CHAPTER 2
LITERATURE REVIEW

Nursing Students in Science Courses

Knowledge of science has been recognized as being critical in the performance of professional nursing skills (Casey, 1996). Nurses rely heavily on an extensive knowledge base in anatomy and physiology, microbiology, chemistry and pathophysiology in their practice. Success in science courses such as anatomy and physiology also has a high correlation with student success in completion of the nursing program of study and success on the state licensure examinations (Harris, Hannum, & Gupta, 2004).

Adequate bioscience knowledge has been linked to improved patient care, enhanced patient monitoring, increased recognition of drug interactions, and improved response to adverse changes in client conditions. Bioscience knowledge has also been proposed to improve communication between nurses and other professionals and nurses with patients (Jordan & Hughes, 1998).

Nursing students frequently have difficulties with content in science courses (Clancy et al., 2000). Several factors are believed to contribute to this problem. Nursing students often lack biology courses in high school and rarely take biology as an elective when they enter college coursework (McKee, 2002). This leads to a lack of familiarity with scientific language, concepts or theory (Gresty & Cotton, 2003). Nursing students often complain that science course content is too in-depth for their needs and often fail to understand the clinical significance of the course content (Nicoll & Butler, 1996).

There are other factors further compounding the problem of lack of science knowledge in nursing students. As the nursing profession emerged over the last half
century, the epistemological approach adopted by nursing increased the focus on behavioral and social sciences and subsequently decreasing the focus on biological and physical sciences (Trnobranski, 1993). Nursing professors and instructors often embrace these disciplines when seeking higher education; few nursing instructors undertake advanced degrees in biology. Likewise, few biology lecturers have nursing experience. This leaves a gap between the scientific knowledge nurses need and the practical application of that knowledge (Nicoll & Butler, 1996).

Graduate level nursing students entering a complex science course are also faced with many internal and external obstacles that can impede their ability to successfully complete the course (Kirby, Biever, Martinez, & Gomez, 2004). As outlined below, these obstacles can relate to their perceived ability in a science course, their lack of science education courses or extended time periods between their previous courses and the current courses, and their inability to organize and manage time and budget constraints (Nicoll & Butler, 1996).

Adult students returning to college often have added burdens of caring for small children, working part or full time while taking classes, and having to drive from hometowns to attend classes at night or on weekends. In addition, social demands may need to be put on hold during school years and limited vacation times have often had to be eliminated. Adult students often have to rely more heavily on extended family members to help achieve or to overcome the obstacles of home, school and work (Kirby et al., 2004).

Science courses in nursing are often taught early in the student’s course of study. The concepts in these courses often contain knowledge detail that is needed in application
of nursing principles (McKee, 2002). For example, in anatomy and physiology, students are taught the mechanisms for gas exchange in the lungs. Applications of those concepts, as related to patient care, are not taught until the nursing courses. In pathophysiology, this anatomy and physiology knowledge is used to relate to disease processes that impair gas exchange. Again, application for patient care is not part of the course content. It is only as the student enters nursing courses that the student is asked to relate the concepts of gas exchange to patient care. Since the application component of science concepts to nursing care occur as much as a year or two behind the anatomy and physiology, students may have lost the detail of the science knowledge.

It should be noted that pathophysiology is not usually taught in associate degree nursing programs. The pathophysiology may be shortened and integrated as part of the nursing course content, but it is usually very limited content. Some associate degree programs attempt to have students taking anatomy and physiology while taking the nursing course content.

This process of teaching all three levels of understanding content at the same time may have some appeal at first glance. Some authors have suggested this approach as a solution to the problem of teaching science to nursing students (Chan, 2002; Courtenay, 1991). Students have lecture on lung anatomy and lung physiology at the same time as the effects of disease on lung physiology and at the same time studying the nursing care of individuals with lung disorders. Professional level nursing students also need to incorporate the psychosocial aspects of care into the plan and incorporate the pharmacology and treatment regimes, so these aspects are taught at this same time. This type of program may put students at risk for cognitive overload.
Cognitive overload has been described as resulting from too much essential information at any given time. One method to prevent this is to segment the knowledge and allow the learner time between successive presentations and skill level challenges so that information can be managed more efficiently (Bruning, Schraw, Norby, & Ronning, 2004). This may create retention problems when students take physiology, pathophysiology and nursing courses progressively.

