship between the level of significance set for a statistical test (i.e., $\alpha$-value), the number of participants in each group (i.e., intervention and comparison), the effect size (i.e., the strength of the relationship between two variables or difference between conditions), and power (i.e., the sensitivity of the study to detect a difference that actually exists) (Cohen, 1992; Lipsey, 1998).

Power analysis typically is calculated a priori during the research planning stage to determine the sample size needed to detect a specific effect size at a pre-determined level of significance (Cohen, 1992; Lipsey, 1998). This determination can establish the feasibility of a proposed study, as well as protect valuable research funds from being applied to underpowered studies.

The quantitative data for this study were collected from archived records. The number of records available were approximately 170 per group. Power analysis was not used to determine sample size. This was because the sample was drawn from archived records the numbers of which pre-determined the sample size. Power analysis was conducted post hoc based on a one-tailed test with alpha (i.e., the probability of committing a Type II error) set at .05.

Selection of significance level.

One-sided tests for significance are considered appropriate when the expected direction of the outcome is known or strongly supported by the study’s theoretical framework and/or literature review (Bruce et al., 2008). Ausubel’s theory of meaningful learning, which underpins
this study, and the literature review cited in Chapter II suggested the existence of a positive correlation between concept-based teaching and meaningful learning. It was therefore predicted that higher order thinking scores would be greater for the concept-based teaching (CBT) group than the traditional group.

An alpha of .05 indicates a 5% probability that a study will find an effect that is statistically significant in spite of there being no actual difference between group outcomes (Lipsey, 1998). The α value used for this study’s power analysis is that which is conventionally used in social and behavioral research (Lipsey, 1998).

Effect size.

Expected effect size can be determined through literature review, by identifying effect sizes reported by similar studies (Lawson, 1997). Therefore, a review was conducted of previous empirical studies in which outcomes of concept-based teaching and active learning were investigated. Studies for this review were restricted to those in which the participants were students in a higher education institution, and in which an effect size was reported.

Two studies were found that met the criteria. The first study (Atkinson, Catrambone, & Merrill, 2003) investigated undergraduates’ depth of understanding related to mathematics following a conceptual teaching strategy. The outcome measure consisted of students’ ability to solve a novel problem. An effect size of .31 was reported for this study when the intervention group outcomes were compared to those of students exposed to a traditional computational approach to the subject. As a means of comparison, effect sizes above .40 are considered to be higher than the average for most educational research (Petty, n.d.).

The second study, conducted by Morse & Jutras (2008), reported an effect size of .73. The intervention for the study combined concept-based teaching with concept mapping as an
active learning strategy, and found the intervention correlated with increased problem solving among undergraduate biology students in a United States university.

Effect size is appropriate to report in social and psychological studies, such as those investigating the effect of educational interventions. This calculation occurred at the completion of this study, in order to provide a measure of the practical significance of the findings and the probability that similar outcomes will be found should the study be replicated (Lawson, 1997).

**Analysis of data.**

SPSS®, originally Statistical Package for the Social Sciences (IBM, 2010), software was used for the statistical analysis of this study’s data. Quantitative data were entered to a Microsoft Excel® document created on a password-, virus-, and firewall-protected computer. A double-check process was implemented to search for data entry errors, errors were corrected, and the final document was cross-referenced to the original data sources.

Data from the final document were imported into SPSS 19® for analysis purposes, and both descriptive and inferential statistics were calculated. Descriptive statistics provided a summary of the data on a univariate level, allowing the basic characteristics of the data to emerge and comparisons to be made between the innovation and comparison groups. Descriptive statistics included measures of central tendency and dispersion (Polit & Beck, 2010; Trochim, 2006).

Distributions were visually inspected for normality in order to determine the appropriate method of analysis for calculating the inferential statistics. Inferential statistics were calculated to aid in interpretation of the data (Polit & Beck, 2010). Specifically, inferential analysis ascertained whether or not a correlation existed between the independent,
dependent, and co-variables and, if so, whether or not those correlations were statistically significant.

This study investigated the change in individual participants’ meaningful learning, or gain, after exposure to either a traditional teacher-centered pedagogy or a concept-based teaching approach with embedded active learning strategies. The change was calculated by standardizing the test scores and then subtracting the pre-test score from the post-test score. Scores from both instruments were converted in order to provide a valid means of comparison prior to calculation of score differences.

Collecting pre- and post-test data from individuals in order to measure change in a variable over time is referred to as a within-subjects design (Mitchell & Jolley, 2003). The power of this particular design is greater than that of a between-subjects design, due to the fact that participants serve as their own controls, thus eliminating a source of variation (Mitchell & Jolley, 2003; Tabachnick & Fidell, 2006).

One possible disadvantage of within-subjects design is carryover effect that can occur when the same instrument is used for both pre- and post-test measures (Trochim, 2006). This is also referred to as a practice effect (Trochim, 2006). For this study, the pre/post design consisted of one within-subject variable, test scores, measured at two different levels: pre- and post-education (Trochim, 2006). The pre- and post-test instruments were not identical, thus preventing a carryover effect due to practice. As previously discussed, the two instruments demonstrate construct and criterion validity.

This study consisted of one independent variable, nursing pedagogy, which existed at two levels: traditional and concept-based. The traditional and concept-based levels were
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

applicable to the comparison and innovation groups, respectively. The specific term for the
design of this component of the study is between-subjects (Trochim, 2006).

This study compared higher order thinking scores of participants in the innovation
group to those in the comparison group. The between group difference was based on higher
order thinking gain. Pre- and post-test scores were converted to z-scores and pre-test scores
(PreTestZ) were subtracted from post-test z-scores (PostTestZ) to calculate higher order
thinking gain (GAINZ).

Significance testing.

The within-subjects difference scores (i.e., post test z-score minus the pre-test z-score)
were statistically analyzed by performing a paired t-test. A paired t-test typically requires that
data be normally distributed, but is appropriate for use with large samples (Feinstein, 2002;
Tabachnick & Fidel, 2007), as was the case with this study. The purpose of this analysis was
to test the first hypothesis: Nursing students who received CBT integrated with active learning
will exhibit a significant increase in meaningful learning, as measured by the difference
between standardized pre- and post-test higher order thinking scores.

Multiple regression.

Additional data analysis was performed following the significance testing. This analysis
consisted of multiple regression using backward elimination. This analysis was performed to
determine the contribution of the independent and co-variables to variance in higher order
thinking gain (GAINZ) and test the study’s second hypothesis. The independent variable was
teaching method (METHOD), which existed at two levels (CBT or traditional pedagogy). The
co-variables were participants’ age, (AGE) pre-test scores (PreTestZ), previous science learning
(PrevSciCourse), and pre- and post-test intervals (TestTimeInterval).
The primary null hypothesis in a multiple regression analysis is that no relationship exists between the independent and dependent variables (Tabachnick & Fidell, 2007). The null hypothesis assumes that the fit of the observed values for the dependent variables to the predicted values of the multiple regression equation are no better than what would be expected by random chance.

The purpose of performing multiple regression is to determine the strength of the direct relationship between variables while controlling for the effects of others. Therefore, a null hypothesis exists for each independent variable during a multiple regression analysis. Each null hypothesis assumes that the addition of each independent variable to the multiple regression equation does not improve the fit of the model any more than would be expected by chance (Tabachnick & Fidell, 2007).

Multiple regression analysis determines whether or not interactions exist between variables that might help explain the variability in main or interaction effects (Tabachnick & Fidell, 2007). The results of this procedure allow the researcher to draw conclusions regarding the probability that effects are due to the intervention or to chance.

It was anticipated that the variable of *previous science learning* (PrevSciCourse) would contribute significantly to the variability in higher order thinking gain (GAINZ). This prediction was based on the theoretical framework for this study. The framework stipulated that underlying knowledge is essential to formation of new knowledge connections and higher order thinking. If the analytic methods described previously supported this prediction, a final analysis was planned.

The final analysis would consist of a matched pairs design in which participants would be matched for number of previous science courses. Data from the matched pairs would be analyzed using a matched pairs t-test (Feinstein, 2002). The purpose of this analysis would be to control
for confounding effects of previous science learning on the dependent variable. A summary of the data analysis plan can be found in Table 5.

**Rigor.**

Rigor refers to the quality of research, and is related to the logic and precision of a study (Burns & Grove, 2009). Use of a theoretical framework, such as Ausubel’s theory of meaningful learning, to underpin a study provides logic to decisions made regarding a study’s methods (Burns & Grove, 2009).

Measures that enhance precision include random sampling and use of a controlled rather than a natural setting. Both measures increase precision by decreasing the introduction of error (Trochim, 2006). This study did not employ random sampling or a controlled setting. The data were collected from archived records of intact student cohorts from the naturalistic setting of the classroom. The strategy was expected to produce information of greater practical use when applied to the real life setting (Creswell & Plano Clark, 2011).

Adequate power and use of reliable and valid instruments are additional measures that increase a study’s rigor (Burns & Grove, 2009; Trochim, 2006). The power for this study was not calculated *a priori*. It was anticipated, however, that power would be adequate due to the sample size of approximately 170 per group and to the fact that similar studies found medium to large effect sizes produced by concept-based teaching.

Psychometric data for the pre- and post-test instruments for this study were provided under *Instruments* in the *Quantitative* section of this chapter. The statistics for both the ATI CTA and the Fundamentals Assessment attest to these instruments as valid and reliable, with the possible exception of the alpha measures of .694 and .648, respectively. As previously explained, the reliability coefficients may be lower than the recommended .7 due to the fact that the items
on each assessment are of varying levels of difficulty, and both assessments are timed tests (Twigg, 2009).

Other threats to a study’s rigor include: (1) the Hawthorne effect, in which additional attention received by participants as a consequence of study participation can bias study outcomes (Polit & Beck, 2010), and, (2) single and multiple group threat (Trochim, 2006). The intervention for this study was a curriculum revision implemented as a means of improving educational practice. Students entering the program after the revision received the curriculum that represented usual care at that point in time. However, although the participants were not research study subjects, they were aware the curriculum revision was undertaken in an effort to improve student learning outcomes. This knowledge could have influenced student performance and, therefore, biased the study outcome.

Single group threat for this study was avoided through use of both an innovation (CBT) and comparison (traditional curriculum) group. The likelihood of multiple group threat was lessened through collection and analysis of pre-test data from both groups (Trochim, 2006).

Rigor of a study applies not only to the planning, implementation, and analysis of a research project, as discussed above, but also to the interpretation of results (Trochim, 2006). Interpretation must represent truth; specifically, truth as it relates to inferences made about causal relationships. If differences in outcomes are noted, measures must be taken to explore factors other than the intervention that could account for the changes (Trochim, 2006).

Measures to rule out alternative explanations include controlling for covariates as identified through previous research, and comparing a pre-test measure of the dependent variable for both the intervention and comparison groups (Trochim, 2006). Both measures were implemented in this study.
Qualitative strand: Detailed Description of Methods

Specific aim.

The specific aim for the qualitative strand of this study was to gain a better understanding of the mechanisms underlying meaningful learning in associate degree nursing students who received concept-based teaching. This study investigated individual nursing student’s verbal expressions in response to questions designed to elicit cognitive connections, as a means of achieving this aim.

Research question.

One specific question, based on Ausubel’s theory, was developed to guide the qualitative strand of this study. This question was: What overall patterns emerge during discussion of a novel patient case study related to the concept of oxygenation, when the thinking of nursing students who received concept-based teaching are analyzed?

Design.

Ausubel’s theory of meaningful learning provided the theoretical framework for this study. This theory emanates from a constructivist philosophy, and is based on the premise that knowledge is connected in the learner’s mind in the form of a unique cognitive structure (Ausubel, 1963, 1968). This viewpoint emphasizes the important role of subjective data in assessment of student learning, and influenced decisions made about the overall design of this mixed methods study (Shavelson & Towne, 2002).

A constructivist philosophy of education is based on the belief that qualitative differences in learning exist among individual learners, and quality of learning is of greater value than quantity of knowledge (Marton & Booth, 1997). Quality of learning is best evaluated by using
non-traditional assessments of learning, such as subjective expressions of learning experience as made by individual learners.

Semi-structured interviews are one means of gathering subjective data, and were used to collect data to answer the qualitative question for this study. The interviews provided a representation of students’ thoughts as they processed information during discussion of a novel patient case study. The student narratives served as a proxy for thinking (Anderson & Demetrius, 1993).

Interview data were collected from students exhibiting varying levels of achievement on the quantitative measure of higher order thinking. It was anticipated that discovery of patterns in student thinking would help identify factors that influence meaningful learning in nursing students. This analysis was expected to facilitate educators’ understanding about students’ knowledge connections, specifically those present (or absent) in response to questions requiring higher order thinking about the concept of oxygenation.

**Procedures.**

**Setting.**

The setting for collection of qualitative data should offer privacy, and have limited distractions and environmental noise (Lindlof & Taylor, 2002). The site should be comfortable and convenient for the participant, in order to promote participant relaxation and enhance communication (Lewis-Beck, Bryman, & Liao, 2004). A neutral site or the participant’s home environment is often recommended for collection of qualitative data, in order to increase the participant’s level of comfort and willingness for disclosure of sensitive information (Lindlof & Taylor, 2002).
The participants for this study were familiar with the environment of the educational institution, having spent a semester in that setting. Moreover, the educational setting offered space in which privacy, freedom from distractions, and minimal ambient noise could be afforded. Therefore, the educational institution was used as the setting for collection of the qualitative data. The space selected for the interviews was adjacent to the nursing college wing of the campus building, but outside the stream of general foot traffic.

**Sampling.**

Sampling for the qualitative strand, as previously discussed, was based on results of the quantitative data analysis. Participants selected for qualitative data collection were drawn from two groups of students: those achieving scores in the uppermost quartile, and those whose scores were from the lowermost quartile on the ATI Fundamentals Assessment, which provided the post-test measure of higher order thinking for this study.

**Participant selection.**

Participant selection for the qualitative strand of this study was based on findings from the quantitative strand. The purpose of this sampling scheme was to use qualitative data to deepen the understanding of the quantitative findings (Creswell & Plano Clark, 2011).

The sampling technique for this strand of the study was a specific type of purposeful sampling known as theoretical sampling (Ayres, 2007). Theoretical sampling is a means of selecting specific cases, or participants, from whom it is theorized the most valuable data can be collected.

Maximal variation sampling was used to gain insight into the phenomenon (Ayres, 2007; Creswell & Plano Clark, 2011) of meaningful learning in nursing students. This
strategy was implemented by collecting data from students exhibiting varying levels of higher order thinking.

**Inclusion and exclusion criteria.**

The inclusion criteria for the qualitative sample included: (1) achievement of a score from the uppermost or lowermost quartile on the Fundamentals Assessment, (2) minimum of 18 years of age, (3) willingness to participate in a 30-45 minute case study discussion, (4) willingness to be audio recorded during the interview discussion, and, (5) signature verifying informed consent.

The sole exclusion criterion was failure to complete the interview session.

**Recruitment.**

A research assistant reviewed the post-test scores from the sixth cohort students in order to select the sample for the qualitative strand of this study. The research assistant was a faculty member in the first semester nursing course, from which the potential participants were drawn. Consequently, the research assistant knew which students were repeating the course, and removed the names of these students from the list of potential participants.

The research assistant then selected students whose post-test scores were from the uppermost or lowermost quartile, and presented this final list of names to the principal investigator (PI). The PI was thus blind to the participants’ quantitative results while conducting the qualitative interviews. The purpose of this strategy was to minimize a potential source of researcher bias during the interviews.

All students whose names were listed as eligible for participation were invited to participate in the research project. The PI extended an invitation to participate (Appendix D) via the college email system. A copy of the qualitative informed consent document was
attached to the email message. Sample selection began with the first student to respond to the invitation, and proceeded until all students had been interviewed.

Students were given a $15 gift certificate as compensation for study participation. This amount was based on minimum wage, the 30-45 minute time frame expected for interview completion, and an average travel time of 20 minutes. A $15 amount was determined to provide a fair level of compensation, while not creating perceptions of coercion in potential participants.

The PI notified the participants verbally and in writing of their rights regarding the compensation. These rights included the participants’ freedom to retain the compensation regardless of: (1) their decision to be interviewed or audio recorded, and, (2) whether or not the interview was completed. Pro-rating of the compensation did not apply because there was only one interview session for each participant.

It was essential that future participants not receive advance information regarding the specific interview questions, previous participants’ responses, or information about the case study. It was expected that advance information would influence participants’ pre-existing knowledge. Changes in participants’ pre-existing knowledge would have prevented the PI from collecting valid data regarding the participants’ underlying ability for higher order thinking. Participants were asked to sign a confidentiality agreement (Appendix E) in order to protect the integrity of the study.

Sample size.

Qualitative findings are not meant to be generalizable to the population (Creswell, 2006). Instead, the goal is to gain a deep understanding of the phenomenon under investigation through collection of subjective data, thereby producing a richness of data not possible through quantitative data collection methods alone.
The decision regarding number of participants for a qualitative study is typically based on the approach being used, such as phenomenology or grounded theory, or the research question (Creswell & Plano Clark, 2011). Sample sizes for qualitative research are smaller than those for quantitative research, varying from one to 30 participants. The number of participants recommended for a qualitative study, other than one in which a grounded theory approach is being used, is between four and ten (Creswell, 2006).

A purposeful sample of eight participants from each of the two higher order thinking score quartiles was selected initially for the qualitative strand of this study. The precise number of participants needed to answer the study question was determined through ongoing analysis of the data as they were collected. Sampling of this type typically is discontinued when data saturation has been achieved; i.e., when new information is no longer being gained. All 22 of the purposefully-selected students were interviewed for this study. This was due to the uniqueness of the specific thoughts expressed by the students, the richness of the data being gathered, and the novelty of the method of analysis in a nursing context.

**Instrument.**

Human thoughts, due to their unique nature, are best studied through qualitative inquiry. Thoughts or cognitive processes, such as those involved in learning, must be expressed in order to be accessible to the researcher. Interviewing is a qualitative data gathering method that allows expression of thoughts and is, therefore, an appropriate technique for exploring cognition (Southerland, Smith, & Cummins, 2005).

*Semi-structured interview.*

The qualitative data for this study were collected through interviews of individual nursing students. Interviews are defined as “conversation with a purpose” (Lincoln & Guba, 1985, p.
268), and can range from a very structured approach, in which the interviewer determines relevant ideas for discussion, to unstructured in which topic relevancy is governed by the interviewee (Lincoln & Guba, 1985).

Structured interviews are used when the researcher knows in advance what specific information is needed to understand a phenomenon (Lincoln & Guba, 1985). Unstructured interviews, in contrast, allow the interview to evolve as participants express their thoughts. The participants’ expressed thoughts and non-verbal communication guide the interviewer in formulating questions as the interview progresses in the unstructured approach (Robert Wood Johnson Foundation, 2008).

This study used a semi-structured interview format, directed by an interview guide (Given, 2008; Lewis-Beck et al., 2004). An interview guide differs from an interview protocol or schedule in that a guide offers greater flexibility in both the questions asked, and the order in which the interview proceeds (Lewis-Beck et al., 2004).

A semi-structured interview approach is appropriate when little is known about a process (Southerland et al., 2005). No pre-existing data about the process of meaningful learning in nursing students were available on which to formulate a structure for this study’s interviews. Moreover, it was anticipated each participant’s thoughts would have a unique pattern. A semi-structured approach was therefore necessary for this study because of the unknown characteristics of the thoughts that might be expressed (Novak & Gowin, 1996; Southerland et al., 2005).

The flexibility inherent to a semi-structured approach allowed the researcher to explore themes that emerged as the participants discussed their thoughts. This was accomplished by seeking additional information as needed to better understand the participants’ thinking patterns.
This approach likewise permitted each participant the freedom to express thoughts in more of a narrative, rather than a question-and-answer, format, thus providing a verbal record of how thoughts were organized in the cognitive structure (Anderson & Demetrius, 1993).

Semi-structured interviews are based on several pre-developed questions, yet there is freedom for the interviewer to develop impromptu questions as each interview unfolds (Creswell, 2011). The interviewer, in this respect, becomes the instrument (Corbin & Strauss, 2008; Fontana & Frey, 2000).

Semi-structured interviews can be compared to the Socratic method, a time-honored method of teaching and assessing student learning (Stanford University Center for Teaching and Learning, 2003). The teacher employing the Socratic method “asks probing questions in an effort to expose the values and beliefs which frame and support the thoughts and statements of the participants in the inquiry” (Stanford University Center for Teaching and Learning, 2003, p. 1). The method is predicated on the premise that an individual’s knowledge is unique, and can be best understood through discourse.

The semi-structured interviews planned for this study provided a vehicle for discourse, allowing the participants some freedom in expressing their thoughts. The decision to use this qualitative form of inquiry aligns with the constructivist viewpoint from which this study proceeded (Creswell & Plano Clark, 2011), and on which this study’s theoretical framework was based.

The semi-structured interview approach addressed the specific aim for the qualitative strand of this study, which was to gain an understanding of the mechanisms underlying meaningful learning in nursing students. Specifically, the interviews provided information about
the participants’ knowledge connections and the principles they understood relevant to the concept of oxygenation and its application to the case study.

*Advantages and disadvantages of semi-structured interviews.*

Semi-structured interviews have several advantages, in addition to meeting the purpose for the qualitative strand of this study. The tone of a semi-structured interview is more conversational than that of a structured interview and, therefore, typically provides a more comfortable environment for the interviewee (Robert Wood Johnson, 2008). Interviews, when compared to questionnaires, afford an opportunity to gather more in-depth information. Interviews can also prevent answer shaping that can occur when a questionnaire is used to collect data. Shaping ensues when respondents scan subsequent questions prior to providing a response to a current question, thus biasing response (Universities of Essex and Manchester, 2009).

Disadvantages of semi-structured interviews include fatigue of the interviewer and interviewee, extensive time involved in conducting, transcribing, and analyzing interviews; and potential bias of the interviewer as a result of direct interaction with participants (Universities of Essex and Manchester, 2009). Measures that were taken to offset some of these disadvantages are addressed in the qualitative *Rigor* section of this chapter.

Qualitative data collected through the participants’ own words are essential for understanding cognitive processes (Southerland et al., 2005), such as meaningful learning. Therefore, the extensive time needed to collect, transcribe, and analyze the semi-structured interviews was a resource necessary to answer this study’s qualitative question.

*Interview procedure.*

The PI interviewed each participant individually. It was estimated that each participant’s session would require approximately 30-45 minutes. This estimate was based on times reported
in previous research studies in which the thinking of higher education students was explored (e.g., Libarkin et al., 2005; Taber, 2008).

Interview sessions were limited to less than one hour to prevent fatigue. The interview protocol included a plan to terminate the session should the participant display signs of tiredness. Intervals were scheduled between each interview to help prevent interviewer fatigue. The interval also allowed time for the interviewer to review and expand on the notes from the previous interview, and prepare for the next scheduled interview.

Each interview was audio recorded for the purpose of accurately capturing the participants’ words and non-verbal communication, such as conversational pauses. Audio recording allowed the interviewer to attend more closely to participants’ words (Robert Wood Johnson Foundation, 2008) and conversational pauses (Lincoln & Guba, 1985), which could indicate confusion or additional thought processing on the part of the participant. This type of non-verbal cue provided a prompt for the interviewer to pursue additional questioning.

Audio recording allowed the conversation to be captured verbatim, so that a record was created of the actual words used by each participant. The recording of participants’ actual words provided additional insight into the meaningful learning process as it related to the concept of oxygenation, and was essential to construction of the flow maps on which the data analysis was based (Anderson & Demetrius, 1993).

A disadvantage of audio recording includes possible discomfort of participants, and resultant guarded conversation (Lindlof & Taylor, 2002). Measures to enhance comfort include placing recording equipment in an unobtrusive location, if possible, and presenting a matter-of-fact manner toward its presence (Lindlof & Taylor, 2002; Robert Wood Johnson Foundation, 2008). Both measures were implemented during this study’s interviews.
The interviews for this study were conducted in a comfortable environment that was familiar to the participants. Each interview began with general questions of a social nature in order to further facilitate participants’ level of comfort.

*Measures to control bias.*

The PI conducted all interviews, which promoted consistency in data collection, and a pilot study was conducted prior to implementation of the main study. The pilot study provided opportunity for the interviewer to rehearse the semi-structured interview technique and become familiar with the interview guidelines.

Particular attention was paid to avoidance of leading questions that could bias the interview outcome. A minimum wait time of three seconds was allowed for student mental processing following each question (Lincoln & Guba, 1985; Rowe, 1986, 2005; Stahl, 1994). The wait time was based on studies indicating that a three to five second wait time is optimal for processing of science-based questions (Novak et al., 2005).

The interviewer documented brief notes of major ideas and principles expressed by participants during each interview. The notes provided preparation for debriefing, a process whereby the interviewer summarized the discussion for each participant. The purpose of the summary was to ensure the essence of the discussion, from the participant’s perspective, was adequately captured (Lincoln & Guba, 1985). The debriefing period also afforded an opportunity for the participant to express additional thoughts, which enhanced the rigor of the qualitative strand (Lincoln & Guba, 1985).

*Description of the case study.*

Ability to transfer knowledge to a novel situation is the ultimate indication that meaningful learning has occurred (Ausubel, 2000; Benner, 2001; Erickson, 2007; Novak, 2010).
Processing information in a new way, such as that which occurs when a novel situation is encountered, requires mobilization of knowledge connections and related principles (Erickson, 2007). A novel patient case study discussion, therefore, provides an optimal condition for exploring students’ cognitive processes in relation to meaningful learning.

The novel case study selected for this study was associated with the concept of oxygenation. Oxygenation is one of the primary, or anchoring, nursing concepts of the nursing program’s revised curriculum. This concept is introduced in the first nursing course with *fundamentals of oxygenation* and *atelectasis* serving as exemplars. These exemplars help to deepen students’ understanding of the oxygenation concept.

Student learning related to the concept of oxygenation is reinforced in the first nursing course through active learning via high fidelity human patient simulation and provision of patient care on the clinical unit. The focus of the simulation is care of the patient with asthma. The clinical experiences include care of patients experiencing alterations in oxygenation, dependent upon patient availability.

Oxygenation was selected as the anchoring concept for the case study because all students in the first semester had authentic experience in applying this concept. Although not all students may have had an authentic experience in the clinical practicum, all had experience caring for the patient with an alteration in oxygenation status through the simulation laboratory experience. Thus, the primary concept in the case study, oxygenation, was familiar to the students. The patient situation involving this concept, however, was unfamiliar.

The case study investigated student nurses’ knowledge integration in response to explicit concept-based teaching on the concept of oxygenation. It was predicted that oxygenation, because of its relationship to multiple physiological processes, would provide an appropriate
anchoring concept to which students might be able to link learning of related concepts and recognition of underlying principles. The procedure used to select the case study follows.

**Development of the case study.**

Three medical-surgical textbooks (Ignatavicius & Workman, 2010; Lewis, Dirksen, Heitkemper, & Bucher, 2010; Smeltzer, Bare, Hinkle & Cheever; 2010) and two nursing case study textbooks (Castillo, 2009; Preusser, 2009) were reviewed as potential sources of an appropriate case study. It was assumed these textbooks are valid sources of fundamental patient care information for nursing students. This assumption was based on the fact that the medical-surgical textbooks have each exceeded five editions, and the case study textbooks are in their fourth publication.

None of the five textbooks were on the assigned reading list for the students in this study’s sample. This decision increased the probability that the final case study selected would be unfamiliar to the participants. The purpose of the case study discussion was to elicit student thinking during processing of a novel patient situation involving the concept of oxygenation. Therefore, selecting an unfamiliar case study was essential.

Each of the books was scanned for the presence of a case study involving the concept of oxygenation. The goal was to find a minimum of three case studies that would be most relevant to the purpose of the discussion. Although it was essential that the case study be novel, it was likewise essential that the case present a situation in which the basic underlying concepts and principles would be familiar to the prospective participants.

Selection of the case studies began with a review of the course materials and learning activities related to the concept of oxygenation. The review began with the Learning Focused
Guide (LFG) for the concept of oxygenation. The LFG outlined the expected learning outcomes and learning activities for this particular concept.

The human patient simulation scenario to which the students were exposed, in which the patient condition was asthma, was reviewed next. Other course materials relevant to the concept of oxygenation were included in the review. These materials were the PowerPoint® handout distributed to students, the Instructor Guidelines, the clinical laboratory guidelines, the textbook reading assignments, and a crossword puzzle distributed as an active learning exercise.

The purpose of reviewing the course materials and learning activities was to determine the principles to which the learners had been exposed. Once the principles were identified, the prospective case studies were again reviewed. Three case studies were found that would allow previous knowledge of the relevant principles of oxygenation to be activated, yet require creation of new connections due to the novelty of the patient situation.

One of the case studies was anticipated to provide the most novel situation. This case was related to emergent care of a patient experiencing a pneumothorax as a result of trauma. This case, however, included additional data regarding patient assessment findings and diagnostic testing that related to impaired perfusion as a result of the chest trauma. The researcher modified the case study by removing the diagnostic testing information. The new case study included only basic assessment data related specifically to pneumothorax as identified in the original case.

All three case studies were presented to three faculty members from the nursing course the participants would complete immediately prior to data collection. The faculty members were selected based on the clinical site at which they supervised the students’ clinical experience. There were a total of three clinical sites, and a member was selected from each of the three.
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

The patient population from each of the three clinical sites was significantly different, in that each site had a different focus. The specialties of the sites included renal, orthopedic, and general medical-surgical conditions. The purpose of the faculty selection strategy was to obtain input from a representative from each of clinical areas. This strategy provided expert opinion regarding the case study that would best represent a novel patient situation for all students, regardless of their clinical experience.

The PI met with each faculty member individually. The PI provided an overview of the purpose for the case study discussion and a written copy of each case study. Each member was asked to select the case study that best represented a novel patient situation yet was basic enough the prospective participants would have been exposed to the underlying principles during the first nursing course.

Each faculty member provided feedback regarding the appropriateness of each case to the intended purpose of the case study discussion. All three members identified one of the cases as being too complex to be meaningfully discussed by a student at the end of their first nursing course. The members indicated students would be unfamiliar with the amount of diagnostic testing and physician order information included in the case description.

All three reviewers identified the researcher-constructed case as being the “most novel”, yet straightforward enough to allow prospective participants to “prioritize the basics”. The reviewers suggested a revision of the case to include a basic definition of pneumothorax because it was predicted students would be unfamiliar with this term. The revision was made, and this case was selected as the basis for the interview discussions (Appendix F).
Development of interview guidelines.

Specific guidelines were followed for the case study discussion during each interview session. The purpose of the guidelines was to collect the data in a manner that best facilitated student expression of thought, and ensured a consistent interview approach toward each participant. Facilitating student expression of thought was essential to meet the specific aim of the qualitative strand of this study (Southerland et al., 2005), whereas consistency of approach was needed to enhance the rigor of the qualitative data collection method (Robert Wood Johnson, 2008).

Interviews began with presentation of the gift card compensation. This was followed by a brief opening conversation, the purpose of which was to establish rapport and enhance the participant’s level of comfort (Lincoln & Guba, 1985). The opening was followed by an introduction, in which the purpose of the interview and the interview format was described. Participants were given an opportunity to ask questions at this point, and/or to decline participation.

Students who agreed to participate were provided with an informed consent form and a confidentiality agreement (Appendix E). The purpose of the agreement was to secure the participants’ assurance that the details of the case study and interview questions would not be shared with other students. Maintaining secrecy was essential to protect the novelty of the case study for future participants. The interview began once the participant’s questions had been answered, and a signature signifying consent and agreement to confidentiality had been obtained.

Participants received a hardcopy of the patient case study, and time was permitted for review of the case. Once the participant signified the review was complete, the case study discussion began.
Opening questions focused on eliciting information from the participant regarding the concept of oxygenation, and how that concept applied to the case study. Open-ended questions were used to seek additional information as the interview progressed. The questions sought to elicit the participant’s thoughts about nursing assessment and interventions relevant to care of the patient experiencing an alteration in oxygenation. Questions emphasizing how and why the assessment, underlying condition, and interventions were related were introduced in an attempt to uncover the participants’ understanding of related concepts and principles (Novak et al., 2005). The interview guidelines can be found in Appendix F.

**Data analysis and management.**

Cognitive or ideational diagrams are considered an acceptable representation of a learner’s knowledge connections between concepts (Anderson, Randle, & Covotsos, 2001; Hay & Kinchin, 2008; Nesbit & Adescope, 2006; Tsai & Huang, 2002), as well as depth of understanding (Anderson & Demetrius, 1993). Cognitive maps, which may include mind, knowledge, concept, and flow maps; have been used by many educational researchers to explore learners’ conceptual understandings (e.g., Anderson & Demetrius, 1993; Bischoff, 2002; Edwards & Fraser, 1983; Hay & Kinchin, 2006; Hay, Kinchin, & Lygo-Baker, 2008; Hay, Wells, & Kinchin, 2008; Ifenthaler, Masduki, & Seel, 2011; Novak, 2002, 2004, 2005, 2010; Torre et al., 2007). Nursing researchers have used cognitive maps to assess students’ critical thinking (e.g., Daley, Shaw, Balistrieri, Glasenapp, & Piacentine, 1999). Cognitive maps also been used by educators to assess their teaching practices (Kinchin, 2008, 2009; Kinchin & Hay, 2000; Kinchin, Cabot, & Hay, 2008).
Flow mapping: Overview.

A flow map of each participant’s interview was created to analyze this study’s qualitative data. The method of analysis began with the audio recording of each participant’s interview. The audio records were transcribed to provide a basis for analyzing each participant’s knowledge network (Anderson & Demetrius, 1993). The transcriptions were then used to create a flow map of each participant’s verbally expressed thoughts.

Flow maps are similar to concept and mind maps as a model of cognitive structure. All three provide a graphic representation of the concepts or ideas in a learner’s mind, and how those ideas are connected. Flow maps differ from concept and mind maps in that flow maps provide a visual record not only of the principles and concepts expressed by the learner, but also of the sequence and temporal order of expressed thoughts as the ideas are recalled from the learner’s memory (Anderson & Demetrius, 1993, p. 954).