In a content-heavy science course, student attitudes and beliefs about the content often relate to perceived relevance to clinical practice (Nicoll & Butler, 1996). Past surveys of science course content ask students to rate feelings about entire course content (Courtenay, 1991) or application of non-specific science knowledge to practice (Jordan & Hughes, 1998). One study compared generic knowledge of both students and experienced practitioners to knowledge and attitudes about biological sciences in general and one concept, an influenza outbreak in their district, specifically. Both students and practicing nurses expressed a lack of confidence in their knowledge of biological sciences and neither group felt confident discussing the cause, biological basis for treatments, or lack of cure for the influenza outbreak although the nurses had taken care of patients during the outbreak (Clancy et al., 2000).

The above authors specified a need for a specific strategy to assist nursing students in improving biological knowledge and in improving outcomes for nursing students in science classes. Much of the student’s criticism of science course content is aimed at depth of content (Nicoll & Butler, 1996). A more thorough evaluation of course objectives and the use of the information in practice may assist in resolving the issues surrounding depth of content in science courses.
Course objectives can be categorized into three major domains: cognitive, psychomotor, and affective. Cognitive domain objectives are commonly used in education and are focused on the acquisition of knowledge. Psychomotor domains encompass performance of tasks. Affective domain objectives are concerned with beliefs, attitudes, values and emotions about the subject being taught (Morrison, Ross, & Kemp, 2001). The value of specific course objectives in the science component of nursing curricula has not been studied.

**Self-regulation strategies**

Self-regulation in learning is a process where the learner transforms their mental abilities into academic skills. Self-regulation initiates students to learn using goal setting, metacognition, time management and physical and social regulation to improve learning outcomes (Chen, 2002). Self-regulation has been proposed an effective strategy for improving learning outcomes, especially in courses where students have low self-efficacy and high anxiety (Pekrun et al., 2002). Studies have suggested that improved teaching techniques are needed to improve nursing student outcomes in science courses, including techniques used in self-regulation (Andrew, 1998).

Andrew and Vialle (1998) assessed undergraduate nursing student self-efficacy and learning strategies to compare them to outcomes in a science course. This study indicated that high self-efficacy and self-beliefs coupled with the use of learning strategies were correlated with high success rates. However, no studies could be found assessing the use of strategies to improve nursing students outcomes in a self-regulated science course. This includes studies on nursing graduate students.
Several models have been developed to improve student’s ability for self-regulation. Schunk and Zimmerman (1998) describe three phase model that include: forethought, performance/volition, and self-reflection. A method encompassing these three phases may be an appropriate model for application in a graduate science course for nursing students.

Schunk and Zimmerman (1998) outline several activities to develop forethought. These should facilitate: goal setting, strategic planning, self-efficacy, goal orientation, and intrinsic interest. Students enrolled in a graduate level science course may be overwhelmed with the amount of material that is covered in the course of a semester (Nicoll & Butler, 1996). Goal setting and forethought should be designed to divide course information into small manageable units to assist in prevention of student procrastination (Zimmerman & Schunk, 2001). To improve the student’s intrinsic interest the instructor needs to design teaching methods to relate materials to clinical performance (Clarke, 1995).

Performance activities include attention focusing, self-instruction, and self-monitoring (Schunk & Zimmerman, 1998). When students are given numerous tasks, they can become overwhelmed in their ability to perform. During lectures instructors can focus student attention on the items of greatest value for learning. However, students often do not understand the important points discussed in lecture and often have less than 50% of items the instructor deemed as important in their notes (Kiewra, 2002).

Therefore, homework assignments can assist the student in condensing the information into manageable tasks. Students with specific homework assignments can more easily perform self-instruction on what material is critical (Morrison et al., 2001).
Frequent testing with prompt feedback also allows students the ability to self-monitor their performance with sufficient time to alter study methods prior to completion of the course (Courtenay, 1991).

**Feedback**

The use of feedback has been recognized as important in assisting a self-regulated learning environment. Feedback has been found to promote self-efficacy, achievement and effort (Zimmerman & Schunk, 2001). Feedback can assist students with self-monitoring of answers and support other metacognitive processes (Kulik & Kulik, 1988).

Feedback can be categorized into three major forms: *load* is the total amount of information given in the feedback from simple correct/incorrect responses to elaborate answers; *form* is the similarity between the information presented in the instructional technique and the feedback; and *type of information* referring to information that is either restated, refers to information in instruction or provides new information (Kulhavy & Stock, 1989).