An additional difference between concept maps and flow maps, as used in educational research, is that learners typically create a concept map (Novak, 2010), whereas the researcher is the creator of a flow map (Anderson & Demetrius, 1993). Researcher-created maps of cognitive networks allow a participant’s thoughts to be diagrammed as they are expressed, thereby providing a more accurate record of the sequence of information processing and ideas as they are considered.

Researcher-created maps provide more consistent records of learners’ cognitive networks than do learner-created maps (Anderson & Demetrius, 1993). This is because the quality of a concept map created by a learner is heavily influenced by the learner’s knowledge of the concept mapping process, and skill in creating the map (Tsai & Huang, 2002).
Flow maps have been used in similar studies in which learners’ ideas related to scientific concepts and principles were investigated (e.g., Anderson & Demetrius, 1993; O. R. Anderson et al., 2001; Bischoff, 2002; Carty, 2009). The findings from these studies indicate that flow maps provide a means of assessing learners’ depth and breadth of knowledge, as well as connections made between concepts, ideas, and principles.

The value of recording a learner’s sequence of thought lies in the opportunity the graphic provides for detecting the principles learners uses to organize and link their knowledge, as well as contextual relations between the ideas expressed (Anderson & Demetrius, 1993). The diagram created as a result of the flow mapping process provides clues to the organization of the learner’s cognitive network, and the ideas or concepts most conducive to information processing and problem solving (Anderson & Demetrius, 1993).

Flow map analysis is based on the development of linkages between ideas. Recurrent and linear linkages between ideas are identified in order to indicate the flow of knowledge in the learner’s mind as verbally expressed (Anderson & Demetrius, 1993). Recurrent linkages indicate the learner is making connections between ideas, concepts, and/or principles. The number of recurrent linkages is interpreted as an indication of the complexity of the learner’s thinking and, hence, depth of understanding (Anderson & Demetrius, 1993).

**Flow mapping: Procedure.**

The process of creating a flow map begins with a review of the interview transcript and creation of a chart representing the participant’s ideational network. The major ideas expressed by the participant are identified and used as column headings for the network chart (Anderson & Demetrius, 1993). For this study, chart development began with creation of an Excel® file in
which the major course concepts served as column headings, and participant statements as rows. The PI and research assistant independently created a flow map of each participant’s interview.

The next step in the flow mapping process is to organize the participant’s narrative using the network chart as a framework (Anderson & Demetrius, 1993). Statements made by the participant are recorded in temporal sequence in an abbreviated form under the appropriate column heading. For this study, the Excel® file provided the structure for creation of the network chart of each participant’s interview. A new worksheet was added for each participant. Once the network charts had been created, each worksheet was converted to Microsoft Word® format. Forward-directed arrows were added to each chart. The purpose of adding forward-directed arrows was to indicate at which point transitions to new, related ideas were made (Anderson & Demetrius, 1993).

Arrows in a flow map are used not only to indicate forward thinking, but also recurrent thinking (Anderson & Demetrius, 1993). A backward-directed arrow was used during this study’s flow mapping to indicate student statements that related to previously expressed ideas.

The final step in the flow mapping process is to number the participant’s statements in chronological order and insert time markers (Anderson & Demetrius, 1993). Chronological numbering provides a more precise record of the sequence in which ideas are expressed, whereas time marking provides clues as to the length of time required for information processing and retrieving information from memory (Anderson & Demetrius, 1993).

The audio recording of each interview was reviewed once again, and was compared to the corresponding network chart. Sequential ordering and time marking were added to each flow map at this time. Time marking consisted of elapsed time beginning with the participant’s
response to the first question. A diagram of the flow mapping process can be found in Appendix G.

*Flow mapping: Analysis.*

The completed flow maps were analyzed to identify patterns of thought. Specific attention was given to the concepts and principles discussed, and any relationships expressed or implied through the participants’ discourse. Each participant’s completed map was then linked to the participant’s higher order thinking score, and the thinking patterns were compared. The purpose of this analysis was to determine whether or not patterns existed that were unique to each group (i.e., the group in which students’ higher order thinking scores were from the lowermost quartile and the group in which students’ scores were in the uppermost quartile). Patterns were compared to the quantitative data and to relevant theory to determine whether or not patterns in cognition existed that could help explain variations in the quantitative measure of meaningful learning.

**Integration of Quantitative and Qualitative Strands**

The educational classroom, which was the setting for this study, is a naturalistic environment. Student cognition, one of the elements explored during this study, is unique to each participant. Both the naturalistic setting and human cognition are characterized by complexity and multiple factors that may affect learning outcomes (Creswell, 2011; Guba & Lincoln, 1997).

The aforementioned conditions and features supported the decision to collect and analyze or interpret both quantitative and qualitative data through a mixed methods approach (Creswell & Plano Clark, 2011; Johnson & Onwuegbuzie, 2004; Shavelson & Towne, 2002). The collection and analysis of both quantitative and qualitative data provided a more vivid picture of the phenomenon under investigation.
The qualitative data, collected from participants with extreme scores on the quantitative measure, were used to help explain differences in the quantitative data (Creswell & Plano Clark, 2011). This process, referred to as *abduction* (Johnson & Onwuegbuzie, 2004), provided a deeper understanding of the quantitative results and was used to answer the integrated questions for this study: (1) Does thinking qualitatively differ between students achieving scores from the uppermost quartile vs. the lowermost quartile on the quantitative post-test higher order thinking measure?, and, (2) How do the patterns identified through analysis and interpretation of the CBT group’s qualitative data help explain the CBT group’s quantitative findings?

Abduction is a means of data triangulation (Modell, 2008). The process of abduction is cyclical, moving in a constant comparative manner between the inductive results of the qualitative strand, the deductive findings from the quantitative strand (Gilbert, 2006), and theory that might explain the findings (Modell, 2008).

For this study, the quantitative findings were compared to patterns that emerged from the qualitative analysis and relevant theory and learning principles. Ausubel’s theory of meaningful learning (1963, 1968, 2000) and the principles of constructivist learning (Bransford et al., 2000) were used during the abduction process. The theory and principles helped guide interpretation and explanation of the findings and how they related to one another. The ultimate goal was to develop a context-rich explanation for the mechanisms (Modell, 2008) underlying meaningful learning in associate degree nursing students relevant to the concept of oxygenation.

**Rigor.**

**Pilot study.**

A pilot study of the case study and interview protocol was conducted prior to initiation of this study. Students recruited for the pilot study were in the first week of their second nursing
course and, consequently, were not enrolled in the course from which this study’s sample was drawn. The pilot study had seven purposes: (1) to verify clarity of the case study from a student perspective, (2) to determine the approximate length of time needed to conduct the interviews, (3) to allow the interviewer opportunity to rehearse the semi-structured interviewing technique and become familiar with the interview guidelines, (4) to provide the interviewer practice in providing adequate wait time for student processing between questions, (5) to provide an opportunity for the PI and research assistant to practice and refine the flow mapping technique, (6) to test the functioning of the audio recording equipment, and, (7) to test the appropriateness of the setting for the interview sessions.

The pilot study protocol was identical to the protocol for the qualitative strand of the main study. Student feedback following each interview indicated the case study was clear. The length of time needed to conduct the interviews ranged from 28 to 45 minutes. There were no equipment malfunctions.

The setting was deemed appropriate for conduction of private interviews, with the exception of one instance where a staff member attempted to unlock the door to the room while an interview was in session. A sign was created that requested and signaled an interview was in progress. This sign was affixed to the door prior to each successive interview and there were no further interruptions.

Transcripts of the pilot study interview sessions were used for training purposes. Prior to initiation of the pilot study, the PI provided the research assistant with four research articles in which flow mapping was the method analysis. The PI and research assistant then discussed the flow mapping process and how it would be implemented for the study.
The PI transcribed the interviews of the pilot study participants, and compared each participant’s transcript to its audio record to ensure accuracy of transcription. Each transcript was identified only by a pseudonym assigned to the participant. Both the PI and research assistant used the transcripts to practice and refine the technique of flow mapping.

The PI and research assistant independently created a flow map of the first student transcript from the pilot study. The two flow maps were compared for consistency and inconsistencies were discussed. The inter-rater agreement for the first flow map was 0.52. The inter-rater agreement was calculated by dividing the number of agreements on concepts and relational statements by the total number of concepts and relational statements identified by the PI and research assistant combined.

The PI and research assistant then independently created a flow map of the second student’s transcript. The two flow maps were compared for consistency and inconsistencies were discussed. The inter-rater agreement for the second flow map was 0.84. The same process was used to analyze the third student’s transcript; the inter-rater agreement for the third transcript was 0.93. Inter-rater agreement for the remaining four flow maps was 0.93-0.94. A total of seven flow maps were created during the pilot study, the final four of which demonstrated acceptable inter-rater agreement as indicated in previous studies using flow mapping to analyze science students’ thinking processes (Bischoff, 2002).

A sample size of seven participants was used in order to meet criteria established by a previous research study conducted by Bischoff, Avery, Golden, and French (2010), and to allow for attrition (i.e., failure to complete the interview). The Bishoff et al. research was an educational study conducted to test an interview protocol and train researchers in flow mapping technique (Bischoff et al., 2010). The study successfully used a sample size of four.
Reliability and validity are terms not often used in the description of qualitative inquiry. Instead, the value of qualitative data is measured in relation to its trustworthiness (Creswell & Plano Clark, 2011; Lincoln & Guba, 1985). Trustworthiness refers to credibility, transferability, dependability, and confirmability in relation to collection and interpretation of the information collected. Trustworthiness is directly related to the overall quality of the research (Lincoln & Guba, 1985).

Trustworthiness of the qualitative data was protected through implementation of several measures. Credibility refers to the validity, or believability, of the data from the perspective of the participant rather than that of the researcher (Lincoln & Guba, 1985). One means of strengthening credibility is through transparency regarding possible sources of researcher bias (Shenton, 2004).

A clear description of the researcher’s philosophical viewpoint, and how this viewpoint influenced decisions made throughout the research process, was created to enhance transparency (Creswell, 2006). This was accomplished through reflective journaling by the researcher, and through presentation of the researcher’s philosophy of learning in description of the study’s background and methods.

Credibility was further augmented through the processes of debriefing immediately following each interview, and audio recording of each session. The PI provided a transcription of each interview, and compared the transcripts to the audio records to ensure accuracy of transcription. Comparison of each transcript to the audio record was conducted three times. The first occurred during the initial check for transcription accuracy, the second when the flow map was created, and the third when the flow map was compared to the audio record for the purpose of time marking.
Member checking is a method frequently employed in qualitative analysis as a means to provide validity through enhancement of credibility and confirmability of findings (Guba & Lincoln, 1997). Member checking consists of presenting the results of a qualitative analysis to a participant or group of participants, for the purpose of establishing that the findings provide a true representation of the participant’s or participants’ point of view (Guba & Lincoln, 1997).

Some qualitative researchers, however, view member checking as a controversial practice (e.g., Angen, 2000; Morse, 1984; and Sandelowski, 1993), citing the subjective nature of reality as one that cannot be confirmed. Opponents of member checking also view the process as one which naturally results in participants having a new perspective on the original data, due to events experienced in the interval between the initial point of data collection and the time of the member checking.

Member checking was not used in this study. The rationale for this decision was based on the theoretical framework for this study, and on previous research regarding student learning. Both the theoretical framework and previous research indicate that instances in which knowledge connections are made increase student learning and the learner’s ability to make future knowledge connections (Ausubel, 1968; Novak et al., 2005). The questions posed during this study’s interview process required students to access knowledge in their cognitive structure and, possibly, make new knowledge connections (Novak et al., 2005). As a result, it was likely additional learning would occur during and following the interview, thus changing the students’ knowledge and precluding confirmation of original thought processes.

Credibility was enhanced through use of a data collection and analysis method that had been tested and found to be successful in collecting and analyzing similar data in previous research studies (Shenton, 2004). This consisted of using a semi-structured interview that
focused on how and why questions. This method is an acceptable and previously tested means of eliciting students’ thought processing related to understanding of science concepts and principles (e.g., Novak et al., 2005).

Peer scrutiny is an additional measure that lends credibility to a research project (Shenton 2004). Peer scrutiny was employed during selection of the case study for the qualitative strand of this study. Three nurse experts reviewed a selection of case studies and independently rated each study’s value as a novel patient situation. The details of the selection process, and measures taken to provide credibility, were presented under the Case study section of this chapter.

Transferability and dependability were augmented by describing the characteristics of the participants, the setting in which the study took place, and the procedures employed throughout the study. This information was provided throughout this chapter. A detailed record of the study methods, theoretical foundation, and collected data were maintained, thus providing a means of audit. This measure was taken to strengthen the study’s confirmability.

Protection of Human Subjects

Approval to conduct the study was sought and received from the appropriate parties at the researcher’s academic institution, and from the institution’s Institutional Review Board (IRB). Following approval from the researcher’s academic institution and IRB, application for approval was made to the college administrative staff at the prospective study setting, followed by application for approval from the IRB of the hospital with which the study setting is affiliated. Approval was received from both institutions and both IRBs. Participants were consented after final IRB approval had been received.
Quantitative strand.

The quantitative strand of this study was based on an analysis of archived data from six intact cohorts admitted to the nursing program over a course of six consecutive semesters. These data were collected through standard educational practice.

Individual participant’s data for the quantitative strand of this study were recorded using an identifier unrelated to the participant’s personal information. Data were reported in aggregate form only, as a measure of protecting participant identity. A list correlating each participant’s name to the corresponding unique identifier was stored on a password and firewall protected computer, and was maintained separately from the raw data.

Potential participants who were enrolled as students at the study site fall under the category of vulnerable participants. This is because the PI and research assistant were employed as faculty at the college where the study was conducted, thus creating the potential for the student/faculty power differential naturally present in the academic setting.

The PI was the sole consenter for this study. No students under the PI’s supervision were consented. However, a specific recruiting strategy was implemented to avoid student perceptions of coercion. This strategy was described in the Recruitment section of this chapter. The rationale for recruiting students for this study follows.

It was necessary to recruit students as participants in order to achieve the purpose of the study, which was to investigate student learning outcomes in response to a curriculum revision. In order to test the efficacy of the revised curriculum in a rigorous manner, student outcomes from the CBT group were compared to those of a comparison group of students in the same academic setting who participated in the traditional teaching curriculum.
The sample for the quantitative strand of this study was: (1) the first three cohorts that had completed their first nursing course in the revised curriculum, and, (2) the three first nursing cohorts immediately prior to implementation of the revised curriculum. It was anticipated these cohorts would provide the most accurate data related to meaningful learning in response to the most recent implementations of the two different curricula. This sampling strategy was expected to enhance the study’s rigor. Sampling students from the same educational institution was anticipated to reduce heterogeneity of the groups that could have occurred had the samples been drawn from different educational institutions.

None of the students in the cohorts of interest were less than 18 years of age prior to initiation of the study. All potential participants had participated in college level coursework. This fact served as confirmation the participants were neither cognitively impaired nor educationally limited.

The risks of participation in the quantitative strand of this study were anticipated to be minimal. These risks included possible feelings of coercion due to the participants’ vulnerable status as students, and concern that participation or non-participation would influence academic status. As previously described, the PI was the sole consenter for this study. The PI was not responsible for supervising or assigning grades for any of the potential participants. The PI was the only person knowledgeable of the students’ decision to participate or to decline participation.

The direct benefits of participation in this study’s quantitative strand were anticipated to be minimal. It is anticipated faculty will begin implementing teaching strategy modifications based on the evidence provided by this study. Student participants who are still enrolled in the nursing program at the time of implementation might benefit from these modifications. There were no other anticipated direct benefits for this study’s quantitative strand.
Qualitative strand.

The sample for the qualitative strand of this study was the cohort that had most recently completed their first nursing course in the revised curriculum. It was anticipated this cohort would provide the most accurate data related to meaningful learning immediately following first exposure to CBT.

The PI did not know and had no contact with participants prior to initiation of the qualitative study, aside from obtaining their consent for the quantitative strand. The PI issued an email invitation (Appendix D) to each student included on the research assistant-provided list (described in this chapter’s Recruitment section) of prospective participant names. Email invitations were sent individually to protect the identity of the prospective participants.

The email provided prospective participants with information regarding the general purpose of the study. The specific purpose was not disclosed because of the potential impact of foreknowledge on validity of the study’s results, on students’ level of confidence, and due to the possible impact of confidence level on student thinking during the interview.

Participants were assigned their pseudonym prior to data collection. Pseudonyms are commonly used in the reporting of qualitative results (King & Horrocks, 2010). The pseudonyms were unrelated to the participants’ demographic data. Each transcript provided to the research assistant for analysis was identified only by the participant’s pseudonym.

The PI consented all participants immediately prior to the qualitative interview. Study benefits were explained to the participants at this time. Potential direct benefits included participants’ increased knowledge of the patient condition presented by the case study, or knowledge of appropriate nursing care for that condition. There were no other anticipated direct
benefits. Indirect benefits included nursing faculty improvement of educational practices in response to the study’s findings.

Study risks included emotional or psychological distress that could occur during the case study discussion and exploration of student knowledge, or due to the fact that the discussions were audio recorded. Possible additional risks included potential emotional or psychological distress that could result from the participants’ perceived impact of participation or non-participation on academic success.

Participants were assured that participation or non-participation would in no way affect their academic progress. The alternative to study participation was declination. The PI requested that participants provide a summary of the informed consent document in their own words after reading the document, in order to ascertain the participants’ understanding.

It was expected that distress due to discussion of the case study would be minimal. The participants had prior experience with interviews used to assess learning. Short interviews were conducted by the participants’ clinical instructors weekly during the clinical practicum experience. Participant discomfort resulting from the interviews was thus expected to be minimal.

Participants were monitored for signs of stress throughout the interview, such as restlessness, facial flushing, significant verbal hesitation, increased speed of verbalizations, or change in tone of voice. The PI requested verbally and in writing that participants inform the PI if they wished to discontinue the interview at any time. Participants were provided with the PI’s name and contact information in order to report any interview-related risk or discomfort that occurred subsequent to the interview session.
Participants were assured their identity would be protected to the fullest extent possible. Participant names were not disclosed to anyone other than the PI, and every effort was made to prevent identification of participants by others.

The audio recording of each interview session was collected electronically, using a digital recorder. The recording of each interview session began with the PI stating the pseudonym of the participant being interviewed. The participant’s actual name was not stated during the recorded portion of the interview session.

The audio files of each interview were transferred to a password-protected and firewalled computer that had antivirus software. The PI deleted and overwrote the audio files on the digital recorder. This occurred after the PI had confirmed each file had been properly saved to the hard drive and could be opened.

The research assistant (RA) assisted with the qualitative strand of the study. The RA was a faculty member in the first semester nursing course and, as such, was one of the instructors teaching the participants during the semester immediately preceding the qualitative data collection. The RA was not involved in recruiting or consenting participants or in collecting qualitative data, but did participate in data analysis. The RA completed the institutions’ IRB-required training prior to assisting with the study.

The RA reviewed interview transcripts and provided independent flow map analysis for the purpose of accuracy verification. The RA was not exposed to audio records of the interviews, in order to protect the participants’ identities.

No personal identification appeared on the participants’ raw data records. Instead, the assigned pseudonyms were used to identify the qualitative data records. A list correlating
participants’ names to their corresponding qualitative pseudonym was stored on a password- and firewall-protected computer, and maintained separately from the raw data.

The purpose of the qualitative interview was to provide participant-specific data that would deepen the understanding of the phenomenon under investigation (King & Horrocks, 2009). The qualitative analysis included the development of themes and categories, based on participant responses (Creswell & Plano Clark, 2011). Participants were informed that selected student comments would be reported verbatim in the communication of this study’s outcomes. This practice is necessary not only to provide greater depth of understanding about the phenomenon of meaningful learning, but also to add credibility to the analysis of the data (Creswell & Plano Clark, 2011; King & Horrocks, 2009).

There is a potential risk that persons who read the final report and are familiar with the participants might recognize words or phrasing unique to a particular participant. Confidentiality of all participants’ interview responses, therefore, could not be assured. Participants were made aware of this possibility during the informed consent process.

The audio records were maintained in a secure, password-protected electronic file following the study’s conclusion. These records provide an audit trail and allow confirmability of data by other researchers (Orb, Eisenhauer, & Wynaden, 2001).

A $15 gift certificate was provided at the beginning of the study to each participant, in compensation for travel time and time spent participating in discussion of the case study. Participants were informed that continued participation was not a requirement to retain the compensation fee. Participants were assured they could withdraw from the study at any time, or refuse to have their individual study data published at any point during the study without fear of
penalty. Information was provided regarding where and how any complaints regarding the study or its implementation could be addressed.

**Scope and Limitations**

The focus of this study was meaningful learning in first semester nursing students from an associate degree program, following a concept-based teaching innovation provided in conjunction with active learning techniques. A small convenience sample was used, drawn from a private college in an urban area of the Midwestern United States.

**Limitations related to quantitative strand.**

Archived data from six cohorts were collected for the quantitative strand of this study. The cohorts consisted of: (1) three educated in the traditional, lecture style manner, and, (2) three who received the concept-based curriculum. The college enrolls an average of 65 students per semester. The population from which the sample was drawn initially consisted of 431 student records. Of these, 85 student records did not meet the inclusion criteria and/or met the exclusion criteria. These were omitted from the sample, producing a study sample size of 346 student records. There were 170 records in the innovation group, and 176 in the comparison group.

It was not assumed that the results of this study would be generalizable to the general population of student nurses, or to student populations in other fields or disciplines, due to the limited sample size, convenience sampling technique, setting, sample characteristics, and inclusion criteria. Transferability of the findings is expected to be limited to settings and populations with characteristics similar to those in the study, or as determined by potential future users of the information (Creswell & Plano Clark, 2011).

This study investigated a phenomenon not previously studied: that of student nurses’ meaningful learning, and subsequent knowledge transfer, in response to concept-based teaching
in conjunction with active learning strategies. Because of the lack of research in this area, generalizability assumes a non-critical role (Creswell & Plano Clark, 2011). More importantly, this study provides foundational knowledge that might inform the practice of nurse educators as they develop teaching strategies based on learner-centered pedagogies, or strive to better understand learners’ thinking processes.

There are a variety of uncontrollable factors associated with the naturalistic setting that might have influenced this study’s learning outcomes. These factors include extrinsic variables such as student collaboration with peers and support for learning from significant others in the students’ personal lives (Bransford et al., 2000). These extrinsic factors were not addressed by this study.

There are additional variables intrinsic to the learner that previous research has found to influence learning. These include cognitive ability, time on task, emotional status, and motivation (Bransford et al., 2000). Although these factors were not addressed in this study, they provide a basis for potential future research.

It is recognized that learning outcomes might have been influenced by historical and maturational changes occurring over the course of this study (Creswell, 2011). Another possible impact on the findings is loss of information due to students lost from the study as a result of withdrawal from the course. In spite of these limitations, the knowledge gained from this study is significant in its own right, by providing information that nurse educators might choose to apply to similar learning settings and populations. Moreover, the study results provide a foundation on which further research in this area might be built.

Previous studies regarding concept-based teaching have indicated that this learner-centered pedagogy produces robust learning as evidenced by longer retention of newly acquired
knowledge (e.g., Halme, et al., 2006; Morse & Jutras, 2008). Although knowledge retention was not the focus of this study, a follow up study is anticipated to address this question.

**Limitations related to qualitative strand.**

There was potential for researcher bias during interpretation of the qualitative data. Measures taken to address potential bias were presented during the *Rigor* section of this chapter.

Limitations related to qualitative research were, in general, due to the subjective nature of the experience, both in terms of the data collected and the role of the researcher as instrument (Creswell, 2011). The intent of qualitative research is to gain depth of understanding regarding a phenomenon as it occurs in the naturalistic setting (Lincoln & Guba, 1985). This intent was fulfilled through the collection of data from the viewpoint of the participants. As such, the findings are not considered to be generalizable to the population.
Table 1

Summary Comparison of the Two Curricula
Table 1
Summary Comparison of the Two Curricula

<table>
<thead>
<tr>
<th>Traditional Curriculum</th>
<th>Concept-Based Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>192 hrs total</td>
<td></td>
</tr>
<tr>
<td>Same faculty</td>
<td></td>
</tr>
<tr>
<td>Lecture &amp; traditional assessments</td>
<td>Embedded active learning</td>
</tr>
<tr>
<td>Organized by body system</td>
<td>Organized by concepts</td>
</tr>
<tr>
<td>Content-laden</td>
<td>Selected concepts &amp; exemplars</td>
</tr>
<tr>
<td>Additional topics:</td>
<td>Additional topics:</td>
</tr>
<tr>
<td>• Sexuality</td>
<td>• Inflammatory response</td>
</tr>
<tr>
<td>• Growth &amp; development</td>
<td>• Information literacy</td>
</tr>
<tr>
<td>• Introduction to pharmacology</td>
<td>• Professional boundaries</td>
</tr>
<tr>
<td></td>
<td>• Information technology</td>
</tr>
</tbody>
</table>

All topics on post-test blueprint were common to both curricula
Table 2

Summary Descriptions of ATI Critical Thinking & Fundamentals Assessment
### Table 2
Summary Descriptions of ATI Critical Thinking & Fundamentals Assessments

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Critical Thinking Assessment (Pre-Test Instrument)</th>
<th>Fundamentals Assessment (Post-Test Instrument)</th>
</tr>
</thead>
</table>
| **Description** | • Electronically administered, timed, proctored, norm-referenced power test consisting of 40 items  
• Items are based on six competencies identified in the American Philosophical Association’s Delphi Research Report on Critical Thinking | • Electronically administered, timed, proctored, norm-referenced and criterion-referenced power test consisting of 60 items, 25 of which measure higher order thinking  
• Test matrix is based on topics as identified by nurse education experts familiar with the content for a beginning level nursing student.  
• Topics are in alignment with content areas identified by National Council of State Boards of Nursing in development of the NCLEX-RN test plan |
| **Purpose** | To determine critical and higher order thinking of nursing students as they enter or progress through a nursing program | To provide an assessment of the student’s basic comprehension and mastery of the fundamental principles for nursing practice |
| **Reliability** | Cronbach’s alpha = .694 | Cronbach’s alpha = .667 |
| **Item Difficulty Index** | .6735 | .71 |
| **Point Biserial** | .411 | .20 |
Table 3

Comparison of ATI Critical Thinking Assessment (CTA) and Nursing Fundamentals Assessment to Bloom’s Taxonomy of Higher Order Thinking
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

Table 3

Comparison of Higher Order Thinking Skills Measured by ATI Assessments to Bloom’s Taxonomy of Higher Order Thinking

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skill</strong></td>
<td><strong>Cognitive Process</strong></td>
</tr>
<tr>
<td><strong>Interpretation</strong> To understand, comprehend, decipher, and explain the meaning of written materials, verbal and nonverbal communications, empirical data, and graphics</td>
<td><strong>Understand</strong></td>
</tr>
<tr>
<td><strong>Analysis</strong> To examine, organize, categorize, or prioritize variables such as signs and symptoms, evidence, facts, research findings, concepts, ideas, beliefs, and points of view</td>
<td><strong>Apply</strong></td>
</tr>
<tr>
<td><strong>Inference</strong> To draw conclusions based on evidence, to differentiate between conclusions/hypotheses that are logically or evidentially necessary and those that are merely possible or probable, and to identify knowledge gaps or needs</td>
<td><strong>Analyze</strong></td>
</tr>
<tr>
<td><strong>Explanation</strong> To explain, in writing or orally, the assumptions and reasoning processes followed in reaching conclusions, and to justify one’s reasoning/conclusions in terms of evidence, concepts, methodologies, or contextual considerations</td>
<td><strong>Evaluate</strong></td>
</tr>
<tr>
<td><strong>Evaluation</strong> To assess the credibility of sources of information, to assess the strength of evidence, to assess the relevance, significance, value or applicability of information in relation to a specific situation, and to assess information for biases, stereotypes, and clichés</td>
<td><strong>Create</strong></td>
</tr>
</tbody>
</table>
Table 4

Summary of Cohorts Based on Preliminary Analysis
### Table 4
Summary of Cohorts Based on Preliminary Analysis

<table>
<thead>
<tr>
<th>Group</th>
<th>Cohort</th>
<th>Date of First Nursing Semester</th>
<th>N</th>
<th>Gender</th>
<th>Age</th>
<th>Critical Thinking Assessment Date</th>
<th>Fundamentals Assessment Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Curriculum</td>
<td>1</td>
<td>January, 2009 – May, 2009</td>
<td>176</td>
<td>F = 160 (91.9%)</td>
<td>Mean = 25</td>
<td>• 4-41 months prior to Fundamentals Assessment</td>
<td>5/1/2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M = 16 (9.1%)</td>
<td>Median = 23</td>
<td>• Mean = 12 months</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>August, 2009 – December, 2009</td>
<td></td>
<td>F = 148 (87.1%)</td>
<td>Mean = 26</td>
<td>• 4-48 months prior to Fundamentals Assessment</td>
<td>12/3/2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M = 22 (12.9%)</td>
<td>Median = 24</td>
<td>• Mean = 13 months</td>
<td></td>
</tr>
<tr>
<td>Concept-Based Curriculum</td>
<td>4</td>
<td>August, 2010 – December, 2010</td>
<td>170</td>
<td>F = 160 (91.9%)</td>
<td>Mean = 25</td>
<td>• 4-41 months prior to Fundamentals Assessment</td>
<td>5/6/2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M = 16 (9.1%)</td>
<td>Median = 23</td>
<td>• Mean = 12 months</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>January, 2011 – May, 2011</td>
<td></td>
<td>F = 148 (87.1%)</td>
<td>Mean = 26</td>
<td>• 4-48 months prior to Fundamentals Assessment</td>
<td>11/18/2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M = 22 (12.9%)</td>
<td>Median = 24</td>
<td>• Mean = 13 months</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>August, 2011 – December, 2011</td>
<td></td>
<td>F = 148 (91.9%)</td>
<td>Mean = 25</td>
<td>• 4-41 months prior to Fundamentals Assessment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M = 16 (9.1%)</td>
<td>Median = 23</td>
<td>• Mean = 12 months</td>
<td></td>
</tr>
</tbody>
</table>
Table 5
Summary of Plan for Analysis
Table 5

Summary of Plan for Analysis

<table>
<thead>
<tr>
<th>Quantitative Research Questions</th>
<th>Knowledge Claim/Hypothesis</th>
<th>Means of Testing the Knowledge Claim</th>
</tr>
</thead>
</table>
| Do learners exhibit a significant increase in meaningful learning, as measured by higher order thinking scores, after receiving concept-based teaching? | Nursing students who received CBT integrated with active learning will exhibit a significant increase in meaningful learning, as measured by the difference between standardized pre- and post-test higher order thinking scores. | **Design:** Within-subjects  
**Process:** Convert to standardized scores. Subtract initial higher order thinking scores (ATI CTA) to end-of-semester scores (ATI Fundamentals Assessment) for students in the concept-based teaching group.  
**Significance testing:** paired t-test                                                                                                                     |
| Is there a significant difference in meaningful learning outcomes, as measured by higher order thinking scores, when outcomes of learners receiving concept-based teaching are compared to those receiving traditional nursing pedagogy? | The nursing student group that received CBT will have a significantly greater HOT gain than the nursing student group that received traditional nursing pedagogy. | **Design:** Between-subjects  
**Multiple regression** to test contribution of teaching method, age, pre-test scores, previous science learning, and pre/post-test interval to variation in dependent variable  
**Matched pairs t-test** using previous science learning (if indicated)                                                                                     |
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

References


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


Espindola, H. K. (2010). *How the method by which concepts are introduced affects students’ ability
to transfer the concepts to more complex and broad situations* (Doctoral dissertation). Retrieved
from ProQuest Dissertation and Theses. (AAT 1481192.)

Assessment and Instruction, The Delphi Report: Research findings and recommendations
prepared for the committee on pre-college philosophy*. ERIC Doc. No. ED 315-423. Retrieved
from http://www.eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED315423&ERICExtSearch_SearchType_0=no&accno=ED315423


and learning in the college classroom* (2nd ed.) (pp. 57-80). Boston, MA: Pearson Custom
Publishing.


Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed.) (pp. 645-671).
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


Ifenthaler, D., Masduki, I., & Seel, N. M. (2011). The mystery of cognitive structure and how we can detect it: Tracking the development of cognitive structures over time. *Instructional Science, 39*(1), 41-61.


Ironside, P. M., & Valiga, T. M. (2007). How innovative are we? What is the nature of our innovation? *Nursing Education Perspectives, 28*(1), 51-53.


*Journal of Nursing Education, 49*(7), 414-417.


dd/vt261001.html


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

Ozuah, P. O. (2005). First, there was pedagogy and then came andragogy. *Einstein Journal of Biology and Medicine, 21*(2), 82-87.


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


CONCEPT-BASED TEACHING & MEANINGFUL LEARNING


Wiechula, R., & Rochmawati, E. (2010). Education strategies to foster health professional students’ clinical reasoning skills. *Nursing and Health Sciences, 12*(2), 244-250.


Appendix A

Relationship Between Purpose, Aims, Questions, & Hypotheses
Appendix A: Relationship Between Purpose, Aims, Questions, & Hypotheses

**Purpose**
To evaluate the effect of a nursing curriculum revision (concept-based teaching) on nursing students’ meaningful learning.

### QUANTITATIVE STRAND

**Specific Aim**
To investigate and compare meaningful learning outcomes in students who received either traditional nursing pedagogy or concept-based teaching.

**Question #1**
Do learners exhibit a significant increase in meaningful learning, as measured by higher order thinking scores, after receiving concept-based teaching?

**Hypothesis**
Nursing students who received concept-based teaching (CBT) integrated with active learning will exhibit a significant increase in meaningful learning, as measured by the difference between standardized pre- and post-test higher order thinking scores.

**Means of Answering Question/Testing the Knowledge Claim**
Within-subjects design: Compare initial higher order thinking scores (ATI CTA) to end-of-semester scores (ATI Fundamentals Assessment) for students in the CBT group.

**Question #2**
Is there a significant difference in meaningful learning outcomes, as measured by higher order thinking scores, when outcomes of learners who received the concept-based teaching intervention are compared to those who received traditional nursing pedagogy?