The importance of feedback and the timing of that feedback have been researched since the 1920’s. Studies have been conducted on the timing, type, and effects of feedback in both applied and simulated experiments. While feedback has been widely considered as a positive teaching strategy, results of the effects of feedback have been varied (Kulik & Kulik, 1988). Bangert-Drowns, Kulik, Kulik, and Morgan (1991) indicated that feedback’s most important instructional effect is in the correction of response errors.
Response error feedback provides students with the ability to learn where errors occur and to correct the errors. Studies have found that correction of errors has a much greater effect than the support for correct answers.

In a study of undergraduate psychology students, Dihoff, Brosvic, and Epstein (2003) found that immediate feedback of answers promoted retention of concepts when provided several days before an examination. In a subsequent study, these same authors (Dihoff, Brosvic, & Epstein, 2004) found that although all types of feedback had positive effects, immediate feedback demonstrated greater recall than end of test feedback or delay of feedback by 24 hours.

Conflicting data have been reported on differences in immediate feedback for each question and end of test feedback. Epstein, Epstein, and Brosvic (2001) found improved performance when feedback was given item-by-item instead of end-of-test. Buzhardt and Semb (2002) reported several studies where students became frustrated and had higher anxiety for item-by-item feedback and promoted the use of end-of-test feedback, but to allow students to go back and review questions and answers for further study before submitting answers.

While timing of feedback has been rigorously studied, research into what type feedback students need has only recently been researched. The use of computer systems allows for much more elaborate answers to provide in student feedback situations. Studies have also focused on ability feedback in comparison with effort feedback (Zimmerman & Schunk, 2001). This concept of complexity of feedback has been discussed for the past few decades.
Gordijn and Nijhof (2002) conducted a study comparing knowledge of correct response and elaborate feedback. They found that complex feedback was no more effective than simple knowledge of correct response feedback as an overall objective. They concluded that students with good reading comprehension had benefited more from the complex computer feedback than the students with poor reading skills. Their belief was that significantly more research needed to be conducted with computer systems to either support or refute their findings. They indicated that future studies comparing specific feedback (elaborate) in comparison with simply correct/incorrect statements should focus on content and student attributes in sorting out this problem. Students may need elaborate feedback with explanations or may be able to discern areas of problems with simple grading of answers however, students may also wish to know simply when they have made an error.

The complexity issue also has the added complication of complexity of content. Feedback is reported to have its greatest effect when the material studied is more complex (Clariana, Wagner, & Roher-Murphy, 2000). Therefore, item complexity needs to be considered. To critically evaluate complexity of science items for nurses one could assess prior knowledge through a pre-test format.

However, pretesting students for content can influence the posttest results (Gordijn & Nijhof, 2002). These authors used identical questions for pre- and posttests. Their belief was that the time of two weeks between the exams would negate the influence of pretesting.
Complexity of Content

Cognitive load theory developed from the premise that some learning activities require a greater amount of working memory than other activities. The high level activities place a greater burden on cognitive processes than lower level activities. Cognitive load can be both intrinsic and extrinsic. Intrinsic cognitive load is added by the content and complexity of the instructional content (Bruning et al., 2004).

Nursing students in complex science courses often complain that the material is difficult (Andrew & Vialle, 1998). Extrinsic cognitive load is added by teaching techniques such as video, drawings and animations (Bruning et al., 2004). Instructors teaching in courses with high cognitive demands should design activities that would reduce the amount of items in working memory at a given time thus reducing the cognitive load and making it easier for students to store information into long term memory. This could include dividing materials into smaller units for study (Bruning et al., 2004).

Self-reflection skills that often are used are self-evaluation, attributions, self-reactions, and adaptability (Schunk & Zimmerman, 1998). Students need to perform a critical self-evaluation of their performance on learning activities such as homework and tests. For example, the students need feedback on missed test items to determine why and how items were missed. The students can then adjust study activities to improve performance on future exams and assignments. Without feedback, even motivated students have a difficult time progressing through the material in a course (Ericsson, Krampe, & Resch-Romer, 1993).
The use of tactics mimicking self-regulation in development of a science course can have significant implications for the success of the student in areas beyond the class where the strategies are taught. Self-regulation can improve student performance in future classes by developing and improving study skills, improving self-efficacy, and building an essential knowledge base. Student clinical reasoning skills have also been strongly related to cognitive and metacognitive skills (Kuiper & Pesut, 2004).