**Hypothesis**
The nursing student group that received CBT will have a significantly greater HOT gain than the nursing student group that received traditional nursing pedagogy.

**Means of Answering Question/Testing the Knowledge Claim**
Between-subjects design: Compare end-of-semester higher order thinking scores of students in the concept-based teaching group to those of a comparison group who received traditional nursing pedagogy.

### QUALITATIVE STRAND

**Specific Aim**
To gain a greater understanding of the mechanisms underlying meaningful learning in associate degree nursing students who received concept-based teaching.

**Question**
What overall patterns emerge during discussion of a novel patient case study related to the concept of oxygenation, when the thinking of nursing students who received concept-based teaching is analyzed?

**Means of Answering Question**
Use Flow Map analysis of interview transcripts to identify patterns in thoughts expressed by students from the intervention group during discussion of a novel patient case study.

**INTEGRATION**

**Question #1**
Does thinking qualitatively differ between students achieving scores from the uppermost quartile vs. the lowermost quartile on the quantitative post-test higher order thinking measure?

**Means of Answering Question**
Compare thought patterns, as identified through Flow Map analysis, of students from the uppermost quartile to those from the lowermost quartile.

**Question #2**
How do the patterns identified through analysis and interpretation of the CBT group’s qualitative data help explain the CBT group’s quantitative findings?
Appendix B

Relationship Between Meaningful Learning, Deep Understanding,

and Higher Order Thinking
Appendix B

Relationship Between Meaningful Learning, Deep Understanding, & Higher Order Thinking

**Meaningful Learning**: the process whereby the learner connects new information, such as concepts and ideas, in a non-arbitrary and non-verbatim manner to her or his pre-existing knowledge.

**Produces**

Hierarchical organization of linked knowledge in the learner’s cognitive structure (mind).

**Creates**

**Deep Understanding**: an ability to grasp relationships between concepts and ideas, and the principles guiding those relationships. Evidence =

**Higher Order Thinking**: the processes of transferring knowledge from one context to another, such as from the classroom to the clinical setting. Includes the cognitive processes of understanding, applying, analyzing, evaluating, and creating.
Appendix C

Verbal Invitation to Participate in the Quantitative Strand
Appendix C
Script: Verbal Announcement/Invitation to Participate in Quantitative Strand

I’m a faculty member at the College and a U.C. student. I’ll be conducting a research study as part of my studies at U.C. The purpose of the study is to gain a greater understanding of student nurse learning in response to concept-based teaching. Not much is known about concept-based teaching, so the results of this study will be of great interest to nurse educators nationally.

You’re being invited to participate in this study because of your experience with concept-based teaching, and because you’ve finished your first semester at the College.

If you agree to participate in the study, you will give permission for the following information to be used as part of the study:

• Your ATI Critical Thinking score
• Your ATI Fundamentals Assessment score
• Your age
• Your gender
• The number of high school and college science course credits you have

There is nothing else you need to do to be in this part of the study. Your information will be combined with other students’ information. No personal information about you will be shared or reported.

The only students who cannot participate in this study are those who will be in my spring clinical group. This is being done to protect those students from feeling pressured.

All other students can decide to be in the study or not. Your decision will not impact your academic success at the College in any way. No matter what you decide to do, your name will not be shared with any faculty or College Administrators outside the research team.

I’m distributing a consent form to each of you right now that describes the study in more detail. Please take time now to read the form. [Allow time for reading]

Do you have any questions? [Allow time for questions] You can also contact me by phone, email, or by stopping by my office if you have questions later. My contact information is on the document you have.

You have two copies of the consent form. If you’d like to participate, please sign and date the last page on one copy. If you don’t want to participate, just leave the last page blank. If you’ll be in my 12-hour clinical group in the spring, please write your name on the first page and the words “Spring Clinical”. I’d like for everyone to put a form in the ballot box that’s being passed around. This is to make sure no other students know what decision you made about being in the study. Keep the second copy of the consent form in case you have questions later.

I’m looking forward to finding out more about student learning. Thank you for your time.
Appendix D

Invitation to Participate in the Qualitative Strand
Appendix D
Email Invitation to Participate in Qualitative Strand

I’m a faculty member at the College and a U.C. student. I’d like to invite you to participate in a study I’ll be conducting for my work at U.C.

The purpose of the study is to gain a greater understanding of student nurse learning in response to concept-based teaching. You’re being invited because of your experience with concept-based teaching.

Not much is known about the effects of concept-based teaching in nursing. Your help would be very valuable, and the results of this study should be of interest and value to nurse educators nationally.

You may participate in this study if you gave permission for your age, gender, and ATI test results to be used in the first part of this study. Please contact me if you’d like to participate and don’t know if you gave permission for the first part.

The study will be conducted during the month of December January at a time that’s most convenient for you. If you agree to participate in the study, you’ll meet privately with me at the College to discuss a patient case study. The case study discussion is expected to take approximately 30-45 minutes. What you have to say about the case study is very important, so the discussion will be audio recorded.

I realize your time is very valuable. If you decide to participate in the study, you’ll receive a $15 gift card to thank you for your time. You may withdraw from the study at any time and can still keep the $15 gift card. No matter what you decide, your decision will not impact your academic success at the College in any way. Your name will not be shared with any faculty or College Administrators outside the research team.

A consent form is attached. It describes the study in more detail. Please read the form. Contact me if you’d like to participate, or if you have any questions. I can be reached at this email address or 513-XXX-XXXX, or you can visit my office (1040.9).

I’m looking forward to finding out more about student learning, and hope to speak with you soon. Thank you for your time.
Appendix E

Confidentiality Agreement
Appendix E

Confidentiality Agreement

Confidentiality Agreement

I, ___________________________________________, will be participating in a study about concept-based teaching and learning. I understand it’s important that others do not find out about the case study or interview questions used in this study.

If other students find out about the case study or the interview questions before they participate in the study, it could interfere with the study results. It would be very difficult for the researcher to know what the students already knew, and what they learned because of my discussion with them. I understand it’s very important for the researcher to get accurate results from this study. Accurate results will be used to help improve teaching and student learning. In order to help with this, I agree to keep the case study and interview questions confidential. I will not discuss them with others, including other students.

_________________________________________  _________________________
Student Signature                          Date

_________________________________________  _________________________
Investigator’s Signature                   Date
Appendix F

Case Study & Interview Guidelines
Appendix F

Case Study

An 18-year-old female patient comes into the Emergency Department with a chest injury following a car accident in which she was a passenger. The patient complains of chest pain and difficulty breathing. Her skin is pale, and she has ecchymosis on her right flank.

Her assessment findings include T 99.8, P 105, R 30, BP 110/58, O2 Sat 91%, and chest pain rated at 8/10. Chest auscultation reveals absent breath sounds in the right base and lateral fields, and diminished breath sounds throughout the remaining right lung fields. Her chest expansion is asymmetrical, with the left side expanding more than the right on inspiration.

The physician orders a chest x-ray that shows a pneumothorax (air or gas in the chest cavity) on the left side. The right lung is partially collapsed, and is approximately 1/3 its normal size.
Appendix F

Interview Guidelines

General instructions for interviewer:
The purpose of this interview is to elicit original thoughts expressed by the student.

Guidelines:
• Do not cue the student or provide leading questions.
• Provide 3-5 seconds for student responses in order to allow for processing time.
• Maintain an active listening stance (eye contact, upright posture or leaning toward the student)
• Avoid use of verbal or non-verbal indicators of “right” or “wrong” responses (i.e., “Good”, “That’s right”, etc.). Instead, use non-confirmatory encouragement, such as, “Okay”, or “tell me more about that”.

Hello, _________________, my name is Mrs. Eby. Thank you for coming in to speak with me today. Would you please have a seat?

[Small talk to promote participant’s comfort - “How are you?”, “How’s the semester coming along?” Etc.]

Thank you for coming in today. I know your time is valuable, and I appreciate you taking time to help with this research study. The purpose of the study is to gain a better understanding of student thinking and learning. When teachers gain a better understanding of student learning, it helps us improve our teaching. I’m very interested in hearing about your thoughts related to a patient case study.

I anticipate we’ll be speaking for 30 minutes to an hour. If at any time you’d like to take a break, just tell me and we’ll stop temporarily. If you wish to stop completely, just let me know and we’ll conclude this interview.

Our discussion will be transcribed in a way that your name won’t appear on the written record of our conversation. In other words, your comments will be anonymous.

Student thoughts about this case study will increase faculty knowledge about student learning, and how student thinking is linked to learning about patient care. The results of this study will be submitted for publication in order to share this information with other nurse educators. It’s possible some comments made by students in this study might appear in a published nursing article. However, no one outside the research team will be told the names of any of the student participants.

Your thoughts and comments are very important, and I want to make sure I have an accurate record of what you have to say. In order to do this, I’ll be recording our conversation. Do you have any objections to being recorded?

I’ll be taking brief notes during our discussion. When we’ve completed our discussion, I’ll review my notes with you to make sure I’ve accurately captured the main ideas you’ve expressed.

Before we begin, do you have any general questions?

[Allow time for general questions.]

Okay, let’s begin.

I’d like to give you a brief overview of how our interview will proceed.
I’ll be asking you some questions about a patient case study. I’m very interested in learning your thoughts about the case. In order to help me understand what you know, it’s important that you tell me exactly what you think. You’re not being graded, and there are no right or wrong answers today. I may ask questions that seem obvious to you, but it’s only because I want to make sure I have a clear understanding of what your thoughts are.

If I’m not sure I understand what you’re telling me, I’ll ask you for clarification.

I’d like you to take a moment to read the case study. Then I’ll be asking about your thoughts related to the study.

[Provide case study]

I’d like you to take a moment to read the case study. Then I’ll be asking about your thoughts related to the study.

[Allow ____ minutes for the student to review the study].

Please tell me your first thoughts about the case study, specifically, what do you think is the most important need for this patient?

[Ideas should revolve around oxygenation, breathing. If this isn’t expressed, ask what the priority ND might be. Regardless of response, continue with the following line of questioning.]

Tell me why you chose _______ as the most important need for the patient in this case study.

[If student answer is unclear or brief, prompt for elaboration: “Can you tell me more about that?” “Go on”, “Anything else you’d like to add?”, etc.]

[If the student doesn’t make reference to the assessment findings, ask the question that follows.]

What are your thoughts about the patient assessment findings in the case study?

[If student answer is unclear or brief, prompt for elaboration: “Can you tell me more about that?”, “Go on”, “Anything else you’d like to add?”, etc.]

[Ask the following questions if the student doesn’t spontaneously make reference to this information.]

How do the assessment findings relate to __________ ? [the patient need identified by the student]

[If student answer is unclear or brief, prompt for elaboration: “Can you tell me more about that?”, “Go on”, “Anything else you’d like to add?”, etc.]

What nursing interventions would be appropriate to help the patient in this case study?

[If student answer is unclear or brief, prompt for elaboration: “Can you tell me more about that?” “Go on”, “Anything else you’d like to add?”, etc.]

I’d like to discuss the nursing intervention(s) you identified. [Ask the student about each intervention separately, using the questions that follow.]

How will ______________ help this patient?
CONCEPT-BASED TEACHING & MEANINGFUL LEARNING

[If student answer is unclear or brief, prompt for elaboration: “Can you tell me more about that?”, “Go on”, “Anything else you’d like to add?”, etc.]

[After all the interventions have been discussed, ask the following.]

Do you have any ideas or thoughts you’d like to share about this case study?

[If student answer is unclear or brief, prompt for elaboration: “Can you tell me more about that?”, “Go on”, “Anything else you’d like to add?”, etc.]

[When the student has completed expressing her/his final thoughts, proceed to the following.]

I’d like to review my notes with you at this time. Here are the main ideas I’ve jotted down during our interview. [Review summary notations.] Do you believe these notes are an accurate summary of the thoughts you’ve shared? [If student indicates notes are inaccurate, request corrections and review corrected notes with student.]

Thank you for your time, and for sharing your thoughts about this case study with me today. The information you provided is very valuable, and will help provide a better understanding of how nursing students learn. A summary of this study’s findings will be shared with you when the study is completed.
Appendix G

Flow Map Diagram
Legend
• First row lists categories of primary concepts or ideas expressed by the participant
• Statements below each category heading are those subsumed under that component idea (concept)
• Numbers in 2nd row+ indicate sequential order of the ideas expressed by the participant
• Backward arrows (dotted lines) indicate cross linkages to ideas previously expressed by the participant
• Numbers in parentheses indicate elapsed time in seconds
Manuscript #1

Meaningful Learning: Theoretical Support for Concept-Based Teaching
Meaningful Learning: Theoretical Support for Concept-Based Teaching

Teresa J. Getha-Eby, Theresa Beery, Yin Xu, and Beth O’Brien

University of Cincinnati

Author Note

Teresa J. Getha-Eby, PhD(c), RN-BC, College of Nursing, University of Cincinnati; Theresa Beery, PhD, RN, ACNP-BC, CNE, College of Nursing, University of Cincinnati; Yin Xu, PhD, RN, College of Nursing, University; Beth O’Brien, PhD, College of Education, Criminal Justice, and Human Services, University of Cincinnati

Correspondence concerning this article should be addressed to Teresa J. Getha-Eby, Good Samaritan College of Nursing and Health Science, 375 Dixmyth Avenue, Cincinnati, OH 45220.

E-mail: teresa.getha-eby@email.gscollege.edu
Abstract

Novice nurses’ inability to transfer classroom knowledge to the bedside has been implicated in adverse patient outcomes, including death. Concept-based teaching is a pedagogy found to improve knowledge transfer. Concept-based teaching emanates from a constructivist paradigm of teaching and learning, and can be implemented most effectively when the underlying theory and principles are applied. Ausubel’s theory of meaningful learning and its construct of substantive knowledge integration provides a model to help educators understand, implement, and evaluate concept-based teaching. Contemporary findings from the fields of cognitive psychology, human development, and neurobiology provide empirical evidence of the relationship between concept-based teaching, meaningful learning, and knowledge transfer. This article describes constructivist principles and meaningful learning as they apply to nursing pedagogy.

Keywords: concept-based teaching, constructivism, meaningful learning, nursing education
Meaningful Learning: Theoretical Support for Concept-Based Teaching

Much of the information communicated to students during traditional nursing education is done so using teacher-centered techniques, such as presentation of discrete factual knowledge using a lecture style format. These techniques and format allow the learner to assume a passive role in the educational process, and produce primarily surface learning of memorized and disconnected facts, rather than a deep understanding of underlying principles and concepts and how they relate to one another (Carver, 2006). A lack of understanding about how nursing knowledge is organized and connected prevents novice nurses from transferring classroom theory to the bedside (Levett-Jones et al., 2010), which is identified as one of the most common causes of patient harm or death (Ebright, Carter Kooko, Moody, & Latif Hassan Al-Ishaq, 2006).

Benner, Sutphen, Leonard, and Day (2010) assert that facilitating students’ knowledge connections during pre-licensure nursing education will improve patient outcomes. When knowledge is connected, students are better able to recognize the relationships between patient assessment data and basic principles governing patient care decisions (Candela, Dalley, & Benzel-Lindley, 2006). Recognizing relationships and principles produces more generic knowledge that can be transferred from the classroom to specific patient situations.

Concept-based teaching is an innovative pedagogy that has shown promise in improving students’ knowledge building (Morse & Jutras, 2008) and transfer (Lasater & Nielsen, 2009). This pedagogy can be implemented most successfully when nurse educators understand the cognitive processes that occur during learning (Quintana, Shin, Norris, & Soloway, 2006). Nurse educators who understand these processes are better prepared to plan learning activities that
MEANINGFUL LEARNING & CONCEPT-BASED TEACHING

enhance nursing students’ knowledge connections and develop strategies to assess student learning (Greer, Pokorny, Clay, Brown, & Steele, 2010).

Background

Most nursing education programs have been based on the Tyler model of education, in which the curriculum is content-laden and teacher-driven, rather than focusing on how learning might best be supported (Dillard & Siktberg, 2009; National League for Nursing, 2004, 2005, 2007; Sauter, Johnson, & Gillespie, 2009). The Tyler model, developed in the 1940’s, was a valuable contribution toward much needed curricular reform at the time, but is not in alignment with contemporary, evidence-based educational principles (National League for Nursing, 2007).

State Boards of Nursing used the Tyler model as a framework to evaluate nursing education programs and grant approval/accreditation, which resulted in an emphasis on the programs’ adherence to a legislated list of content to be covered (Bevis & Watson, 1989). Many nursing curricula continue to fit this model, both in format and in assessment of student learning. The format is topic-directed, linear, and inclusive of a continuously expanding volume of information related to the prescribed content (Ebright et al., 2006), and student outcomes are assessed by testing how many facts and procedures learners are able to recall after being taught (Sawyer, 2006).

The large volume of content presented in a Tylerian-based curriculum does not afford students the cognitive processing time needed to recognize connections between related pieces of information (Ironside, 2005). The topic-directed, linear format does not facilitate students’ comprehension of how nursing knowledge is organized and linked, and the assessment methods reinforce the notion that knowledge recall is the only expected outcome. Many nursing students respond to this situation by relying on rote learning, or memorization of superficial facts, as a
means of survival, rather than attempting to understand why and how information relates to nursing practice, such as why patients’ conditions manifest as they do and how nursing interventions influence those conditions. The student using rote memorization as a learning strategy creates a disorganized collection of facts in her or his mind (Ausubel & Fitzgerald, 1961).