Metacognition refers to the ability of the learners to have knowledge of or monitor and have control of their learning process (Bruning et al., 2004). Learners assess their own cognitive skills and manage their continued development during the learning process (Imel, 2002). This assessment allows students to discriminate between effective and ineffective strategies (Chen, 2002). Homework assignments can help students to monitor and control learning processes.

**Time Budget**

Adults returning to school face stress from four major sources: family stress, work stress, social stress and school stress. The return of an adult to school complicates a family life that is already under stress from demands of caring for children while balancing work and social demands. Students often have to cancel or forego many of the family and social obligations while in school and need significant support from extended family members as well as those within the core family unit (Kirby et al., 2004).

In a study on adults returning to school, many students reported increased status and respect at work. However, many reported increased stress due to scheduling difficulties, feeling busy, or tired. The students believed they lack negotiating skills to deal with employers demands on their time (Kirby et al., 2004).
Graduate nursing students frequently face these same time budget constraints. Nationwide approximately 76% are attending graduate school on a part-time basis, but 72% are employed on a full-time basis while attending school (Spratley et al., 2000). Instructors often complain that students are working late hours. In a study on adults returning to work, 93% of 522 reporting students indicated they were working full time (Kirby et al., 2004).

The nursing shortage often has students working nights and weekends to complete the workweeks shortened by classes. Employers are often forced to call students to work on days off due to staffing shortages. In addition to a regular work hours coupled with school and family obligations, many hospitals require mandatory overtime for all nursing employees; over one-third of all nurses reported they worked involuntary overtime in the past year (Lafer, Moss, Kirtner, & Reeves, 2003).

Many nursing students face additional pressures on time related to family obligations. Many have children living at home while attending school. If the nursing graduate students are single mothers, they have the added pressure of needing the job to provide for their children while they are attending school (Spratley et al., 2000). Kirby et al. (2004) stated that women returning to school were especially vulnerable to the effects of family and full-time work, especially where job was high-stress such as nursing. The authors also suggested that female students find it especially difficult to negotiate with employers for flexible time schedules to enhance educational opportunities.

When students have these types of home and work pressures, graduate courses that place heavy time budget demands on students may have poor performance outcomes.
if the learning processes are not streamlined and focused so that students can spend their limited study time efficiently.

Formation of a community of learners is one self-regulation strategy. Student communities are important in student satisfaction, retention and learning. Peer learning opportunities are often limited for nursing graduate students, yet the support of friends and classmates had a positive effect of reducing stress of work and school (Kirby et al., 2004).

Commuting time has also been identified as placing additional strain on student performance (Sherrod et al., 1992). Graduate nursing students are often separated from their peers by distance. These students rarely live in dormitory settings and often live at home. Many students state they have little or no contact with other students for peer or social learning development. Although instructors often encourage students to find study partners or to establish relationships for peer learning, students often have significant work and family demands which decrease their resources in attending the limited activities that offer opportunities for peer or social interactions (Kirby et al., 2004).

Effects of Computerized Teaching Methods on Self-Regulation

The use of self-regulated learning theories has proven effective in assisting students in disciplines outside of nursing, but self-regulation strategies have not often been applied to nursing students, especially as related to enrollment in science courses. Rarely are graduate students and their special needs addressed in the literature (Kirby et al., 2004).

Development of self-directed activities based upon the Schunk and Zimmerman (1998) model would include three major steps. First, motivation could be assessed.
Nursing students enrolled in science courses have often complained that the material is often not applicable to practice (Wynne et al., 1997). Student attitudes of course objectives could be measured to determine beliefs about applicability of the material. Each objective could be measured independently on a Likert-type scale. In a graduate nursing class, students are likely to have practical experience on the applicability of the course objectives to nursing practice (Courtenay, 1991). However, since these students are transitioning to a position where a higher skill/knowledge level is required, their expectations for the applicability of this knowledge to future practice need to be assessed.

The second step in Schunk and Zimmerman’s model for self-regulation is modeling. In areas where coursework is difficult, newly introduced or where self-efficacy is low, students need extensive modeling. This can include traditional homework activities that would help the students in the four methods of observational learning: attention, retention, production, and motivation. The students must also plan and organize their time in order to have sufficient time for rehearsing and coding of information (Schunk & Zimmerman, 1998). The content heavy science courses would be an important model for this system for nursing students where self-efficacy may be low and prior knowledge base limited (Andrew & Vialle, 1998).