The lack of organization and accurate connections associated with rote learning limits information retention and retrieval (Ausubel & Fitzgerald, 1961), somewhat analogous to how a scrambled electrical circuit impedes electrical transmission. The ultimate outcome is a novice nurse who possesses a great number of disconnected facts that cannot be recalled rapidly enough to engage in the decision-making necessary for safe and effective patient care. Moreover, the absence of purposefully created knowledge connections prevents the nurse from recognizing general conceptual principles that can be applied to similar but different patient situations. The novice nurse with a well-organized and integrated knowledge structure, in contrast, is a more agile thinker and better able to process information in a more abstract or conceptual manner (Benner, 2001; Benner et al., 2010). This nurse is more adept at rapid knowledge recall and the knowledge transfer so essential to sound clinical decision-making.

**Meaningful Learning Theory and Constructivism**

Teaching and learning strategies that promote meaningful learning (Ausubel, 1963, p. 22) are the key to effective transfer of knowledge from the classroom to real world situations (Ausubel, 1963; Novak, 2010). Meaningful learning occurs when the learner connects new information “in a nonarbitrary and substantive (nonverbatim) fashion” (Ausubel, 1968, pp. 37-38) to her or his pre-existing knowledge. Substantive refers to the unique knowledge created when the learner translates new information into a form that makes sense, or has meaning, to her
or him, and connects the new information to related pre-existing concepts or ideas in her or his mind (Ausubel, 1968). The end result is a hierarchical organization of knowledge in the learner’s mind, referred to as “cognitive structure”, and a greater understanding of both pre-existing and new knowledge (Ausubel, 1968, p. 38).

Meaningful learning theory stems from a constructionist paradigm. The basic tenet of constructivism is that learning is an active process, one in which a learner constructs unique knowledge while attempting to make meaning of the world (Kafai & Resnick, 1996). The purpose of teaching, from a constructivist perspective, is to facilitate learning by providing an appropriate environment and relevant experiences that will assist the learner to create her or his own knowledge, rather than receive it intact and unchanged from others (Brandon & All, 2010; diSessa, 2006).

Contemporary educational and cognitive research studies provide evidence of the effectiveness of constructivist-based pedagogy (e.g., Bransford, Brown, & Cocking, 2000). Constructivism, however, is not a new teaching and learning philosophy. Constructivist philosophy is evident in the work of well-known educational theorists from the early 1900’s, such as John Dewey (1859-1952), Jerome Bruner (1915- ), and David Ausubel (1918-2008).

Dewey, Bruner, and Ausubel proposed that a learner’s underlying knowledge and previous experiences influence her or his interpretation of new experiences and subsequent learning (Ausubel & Fitzgerald, 1961; Bruner, 1960; Dewey, 1910). The learner’s recognition of connections between previous knowledge and events or objects encountered during formal or informal learning experiences results in the formation of abstract concepts (Ausubel & Fitzgerald, 1961; Bruner, 1960; Dewey, 1910). The learner uses concepts to organize her or his knowledge, and as a means of understanding new, related ideas. Understanding, however,
requires synthesis; the new idea is not merely added to the collection already existing in the learner’s mind, but is integrated meaningfully into the network of related knowledge (Ausubel & Fitzgerald, 1961; Dewey, 1910).

Integration and construction of new knowledge occurs when a learner actually transforms incoming information into a form that is understandable to her or him (Ausubel, 1961; Ausubel & Fitzgerald, 1961; Bruner, 1960, 1963). The best indication that this has occurred is not what the learner knows, but how he or she uses that knowledge (Ausubel & Fitzgerald, 1961; Bruner, 1960; Dewey, 1910). Once the learner establishes a clear understanding of underlying concepts and ideas and how they relate to new information or ideas, the knowledge becomes usable. Bruner referred to this as “generic” learning, which he viewed as the essence of “thinking” (Bruner, 1959, p. 192), whereas Ausubel referred to the process as meaningful learning (Ausubel, 1965).

Meaningful learning allows the learner to organize knowledge into a coherent whole. It is this coherence that allows significant relationships between new information and the pre-existing knowledge to be recognized, and the principles governing those relationships to emerge (Erickson, 2007; Marton & Säljö, 1976; Novak, 2010). The learner thus acquires a deep understanding of the knowledge. Deep understanding produces usable conceptual knowledge, as opposed to inert factual knowledge (L. W. Anderson et al., 2001), which learners can transfer to real world problem solving and decision-making (Erickson, 2007).

Deep understanding and knowledge transfer are of particular importance in nursing practice. Clinical judgment and decision-making are dependent upon the nurse’s ability to quickly recall pre-existing knowledge, manipulate and connect underlying knowledge and new information, and transfer underlying knowledge in an appropriate manner to the clinical situation.
at hand (Thompson & Dowding, 2009). Capacity for recall, manipulation, and transfer are influenced by an individual’s knowledge organization and number of connections in the cognitive structure (Ausubel, 1963, 1968; Ausubel, Novak, & Hanesian, 1978). When nursing students link new information to a concept already established in their cognitive structure, the new information attains stability and is thus more likely to be retained over time (Ausubel, 1963, 1965, 1968). The connected structure, moreover, serves as a network that facilitates information retrieval.

Recent research from the field of neurobiology provides empirical evidence of cognitive structure as a physical network that responds to learning experiences and specific types of thinking. Brain imaging studies indicate that learning produces structural changes in the brain itself. Kumaran, Summerfield, Hassabis, & Maguire (2009), for example, focused on brain responses during learning and decision-making. Neuronal connections were created and expanded upon during every learning experience, providing a physical manifestation of previous learning. Moreover, the connections appeared to serve as a pathway for information transmission (Kumaran et al., 2009).

Just and Varma (2007) report that strength and number of neural connections between different areas of the brain are associated with improved learning. Increased connectivity between areas that are “coactivated” during a learning experience coincide with positive changes in learning outcomes (Just & Varma, 2007, p. 187). Theoretically, this is because the augmented connections provide more efficient processing pathways between the involved brain areas.

Strong neural connections are activated during decision-making, particularly when a novel situation is encountered (Kumaran et al., 2009). Understanding a novel situation requires knowledge that is conceptual and, therefore, not context bound (Ausubel et al., 1978). This
suggests that conceptual thinking and strong neural connections are interrelated, and that meaningful learning, during which learners forge and stabilize knowledge connections, has the potential to improve nursing students’ recognition and understanding of novel or unfamiliar patient situations. Nurses encounter novel situations regularly and so require knowledge that is strongly linked and conceptual in origin. Concept-based teaching is a pedagogy that provides this foundation.

**Meaningful Learning Through Concept-Based Teaching**

Concept-based teaching operates from the premise that learners must have an accurate understanding of basic anchoring concepts and be actively engaged in the learning process in order to construct new knowledge in a meaningful manner (Erickson, 2007). Discipline-specific concept-based teaching coupled with active learning strategies allows learners to develop conceptual knowledge that can be transferred from the classroom to the world of work (Ausubel, 1963).

Ausubel’s (1968) theory of meaningful learning emphasizes the critical role served by a learner’s underlying knowledge, such as basic anchoring concepts. This emphasis is apparent in most well known quote:

“If I had to reduce all of educational psychology to just one principle, I would say this:

The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him (sic) accordingly.” (p. vi).

In concept-based teaching, foundational and discipline-specific concepts at a high level of abstraction are provided during initial learning experiences (Erickson, 2007). The abstract nature of the concepts makes them highly generalizable to a variety of related ideas. The concepts create a foundation on which students can build and organize subsequent knowledge (Ausubel,
Meaningful Learning & Concept-Based Teaching

1968; Novak, 2010). Logically organized and accurately integrated knowledge, in turn, produces meaningful learning.

Ausubel referred to key abstract ideas as *superordinate* concepts (Ausubel, 1965, p. 420). Superordinate concepts serve as linchpins to which related information is connected. They provide not only a foundation on which future knowledge can be built, but also a context to facilitate the student’s understanding of related, but more specific, information.

In a nursing curriculum, for example, the concept of homeostasis learned during a prerequisite science course might be explicitly related to the concept of fluid balance during a medical-surgical nursing course. Homeostasis, as a highly abstract concept with which the student is already familiar, serves as the anchoring or superordinate concept. Knowledge about homeostasis provides the student with a context from which the understanding of a new, related concept, such as fluid balance, might proceed. When a nurse educator implements learning activities that require students to relate the concepts of homeostasis and fluid balance, the students achieve a greater understanding of the new information related to fluid balance, while also acquiring a greater depth of understanding regarding homeostasis.

As more and more ideas are integrated into students’ cognitive structure, they develop a more nuanced understanding not only of the anchoring concept, but also of all other ideas and concepts connected to the anchor (Ausubel, 1963, 1968; Novak, 2010). When new ideas are connected to related but more abstract ideas, the entire network of related ideas becomes increasingly more distinguished (Ausubel, 1965). In other words, a nursing student’s pre-existing knowledge becomes modified when new knowledge is added. The more examples the student recognizes and relates to a general concept, the greater the student’s facility for recognizing related examples in the future, regardless of context (Ausubel et al., 1978).
Exemplars

Concept-related ideas are presented to students as *exemplars* in a concept-based nursing curriculum (Giddens & Brady, 2007, p. 68). Exemplars are examples of how specific concepts manifest themselves in nursing practice. As such, exemplars foster differentiation of a student’s knowledge structure (Erickson, 2007). Two exemplars that can assist students in differentiating the concepts of homeostasis and fluid balance, for example, are congestive heart failure and shock. These exemplars expand and define the existing network of information in the nursing student’s cognitive structure related to homeostasis and fluid balance.

The introduction of each concept and exemplar is accompanied by an explicit description of how the concepts and exemplars are related to one another, thus helping the student create a better-integrated cognitive structure. The nurse educator who explicitly connects the new information (i.e., the exemplars) to the student’s pre-existing knowledge base (i.e., the anchoring concepts) facilitates the student’s meaningful learning not only of homeostasis and fluid balance, but also of congestive heart failure and shock.

When a learner’s underlying knowledge is explicitly connected to new information, the learner is able to discern patterns and relationships (Ausubel, 1968; Erickson, 2007; Novak, 2010). Learners who discern relationships between concepts and ideas discover principles that can be applied to everyday life (Erickson, 2007). A learner’s ability to use knowledge in order to be productive and successful is one of the public’s greatest expectations of higher education (Higher Learning Commission, 2003), and is essential to safe and effective nursing practice.

Exemplars help nursing students recognize not only relationships between ideas, but also subtle differences that exist between those ideas. The ability to detect differences in similar but unfamiliar situations is particularly important in nursing practice, in which novel situations occur.
regularly due to the complex and dynamic nature of human beings. Exemplars help students create a deep conceptual understanding that allows them to apply knowledge from the context of one patient to the context of another, and to the changing context of the individual patient as that patient’s condition evolves.

Students, unfortunately, do not always make connections to pre-existing knowledge in a meaningful manner. This occurs when the student either makes an erroneous connection or fails to make any type of linkage. Erroneous connections are often created during the process of integrative reconciliation, whereas absence of appropriate linkages results from arbitrary connections.

**Integrative Reconciliation**

Integrative reconciliation is a process whereby learners make adjustments in thinking in order to resolve seemingly contradictory information (Ausubel et al., 1978). This occurs when learners are confused, particularly when new information seems to contradict pre-existing knowledge (Ausubel et al., 1978). Learners reconcile contradictions between new information and what is already known by recombining ideas in the cognitive structure to create linkages that make sense (Ausubel et al., 1978). However, the process of integrative reconciliation sometimes produces misconceptions that prevent the learner from connecting and understanding related information in the future.

Learners sometimes create arbitrary knowledge connections (Ausubel, 1963). Arbitrary connections occur when learners acquire disconnected facts and pieces of information, have no information in their cognitive structure related to the new information, or are unaware of how new and pre-existing knowledge are related (Ausubel, 1963). The lack of connection results in inefficient, or complete lack of, recall of the arbitrarily connected information (Ausubel, 1963,
1968; Ausubel et al., 1978). The lack of organization associated with arbitrarily acquired information, due to a failure to connect new incoming information in a meaningful way to pre-existing information in a learner’s mind, is what typically occurs in rote learning. Concept-based teaching, in which key nursing concepts provide a foundation for understanding new, related ideas, can decrease students’ formation of arbitrary connections. In order to be effective, however, teaching strategies that require students’ cognitive engagement must be implemented in the concept-based classroom.

Ausubel proposed that meaningful learning does not occur unless the learner elects to integrate the new information into her or his pre-existing cognitive structure (Ausubel, 1968). Substantive integration of new information requires that the learner transform incoming information to a form that makes sense and aligns with her or his pre-existing knowledge. This process requires significant mental effort on the part of the learner and cannot be accomplished without cognitive engagement.

**Advance Organizers**

Advance organizers are teaching tools or strategies provided in advance of a learning experience. Advance organizers are an active learning technique because they stimulate learners to make meaningful connections between pre-existing and new knowledge (Ausubel, 1965). Advance organizers are capable of serving this function due to the fact that they are at a higher level of abstraction or generality than the information that follows, and are based on what the learner already knows (Ausubel, 1965).

Advance organizers scaffold learning by activating specific pre-existing knowledge in the student’s cognitive structure (Gurlitt, Dummel, Schuster, & Nückles, 2012). Learning activities that impel students to discover relationships between a previously learned concept and new
information provide a context from which new information can be understood, and a means of connecting new information to pre-existing knowledge (Erickson, 2007). Advance organizers are particularly successful with students who struggle academically. This is because struggling students often have difficulty making knowledge connections independently (Bruner, 1960).

*Perfusion* is one example of a nursing-specific concept abstract enough to be developed into an advance organizer. A diagram illustrating blood supply to the major organs of the thorax and abdomen, for example, can be used to prepare learners prior to a presentation of renal and heart failure. Learning activities that stimulate discussion of the principles of perfusion provide a framework from which learners can create their own understanding of how renal and heart failure are related, and how one might impact the other. Perfusion thus creates an explicit linkage between the two health conditions, rather than the arbitrary connection that would occur during the rote learning associated with a more traditional teaching approach.

**Implications for Nurse Educators**

A recent synthesis of more than three decades of research from the fields of educational and cognitive psychology, neuroscience, and human development generated principles to guide educators in the development of constructivist-based learning environments that promote meaningful learning (Bransford et al., 2000). The results of this synthesis were made available in a report entitled, *How people learn: Bridging research and practice*, published by the National Research Council (NRC).

The NRC findings indicate that teaching is most effective when: (1) learners’ thinking processes and underlying knowledge are considered during the planning, implementation, and evaluation of learning activities; (2) depth rather than breadth of a subject is addressed, and, (3) learners are cognitively engaged during the learning process (Bransford et al., 2000). These core
learning science principles are in direct alignment with Ausubel’s theory of meaningful learning, and the principles underlying concept-based teaching.

Nurse educators can apply these teaching and learning principles by: (1) emphasizing concepts and principles most essential to nursing practice, (2) explicating the relationships between nursing concepts and principles and those learned in general education courses, and, (3) embedding active learning strategies throughout the curriculum, not only to provide opportunity for students’ knowledge building, but also to assess student learning.

Conclusions

National organizations have recommended that learner-centered pedagogies be instituted to facilitate nursing students’ ability for knowledge transfer, the ultimate goal of which is to ensure delivery of safe and effective patient care (Institute of Medicine, 2000, 2011; National Council of State Boards of Nursing, 2006a, 2006b, 2009a, 2009b; Tanner, 2011). Students must learn meaningfully in order to execute knowledge transfer (Ausubel, 1963). Concept-based teaching, a learner-centered pedagogy, has been found to significantly improve student’s meaningful learning in disciplines such as medicine (González, Palencia, Umaña, Galindo, & Villafrade, 2008) and college students’ understanding of science (Morse & Jutras, 2008).

Concept-based teaching facilitates meaningful learning through strategies that support learners’ knowledge integration, discovery of emerging principles, and development of conceptual knowledge (Ausubel, 1963; Novak, 2010). Concept-based teaching enhances learners’ depth of knowledge by helping them create a knowledge base that becomes increasingly more differentiated as new knowledge is incorporated.

Ausubel’s conception of a linked and hierarchically arranged cognitive structure helps explain why knowledge depth, rather than breadth, has been found to improve student learning.
outcomes, specifically outcomes related to knowledge transfer. The increasing differentiation that occurs as subordinate concepts and principles are integrated into the structure permits the learner to detect gradations in connected knowledge (Ausubel, 1968). The detection of subtle differences, in turn, enables the learner to select knowledge most relevant when interpreting familiar situations or trying to understand similar, yet unfamiliar, situations.

Strength and number of knowledge connections have been found to be significant factors in nurse performance. Specifically, decreases in both strength and number of connections negatively influence the nurse’s ability to attend to relevant data (Benner et al., 2010). In other words, in the absence of significant cognitive connections, such as those created during meaningful learning, nurses find it difficult to determine what information might be most pertinent to a clinical situation. As a result, essential patient assessment data is more likely to be missed, and patient safety and effective care jeopardized.

It is essential that nurses as “knowledge workers” (Ebright et al., 2006, p. 339) have a deep understanding of classroom-acquired, nursing-specific knowledge. Deep understanding produces context-free knowledge. Context-free knowledge allows the nurse to recognize various manifestations of nursing concepts, regardless of the specific health condition associated with the concept, and to apply the principles needed for safe and effective patient care.
References


MEANINGFUL LEARNING & CONCEPT-BASED TEACHING


MEANINGFUL LEARNING & CONCEPT-BASED TEACHING


MEANINGFUL LEARNING & CONCEPT-BASED TEACHING


MEANINGFUL LEARNING & CONCEPT-BASED TEACHING


Manuscript #2

Flow Mapping to Assess Student Learning
Flow Mapping to Assess Student Learning
Flow Mapping to Assess Student Learning

A multiyear study of professional education funded by The Carnegie Foundation for the Advancement of Teaching Support found that novice nurses are not adequately prepared for the demands of practice in the current healthcare arena (Benner, Sutphen, Leonard, & Day, 2010). The researchers concluded that continued use of traditional pedagogies is a primary factor contributing to nurses’ difficulty in applying classroom knowledge at the patient bedside. Instead, cognitive-based pedagogies known to improve nursing students’ transfer of discipline-specific knowledge are needed. The challenge is finding innovative ways to operationalize ideas from cognitive science and apply them to classroom teaching.

Research from the field of cognitive psychology indicates that knowledge transfer is best facilitated by pedagogies that promote meaningful learning (Ausubel, 1965). Meaningful learning occurs when a student makes connections between new information and her or his pre-existing knowledge. The connections help organize the knowledge in the student’s mind and create a structure that is more stable over time and more deeply understood. The organization and greater depth of understanding create conceptual knowledge that can be applied across a variety of contexts. Contextual thinking is essential to safe and effective nursing practice. This is because knowledge must be transferred from the context of the classroom to the bedside, from one patient’s situation to that of another, and from a specific patient’s baseline status to her or his evolving condition.

Nurse educators who understand how students create and use knowledge connections are better equipped to develop, implement, and evaluate pedagogies that foster discipline-specific knowledge building. Little nursing education research exists, however, to provide support in this regard. A review of studies included in a systematic review conducted by The National Council
FLOW MAPPING TO ASSESS STUDENT LEARNING

of State Boards’ of Nursing indicates that much nursing education research has focused on students’ attitudes, perceptions, and feelings, rather than on the cognitive processes students use to build nursing knowledge (Spector, 2006). Therefore, cognitive-based research is needed, as are methodologies to examine the mechanisms underlying knowledge building in nursing students. Flow mapping is a data collection and analysis technique that can help meet this need.

Literature Review

Cognitive maps, such as mind, knowledge, concept, and flow maps; have been used by educational researchers to explore learners’ conceptual understandings (e.g., Ifenthaler, Masduki, & Seel, 2011). Flow maps provide more consistent records of students’ cognitive networks than do student-created cognitive maps. This is because students differ in their ability to create student-created maps, such as concept maps (Tsai & Huang, 2002), making it difficult to compare one student’s cognitive organization to that of another.

A flow map, in contrast, is a graphical representation of a student’s expressed thoughts as diagrammed by the researcher (Anderson & Demetrius, 1993). Flow maps allow a student’s thoughts to be diagrammed as they are expressed, thereby providing a more accurate record of the chronological sequence of information processing. Flow maps have been used in studies in which students’ understanding of scientific concepts and principles were investigated (Carty, 2009). The findings indicate that flow maps provide a means of assessing learners’ depth and breadth of knowledge, as well as connections made between concepts, ideas, and principles or relational statements.

Process

The flow mapping process was developed by Anderson and Demetrius (1993) to represent the cognitive structure of individual high school science students. The method can be
adapted to create a graphic of nursing students’ knowledge organization. A patient case study is used as the discussion point for the flow mapping process in nursing students. Faculty experts review the case study and identify its primary concepts. Concepts underlying a congestive heart failure case study, for example, might include oxygenation and perfusion. A one-on-one, semi-structured interview is conducted and a narrative is created as the student responds to how and why questions related to the patient in the case study. The interview might begin by asking the student to identify the priority need for the patient in the case study, followed by a request to explain why the student selected the specific priority. The formation of an explanation requires that the student search through what she or he knows in order to find related, supporting information.

Open-ended questions are used to seek additional information as the interview progresses. The questions center around nursing assessment and interventions relevant to care of the patient experiencing the condition(s) identified by the student. Questions emphasizing how and why the nursing assessment, patient’s underlying condition, and nursing interventions are related are introduced in an attempt to reveal the participants’ understanding of related concepts and principles.

The flexibility inherent to the semi-structured interview allows the interviewer to explore themes that emerge as students discuss their thoughts. The interviewer uses open-ended questions to better discern students’ thinking patterns. The interviewer must avoid leading questions, and allow sufficient wait time for students’ mental processing following each question. Unbiased questions or thought probes are less likely to direct students’ thinking than are leading questions. Examples of probes include, “Can you tell me more about that?”, and, “Can you give me an example of that?”. Three to five seconds is the recommended wait time for
processing of science-based questions (Novak, Mintzes, & Wandersee, 2005). Conducting a pilot study in advance of the research interviews allows the interviewer to practice using non-directive questions and maintain sufficient wait time. It is imperative that the researcher interview students of varying levels of achievement during the pilot. This affords the interviewer experience in continuing a line of questioning with students who might be less articulate than others.

The interview is audio recorded and then transcribed to accurately capture the student’s words. The verbatim record provides additional insight into the meaningful learning process, and is essential to construction of the flow map (Anderson & Demetrius, 1993). Audio recording also allows the interviewer to attend more closely to the student’s words and conversational pauses, which might indicate confusion or additional thought processing. These cues prompt the interviewer to pursue additional non-directive prompts to better understand the student’s thinking.

Construction of the flow map begins with a review of the interview transcript and creation of a chart representing the student’s ideational network (Anderson & Demetrius, 1993). The chart’s column headings consist of the faculty-identified concepts. A column is created when the student references the concept. The student’s words or phrases related to the individual column headings are added sequentially in the appropriate column. Each column of the completed flow map provides insight into the student’s depth of understanding, as well as possible misconceptions regarding the corresponding concept.

Once the network chart has been created, arrows are added to indicate knowledge connections between concepts, principles, and ideas. Both linear and recurrent linkages, or connections, are identified. The arrows indicate the flow of knowledge in the student’s mind (Anderson & Demetrius, 1993). Linear connections indicate forward flow of the expressed
FLOW MAPPING TO ASSESS STUDENT LEARNING

thoughts and are designated by a forward-directed arrow, whereas recurrent linkages are signified by a backward-directed arrow. Recurrent linkages connect statements that relate one idea to another and thus reveal complexity of the student’s thinking and depth of understanding (Anderson & Demetrius, 1993).

The final step in the flow mapping process is to number the student’s statements in chronological order and insert time markers (Anderson & Demetrius, 1993). Chronological numbering provides a more precise record of the sequence in which ideas are expressed, whereas time marking provides clues as to the length of time required for retrieving information from memory and processing it (Anderson & Demetrius, 1993). Both provide quantitative measures that can be used to compare students’ thought processing.

Conclusions

The value of flow mapping lies in the opportunity it provides for detecting the principles students use to organize and link knowledge, and the contextual relations between the ideas expressed. The map also provides clues to the ideas or concepts most conducive to information processing and problem solving (Anderson & Demetrius, 1993).

Case study interviews require approximately 30-45 minutes. The benefits derived from the completed flow map, however, greatly outweigh the time investment. A flow map provides a rich graphic that demonstrates how nursing students come to understand, or misunderstand, discipline-specific knowledge, and is a means to assess and compare effectiveness of various teaching practices. Students’ thought patterns can be used to develop teaching strategies that facilitate accurate knowledge building, such as providing explicit explanations of commonly misunderstood principles or concepts and organizing curricular content in a manner that more closely mimics students’ natural thought sequences.
FLOW MAPPING TO ASSESS STUDENT LEARNING

References


Ifenthaler, D., Masduki, I., & Seel, N. M. (2011). The mystery of cognitive structure and how we can detect it: Tracking the development of cognitive structures over time. *Instructional Science, 39*(1), 41-61. doi: 10.1007/s11251-009-9097-6


Manuscript #3

A report of the study, its findings, conclusions, and implications for practice
Nursing Student Learning Outcomes in Response to Learner-Centered Pedagogy

Teresa J. Getha-Eby, PhD(c), RN-BC (Beta Iota Chapter); doctoral student, College of Nursing, University of Cincinnati, Cincinnati, OH; teresa.getha-eby@email.gscollege.edu

Theresa A. Beery, PhD, RN, ACNP-BC, CNE (Beta Iota Chapter); Professor; Director, Center for Education Research; College of Nursing, University of Cincinnati, Cincinnati, OH; beeryt@ucmail.uc.edu

Beth O’Brien, PhD, Assistant Professor; Developmental and Learning Sciences Research Center, University of Cincinnati, Cincinnati, OH; obrienba@ucmail.uc.edu

Yin Xu, PhD, RN (Beta Iota Chapter); Associate Professor, College of Nursing, University of Cincinnati, Cincinnati, OH; xyi@ucmail.uc.edu

Correspondence to: Teresa J. Getha-Eby, Good Samaritan College of Nursing and Health Science, 375 Dixmyth Ave, Cincinnati OH 45220, 513.862.3719/513.862.3575, teresa.getha-eby@email.gscollege.edu
Abstract

Purpose: This study investigated meaningful learning outcomes of first semester associate degree nursing students. Design: The mixed methods explanatory sequential design was conducted at a private nursing college in the Midwestern United States. The quantitative strand compared meaningful learning, as measured by higher order thinking (HOT) gain (i.e., pre- to post-test difference), of two groups: students exposed to concept-based teaching (CBT) and students exposed to traditional nursing pedagogy. Data were extracted from 346 archived records of six consecutive cohorts, three CBT and three traditional, collected between spring, 2009 and fall, 2011. The qualitative data were collected in spring of 2012 from 22 CBT students purposefully selected by HOT scores, using maximal variation sampling to increase understanding of the learning process. Methods: Multiple regression was used to determine group differences in HOT gain and analyze predictor variables. Qualitative one-on-one discussions of a novel case study were analyzed through flow mapping. Findings: There were no significant between group differences. Pre-test score, which demonstrated an inverse relationship with gain, was found to be the best predictor of gain for both groups. Integrative analysis found CBT students who verbalized a greater number of knowledge connections had higher HOT scores and a deeper understanding of principles underlying nursing interventions, than did students with lower HOT scores. Conclusions: Beginning associate degree nursing students who struggle in creating knowledge connections experience significant improvement in this skill, regardless of teaching method. Theoretically, CBT has the potential to improve this skill over time.

Key words: educational outcomes, meaningful learning, concept-based teaching, cognition

Clinical Relevance: This study is unique in being theoretically underpinned by accepted learning theory. Future research can build on the results to determine best practices in nursing education.
Student Learning Outcomes in Response to Learner-Centered Pedagogy

Traditional pedagogies, such as lecture-style presentation of a content-heavy curriculum, have been identified as a factor contributing to novice nurses’ difficulty providing safe and effective patient care (Benner, Sutphen, Leonard, & Day, 2010). Learner-centered pedagogies are needed to remedy this situation - pedagogies that are based on evidence from the cognitive and learning sciences (Emerson & Records, 2008) and better facilitate new graduates’ transfer of classroom theory to the patient bedside (Finkelman & Kenner, 2009). More than three decades of research synthesized from education, cognitive psychology, and neuroscience indicates that learner-centered pedagogies promote knowledge transfer by fostering meaningful learning (Bransford, Brown, & Cocking, 2000). Meaningful learning occurs when students make substantive connections between new information and their pre-existing knowledge (Ausubel, 1968). The connections help students organize their knowledge, recognize underlying principles, and create a cognitive structure that is more nuanced and stable over time. These processes produce a more generic, conceptual understanding that can be applied across a variety of contexts (Ausubel, 1968), such as from one patient to another and from an individual patient’s baseline condition to changes that manifest as the patient’s condition evolves.

Concept-based teaching (CBT) is a learner-centered pedagogy that has been found to significantly improve student’s meaningful learning in medicine (González, Palencia, Umaña, Galindo, & Villafrade, 2008) and college science courses (Morse & Jutras, 2008). Very little is known, however, about the effect of CBT on cognitive learning outcomes in nursing students. Much of the CBT nursing literature has been anecdotal (e.g., Kantor, 2010) or, if research-based, has focused on students’ clinical performance (e.g., Lee-Hsieh, Kao, Kuo, & Tseng, 2003) or on cognitive outcomes of groups rather than individual learners (e.g., Lasater & Nielsen, 2009). The primary purpose of this study was to provide empirical evidence of CBT’s cognitive effects on individual nursing students’ meaningful learning. The framework for this study is David Ausubel’s (1968) theory of meaningful learning.
CBT learning experiences begin with faculty presentation of foundational, discipline-specific concepts at a high level of abstraction (Erickson, 2007). These highly generalizable concepts serve as anchors in the student’s cognitive structure and provide context for future learning, thus scaffolding comprehension of newer related information (Ausubel, 1968). Anchoring concepts are followed by faculty introduction of related concepts and examples, referred to as exemplars, of how the concepts manifest, and opportunities for students’ cognitive engagement (Erickson, 2007). The combination of explicit instruction and engagement allows the student to create knowledge connections in a manner that makes sense to her or him. This process modifies and differentiates the entire network of related ideas in the student’s mind, improves the student’s ability for conceptual thinking (Ausubel, 1968), and creates synaptic links that increase transmission in the brain (Kumaran, Summerfield, Hassabis, & Maguire, 2009).

Oxygenation is an example of a concept abstract and generalizable enough to serve as an anchoring concept. This concept, often presented in a prerequisite biology course, can function as an anchoring concept in a nursing curriculum and be accompanied by exemplars of oxygenation compromise, such as atelectasis and pneumonia. A case study or human patient simulation scenario focusing on postoperative pneumonia would provide opportunities for students to actively process key ideas and principles related to oxygenation, thus creating a favorable condition for meaningful learning.

Empirical studies of meaningful learning are scarce in the current literature. The literature review for this study, therefore, includes findings from earlier works in which age, gender, and previous education were found to influence meaningful learning as evidenced by conceptual understanding. Berlyne (1957) found a positive relationship between conceptual understanding and age in children, whereas Lawton (1977) found age to be inconsequential. The findings related to gender have also been inconsistent. Gerstner and Bogner (2009) found performance of females to exceed that of males when concept maps were used to measure meaningful learning, whereas Kost, Pollock, & Finkelstein (2009) found males to outperform females on a test of conceptual understanding. The difference in the latter
STUDENT LEARNING OUTCOMES

study appeared to be related to males’ previous science course exposure, rather than gender itself, and to the influence of male students’ positive attitudes toward science (Kost, Pollock, & Finkelstein, 2009).

Conceptual understanding is only one of five higher order cognitive processes contingent upon meaningful learning experiences. A student’s ability to apply, analyze, evaluate, or create knowledge also provides evidence of meaningful learning (Anderson, et al., 2001). This study used a measure of multiple higher order thinking processes to compare meaningful learning outcomes of two nursing student groups exposed to two different nursing pedagogies. One group received traditional pedagogy with infrequent classroom opportunities for active learning, and the other to CBT received regularly scheduled, classroom-embedded active learning.

Methods

Design, Hypotheses, and Research Questions

An explanatory sequential design was used to test the quantitative hypotheses, and answer the qualitative and integrative questions. The hypotheses were: (1) Nursing students who received CBT integrated with active learning will exhibit a significant increase in meaningful learning, as measured by the difference between standardized pre- and post-test higher order thinking scores, and, (2) The nursing student group that received CBT will have a significantly greater HOT gain than the nursing student group that received traditional nursing pedagogy.

The aim of the qualitative strand was to gain a greater understanding of the mechanisms underlying meaningful learning following CBT. This was accomplished by exploring the knowledge connections students made between nursing-specific concepts and principles during a case study discussion, and by identifying students’ patterns of thinking.

The ultimate expression of meaningful learning is the ability to process information in a new way, such as that which occurs when a novel situation is encountered (Benner, 2001; Novak, 2010). This is because novelty requires mobilization of multiple knowledge connections and related principles. The qualitative strand of this study used a novel patient case study as the point of discussion during student interviews. The qualitative question was: What overall patterns emerge during discussion of a novel
STUDENT LEARNING OUTCOMES

patient case study related to the concept of oxygenation, when the thinking of nursing students who received CBT is analyzed?

The quantitative and qualitative strands interfaced at two points. The first occurred when the qualitative sample was purposefully selected based on individual students’ quantitative results, and the second when information from the qualitative analysis was used to help interpret the quantitative findings. The quantitative and qualitative data were iteratively compared to one another and to relevant theoretical information to answer the integrated questions: (1) Does thinking qualitatively differ between students achieving scores from the uppermost quartile vs. the lowermost quartile on the quantitative post-test higher order thinking measure?, and, (2) How do the patterns identified through analysis and interpretation of the CBT group’s qualitative data help explain the CBT group’s quantitative findings?