Cognitive views of teaching students requires providing an acceptable set of strategies that students can use to process concepts being taught into meaningful and useful memory units. One strategy is to determine importance (Bruning et al., 2004). Nursing students may have difficulty determining which concepts have importance to their clinical practice and also which ones are the focus on exam questions (Nicoll & Butler, 1996). Since student awareness of importance improves with practice and
feedback, it would be important to develop a technique in the modeling phase that would provide both of these.

The use of computers is especially important in the modeling phase of a self-regulated learning environment (Hargis, 2001). Computer simulations and problem solving could provide an essential element that might be more difficult in a non-computer environment. That problem-solving element would be immediate corrective feedback.

Since science courses for nurses such as anatomy, physiology, and pathophysiology often rely on weekly, biweekly or at least frequent testing, the student work would have little chance of receiving corrective feedback through traditional method of instructor graded exams. Students often do not self-test themselves prior to an exam and then cannot make corrections in time to affect outcomes. Therefore, instructor designed practice tests and tutorials can give the student the opportunity to evaluate potential problems prior to taking the exam (Kiewra, 2002). The feedback from computer practice exams can be an essential tool in providing this evaluation step.

Computer systems can also assist students who have time constraints. If a tutorial were available to students at all times of day or night, students could access when they are free to spend time studying and focusing on the task at hand (Fredrickson, Clark, & Hochner, 2002). This is especially true for nursing students who may all be working different shifts, days of the week, and have special needs caused by their children’s schedules.

Care must be taken to reduce student problems with technology such as adequate training on the software and hardware components. Complications from technology such
as operating computers or television or video equipment can add to extrinsic cognitive load, especially if the equipment doesn’t always work smoothly (Bruning et al., 2004).

The final phase of Schunk and Zimmerman’s model is self-reflection. Self-reflective practice allows students to monitor their progress and learning, evaluate their performance to date, and adjust their performance during the learning process (Schunk & Zimmerman, 1998). Too often, this is accomplished simply by giving students feedback of their performance on exams. Feedback on exam performance is important and it is one technique to allow students to monitor their progress. However, students need to have feedback prior to the exam so they have time to evaluate content, questions and answers prior to the exam (Ericsson et al., 1993).

In content-heavy science courses, time for feedback and reflection is especially limited. Students enrolled rarely meet with instructors every day and in some courses, especially graduate courses, students meet with instructors only once before exam. This meeting would be during the course of the lecture over the material, denying the student the ability to reflect about the content, practice, and discover areas where questions may occur.

Development of academic expertise requires significant hours of practice. This would make the production and grading of homework essential in giving a student the opportunity to practice. To be effective, the instructor must devise a method to provide corrective feedback so that students can self-reflect, determine where errors are occurring and correct answers prior to examinations over the material (Schunk & Zimmerman, 1998). The instructional method that would help nursing students achieve in a difficult science course has not been studied.
Computer-based instruction could have a distinct advantage for students in self-reflection. Asynchronous communication between students and instructor enhances student motivation, intellectual commitment, and relationship between student and instructor (Conway, 2003). Students could be allowed to post questions in an asynchronous on-line discussion area, answer and assist each other with problems and problem-solve prior to the date of the exam. Allowing students to problem-solve prior to the exam is essential. The instructor could also present information in this format to assist in clarifying questions students may have asked in person, e-mail or telephone; allowing all students to benefit from the questions of one student. This discussion may be less threatening if students were allowed to post anonymously. In addition, if students are having difficulty with a question, the instructor can assist with this discussion and provide assistance to all students at one time (Gresty & Cotton, 2003).

In addition to feedback, other methods for self-reflection include personal attributions of which strategies were successful and which were not. Although students need to find success before the end of a course, it can also be positive to reflect upon strategies once the pressure of learning is past. Students can then carry this information forward to use in other courses. Finding positive attributes can assist students to develop a positive self-image as a learner and greater self-efficacy about future endeavors in use of the course content (Schunk & Zimmerman, 1998).

Self-regulation of learning could be an essential tool for improving outcomes for graduate nursing students in a content heavy science course. Methods to achieve positive outcomes in other situations have been well documented (Andrew, 1998; Howard, McGee, Shia, & Hong, 2001). However, the special needs of nursing graduate students
in a content heavy science course have not been investigated. Therefore, this
test could provide essential information on techniques that meet the needs of the
students for content while reducing the cognitive load, personal stress and improve self-
regulated learning techniques employed by students.