Quantitative Strand

Sample and Procedures

This study’s convenience sample was drawn from students in a private, hospital-affiliated associate degree nursing program in the mid-western United States. The college, with an approximate enrollment of 250, is a private, not-for-profit institution accredited by the Higher Learning Commission and the National League for Nursing Accrediting Commission, Inc.

The data were extracted from archived records of six consecutive cohorts enrolled in the first nursing course in the semesters prior to and immediately following a curriculum revision. Three cohorts represented the final three offerings of the traditionally formatted course (i.e., spring, 2009; fall, 2009; and spring, 2010), and three represented the first three offerings of the CBT course (i.e., fall, 2010; spring, 2011; and fall, 2011). The rationale for selecting first semester students was to evaluate the initial effects of the revised curriculum during the phasing-in process.

Although both courses consisted of 192 hours and addressed similar topics, the pedagogy differed. The CBT class sessions focused on specific nursing concepts, such as oxygenation. The traditional curriculum, in comparison, was content-laden and organized by body system. Sexuality, growth and development, and an introduction to pharmacology were included in the traditional first
STUDENT LEARNING OUTCOMES

semester course but were absent from the CBT. Topics presented in the first semester CBT course but not in the traditional included inflammatory response, information literacy, osteoporosis, professional boundaries, and information technology.

The total number of students enrolled in the course during the time of interest (spring, 2009 - fall, 2011) was 430, with 224 students in the traditional group and 206 in the CBT. The inclusion criteria were pre- and post-test completion. Students repeating the course were excluded to prevent potential confounding influence of repeated content exposure on learning outcomes. The sample size was 346, with 176 students in the traditional group and 170 in the CBT group, after eliminating records of students who repeated or did not complete the course.

All data were collected from archived records after Institutional Review Board approval was received. Variable selection was based on those found to affect meaningful learning as indicted by the studies previously discussed. These variables included age in years, previous science coursework, and gender. Previous science learning was operationalized as the total number of high school and college life or physical science course credits awarded to a participant in the five years preceding the beginning of the first nursing course. The life and physical science courses (i.e., biology, chemistry, physics, etc.) were identified in accordance with descriptions from the National Education Association and The College Board. The Carnegie formula was used to convert all course credits to the equivalence of a college semester hour. Data on gender were collected to describe and compare the samples but were not included in the statistical analysis due to the low number of males, which is common among nursing student cohorts.

Meaningful learning was operationalized as participants’ higher order thinking (HOT) scores on enrollment (pre-test) and at conclusion of the first nursing semester (post-test), as measured by the Assessment Technologies Institute (ATI) Critical Thinking Assessment (CTA) and ATI Nursing Fundamentals 2007 Assessment (Form B), respectively. Both tests are based on six competencies identified in the American Philosophical Association’s Delphi Research Report on Critical Thinking (ATI, 2006) that correspond to cognitive processes of Bloom’s Revised Taxonomy. Both the CTA and
STUDENT LEARNING OUTCOMES

Nursing Fundamentals demonstrate acceptable reliability and construct and criterion-related validity (ATI, 2008). The process and criteria for labeling the cognitive level for each test item is identical for both instruments, the labels are in alignment with those of the NCLEX-RN test items (ATI, 2001), and both instruments have been found to correlate with NCLEX-RN performance (Carl, 2007; Vendenhouten, 2008).

The pre-test instrument provides a measure of higher order thinking processes necessary for success in nursing, such as explanation, analysis, and inference; as applied to general knowledge, whereas the post-test instrument measures higher order thinking as applied to nursing content knowledge. The difference in content was considered acceptable because higher order thinking, rather than specific content knowledge, was the construct of interest for this study and participants were expected to have little to no nursing content knowledge prior to beginning the first nursing course experience. The post-test blueprint was compared to the course outline for the traditional and CBT course to determine whether or not the instrument included content addressed in one course but not the other. No differences were found.

Data Management and Analysis

The data were entered to an Excel® file created on a password-, virus-, and firewall-protected computer and analyzed using SPSS 19®. The pre- and post-test scores were standardized and the difference calculated to measure change in HOT gain (GAINZ). Descriptive and t-statistics were calculated to compare groups, and multiple regression using backward elimination was used to determine the contribution of the five independent variables to variance in GAINZ, which served as a proxy for change in meaningful learning. The variables entered into the model included METHOD, AGE, PrevSciCourse (science credits), PreTestZ (standardized pre-test score), and TestTimeInterval (pre/post interval). Partial correlation for METHOD (CBT or traditional teaching) and GAINZ was calculated to determine the strength of the direct relationship between these variables while controlling for the four other independent variables.
STUDENT LEARNING OUTCOMES

Results

The two groups did not differ significantly on demographic composition, number of previous science credits, pre/post raw scores, or pre-/post-test interval (Table 1). The mean gain for both groups equaled zero, due to negative gain scores. Multiple regression analysis, using the backward elimination method, found METHOD and AGE contributed the least to variance in GAINZ with an observed significance greater than 0.10. Consequently, METHOD and AGE were removed from the model. A significant model emerged ($F_{3,342} = 70.691, p < .0005$, adjusted $R^2 = .38$). The significant predictor variables were PreTestZ ($\beta = -.627, p < .0005$), PrevSciCourse ($\beta = -.146, p = .001$), and TestTimeInterval ($\beta = -.074, p = .08$). Partial correlation between METHOD and GAINZ while controlling for AGE, PrevSciCourse, PreTestZ, and TestTimeInterval found a negligible relationship that was not statistically significant ($r = 0.17, p = .76$).

Qualitative Strand

Sample and Procedures

The sample was purposefully selected from students in the final CBT cohort. The research assistant (RA), a first semester faculty member, prepared a list of students whose end-of-semester HOT scores were from the upper- or lowermost quartile of the quantitative post-test. The purpose of this maximal variation sampling was to provide a more complex understanding of meaningful learning. There were 22 participants, four males and 18 females, with 11 participants in each HOT group. The PI had no interaction with the students prior to the study.

The qualitative data consisted of students’ thoughts as verbally expressed during discussion of a novel patient case study. First semester faculty unanimously selected the case study from three PI-provided alternatives. The studies were drawn from nursing textbooks with high market share that were not assigned reading for the students in the study. The primary condition described in all three case studies related to the concept of oxygenation, a concept to which the students had been exposed through didactic, clinical, and human patient simulation experiences. The secondary concept was perfusion. Faculty selected the study that best exemplified principles with which the students would be familiar, yet
focused on an unfamiliar exemplar. The exemplar in the selected case study was traumatic pneumothorax following an auto accident. The faculty expected students would easily identify oxygenation as the patient’s primary need due to the frank respiratory findings, but would find it difficult to identify a perfusion need due to the more subtle cardiovascular data.

**Data Management and Analysis**

The PI maintained detailed audit records for confirmability and a journal in which potential biases were identified and addressed. The data were collected during a one-time, one-on-one, semi-structured interview. Prior to the interview, participants received a $15 gift card as compensation and signed a statement agreeing to maintain confidentiality of the case study discussion. The PI conducted all interviews in a private location adjacent to the college. Students were asked to identify the priority need for the patient in the case study, suggest nursing interventions, and provide explanations for their decisions. Subsequent questions emphasizing *how* and *why* the assessment data, underlying conditions, and nursing interventions were related were introduced to elicit students’ depth of understanding (Novak, 2010). All interviews were audio recorded.

Data were analyzed through flow mapping, a technique developed by Anderson and Demetrius (1993) to evaluate students’ knowledge connections and understanding of scientific concepts and principles. Flow maps are a graphical representation of the chronological order in which a student’s thoughts are expressed that illustrate the sequence of information processing (Anderson & Demetrius, 1993). Flow maps are researcher-created and, consequently, are more consistent in quality than student-created cognitive maps. Flow maps have been used to investigate students’ understanding of scientific concepts and principles, and have been found to provide a means of assessing learners’ depth and breadth of knowledge as well as the connections learners make between concepts, ideas, and principles (Carty, 2009).

A pilot study was conducted to provide the investigators experience in the flow mapping process and to develop the PI’s skill in conducting the interviews, formulating non-leading questions, and providing adequate wait time for student processing. Inter-rater agreement for the pilot study, calculated
by dividing the number of relational statements identified by both raters by the total number of relational statements identified, was 0.93.

The case study interviews were transcribed and triple-checked for accuracy against the audio record. Each transcript was identified by a pseudonym in order to blind the RA to students’ identities. The PI and RA independently created a chart of each student’s transcript. Column headings were created for each concept referenced by the student, and student statements relevant to each concept were entered in chronological order as rows. Directional arrows were added: forward-directed to indicate temporal flow of the student’s expressed thoughts, and backward-directed to indicate relational statements. Relational statements were those in which the student explained how ideas or concepts were related, or which provided rationale for nursing interventions. Inter-rater agreement for the PI and RA-created flow maps, calculated in the same manner as in the pilot study, was 0.95. The PI and RA iteratively compared and contrasted the completed flow maps to identify patterns in students’ verbalized thoughts.

Results

Several patterns were identified when the completed flow maps were compared, allowing the maps to be divided into two groups with distinct differences. One group displayed two to four times the number of relational statements than the other, and more frequent movement between the concepts of oxygenation and perfusion. The other group displayed more frequent examples of circular thinking and fewer oxygenation/perfusion connections. A similarity noted in both groups was misconception regarding carbon dioxide processing. Approximately one-third of the students identified carbon dioxide as being retained during periods of hyperventilation. The effect of this misconception on students’ further thought processing was evident in verbal expressions of confusion when they tried to explain the relationship between carbon dioxide and oxygen, their effects on patient signs and symptoms, and nursing interventions.

Integrated Strand

HOT scores were examined after the thinking patterns had been identified, to determine whether or not there was a qualitative difference in thinking patterns associated with HOT scores. The maps
containing a greater number of relational statements were found to belong to students whose HOT scores were from the upper quartile (Figure 1). One student with a high HOT score, for example, stated, “The heart rate would increase umm . . . to try to get more oxygen to the body. Umm . . . and then also because the chest – the left side is expanding more than the right on inspiration; that could be the reason for the increased respirations, because she’s not taking in enough oxygen”. The maps from this group of higher scoring students also exhibited more frequent movement between the concepts of oxygenation and perfusion. The maps demonstrating less movement between concepts and fewer relational statements, in contrast, were found to be from interviews of students with low HOT scores.

Another pattern identified was that of circular thinking. The maps demonstrating this pattern were found to be from students whose HOT scores were in the lowermost quartile. The student with the lowest score, for example, described the patient’s priority as, “She’s having trouble breathing”, and explained the cause as, “Because she’s not getting enough oxygen”. When asked why the patient wasn’t getting enough oxygen, the student responded, “Because she’s having trouble breathing”. Students in this group frequently made references to the body “working harder” when asked to provide a possible explanation for the patient’s physical findings. In comparison, students in the other group provided greater physiology-based detail such as, “She’s not getting enough oxygen in her body because her lungs – her right lung is partially collapsed. She’s not able to . . . fill her lungs completely and have gas exchange”. Maps containing this type of explanation were found to be from students with high HOT scores.

Discussion

CBT was not shown to make a significant quantitative difference in meaningful learning outcomes within or between groups. This finding is in contrast to previous research studies in which CBT improved meaningful learning in medical (González, et al., 2008) and college level science students (Morse & Jutras, 2008), and in nursing student groups (Lasater & Neilsen, 2009). The dissimilar results are possibly due to differences in length of time permitted for students’ cognitive processing and pedagogical strategies used. The length of time between initiation of the academic program and the point at which the outcome measures were taken was two to three times longer in previous studies than the
STUDENT LEARNING OUTCOMES

interval for this study. Increased time provides opportunity for additional learning experiences in which concepts can be reinforced and additional processing time in which students can more fully integrate new information into their cognitive structures (Novak, 2010) and increase higher order thinking (Anderson, et al., 2001).

This study’s limited time interval between receipt of the new nursing information and measurement of meaningful learning outcomes perhaps also contributed to the students’ post-test scores. A large number of students, 48% of the CBT group and 53% of the traditional group, demonstrated negative gain due to a decrease in higher order thinking from pre- to post-test. This finding is likely influenced not only by the limited time for cognitive processing (a maximum of 14 weeks), but also by the fact that the measurement was taken at the conclusion of the first nursing course, rather than further along in the program when a broader foundation of nursing-specific knowledge had been created.

Pedagogical strategies used in previous CBT studies but not emphasized with this study’s CBT group included regularly scheduled collaborative learning and faculty correction of students’ misconceptions (i.e., González, et al., 2008; Morse & Jutras, 2008). Both strategies facilitate students’ depth of knowledge and higher order thinking (Bransford, Brown, & Cocking, 2000). Peer collaboration was also implemented in the Lasater and Nielsen study (2009) in which clinical judgment of student dyads and triads, rather than individuals, was measured.

The best predictor of meaningful learning, operationalized as HOT gain, was pre-test score, which exhibited an inverse relationship with gain. Students who began the nursing program with the lowest pre-test scores made the greatest increase in gain, as measured by higher order thinking. Teaching method did not impact this relationship. Students who scored high on the pre-test possibly had a pre-existing capacity to seek knowledge connections, whereas students with lower pre-test scores experienced difficulty with this process and, as a result, received greater benefit and exhibited higher gain, regardless of the teaching method. A ceiling effect in the post-test might also explain the downward trend in higher order thinking gain as pre-test scores increased. Ceiling effect would prevent capture of actual higher order thinking of students with high pre-test scores.
STUDENT LEARNING OUTCOMES

Previous science course exposure was found to contribute significantly to variance in the higher order thinking of this study’s students, and to have an inverse relationship. This is inconsistent with findings from previous studies (i.e., Kost, Pollock, & Finkelstein, 2009). The participants in this study obtained their previous science credits from a variety of educational institutions. It is possible the course quality varied among institutions and, as a result, influenced the relationship between science education and gain.

This study did not find age to be a significant predictor of higher order thinking as measured by gain. Previous studies (Berlyne, 1957; Lawton, 1977) found inconsistent results when age and higher order thinking relationships in children were analyzed. It may be that age-associated developmental differences account for the discrepancies between studies.

The findings from the study’s integrative strand, in which students who verbalized more relational statements were found to have higher HOT scores than students who verbalized fewer statements of this type, are supported by the principles underlying meaningful learning. Relational statements are evidence of knowledge connections and depth of knowledge, with a higher number of statements indicating greater depth of knowledge (Anderson & Demetrius, 1993). Depth of knowledge, in turn, increases one’s ability for higher order thinking (Ausubel, 1968). Theoretically, CBT improves aptitude for students’ higher order thinking by promoting development of knowledge connections. It may be that this effect of CBT becomes apparent over several academic terms and can be augmented by peer collaborative learning, as demonstrated by previous research (e.g., González, et al., 2008; Lasater & Nielsen, 2009; Morse & Jutras, 2008).

Limitations

This study failed to find significant differences in higher order thinking outcomes between CBT students and those in a more traditional curriculum. Possible explanations, in addition to those described in the preceding discussion section, include: (1) a difference does not exist, (2) the instruments were not sensitive enough to adequately capture HOT, and/or, (3) variation in HOT score was jeopardized by loss of students who failed to complete the course.
STUDENT LEARNING OUTCOMES

Summary and Implications

This study’s findings provide a foundation on which to build further nursing education research, specifically research focused on the cognitive processes involved in meaningful learning. The downward trend in gain associated with increase in pre-test score suggests students who have difficulty making knowledge connections receive greater teaching benefit than do students who are more adept at connecting knowledge at the outset. This study’s findings, in synthesis with information from previous research, suggest meaningful learning outcomes require more than one semester to become apparent. These outcomes might be enhanced through peer collaboration and faculty assistance in identifying and correcting misconceptions.

Quantitative research using larger sample sizes and evaluating long-term effects of CBT will be of great value in the future, as will qualitative methods that richly illustrate the important role knowledge connections play in nursing students’ higher order thinking.

Acknowledgements: This study was funded, in part, by a research grant from the University of Cincinnati’s Beta Iota Chapter of Sigma Theta Tau International.

References


STUDENT LEARNING OUTCOMES


Table 1

*Descriptive & t-Test Statistics for Traditional and CBT Groups*

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>%</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Traditional (N = 176)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>160</td>
<td>91.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16</td>
<td>9.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender CBT (N = 170)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>148</td>
<td>87.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>22</td>
<td>12.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional (range = 18 - 58)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBT (range = 19 - 58)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Science credits &lt; 6 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional (range = 0 – 80)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBT (range = 4 – 90.08)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Test Raw Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional (range = 40 - 92.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBT (range = 42.5 - 90)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-Test Raw Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional (range = 36 - 92)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBT (range = 44 - 92)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre/Post Interval (months)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional (range = 3.7 - 41.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBT (range = 4 - 48.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher Order Thinking gain (z-score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional (range = -2.83 – 3.03)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBT (range = -2.61 – 3.88)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Group differences by variable
Figure 1

Maximum Number of Relational Statement Identified on Flow Maps

**Figure 1: Maximum Number of Relational Statements Identified on Flow Maps**

- Maps Representing Uppermost Quartile on Post-Test
- Maps Representing Lowermost Quartile on Post-Test