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UNIVERSITÉ DE SHERBROOKE

Faculté d'éducation

L'application de l'analogie conçue par les étudiants en tant que stratégie d'apprentissage dans un cours de biologie en soins infirmiers

The use of student-generated analogies as a learning strategy in biology for nursing

by

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SUMMARY

Numerous studies have identified the difficulty that students have in learning biological sciences in the context of their nursing education. Various strategies have been recommended, ranging from the choice of instructors to integrating more interdisciplinary work. One of the main concepts at the root of these strategies is the need to emphasize a bio-nursing approach, whereby the biological science course focuses on the occupation-specific knowledge necessary for effective nursing professionals. Drawing from this need for a bio-nursing approach and the role of biological sciences in nursing education, this study focused on exploring strategies to prepare students to be patient educators. With the intention of helping nursing students learn biological sciences, while also equipping them for their career as nurses, the researcher chose to explore the use of student-generated analogies. This focus came from the exploration of studies confirming that analogies are successfully used in science classrooms and that, in particular, student-generated analogies have shown great potential as an active learning strategy.

The purpose of this study was to explore the use of student-generated analogies in biological sciences for nursing as a bio-nursing approach. More specifically, the study focused on exploring the potential of student-generated analogies in improving the understanding and communication skills of students.

The sample group consisted of 23 students, the entire student group in an Anatomy and Physiology III course at Champlain - College in Lennoxville. The researcher chose a mixed methods approach, gathering quantitative and qualitative data with a variety of instruments. Each student produced two short video presentations (in the form of patient education) based on a health-related scenario of their choice. The first video was produced using traditional science-based instruction, and the second

video with an analogy created by the student. Before the second video assignment, the researcher provided instructions on creating analogies based on the Teaching With Analogies model (Glynn, 2007).

The video assignments were assessed using three specific rubrics produced by the researcher: a rubric for student understanding, a rubric for communication and a rubric for analogy creation (second video only). Questionnaires were also constructed by the researcher in order to ascertain and evaluate student perception of their improvement in understanding and communication. The students' grades from both assignments were used to quantitatively assess their improvement in understanding and communication. The students were asked to fill out a pre-intervention questionnaire after the first video assignment and a post-intervention questionnaire after the second video assignment. The questionnaires generated both quantitative data and qualitative data. Finally, four students agreed to be interviewed a few weeks later, resulting in greater depth to the qualitative data collected on the intervention.

Upon analysis, it was found that the use of student-generated analogies resulted in a significant improvement in student understanding of their topic – a fact that they also perceived. In their comments, student expressed that the intervention was helpful in encouraging greater depth of knowledge of their chosen subjects. However, no change was noted on their ability to communicate – one of the variables being evaluated. The students also noted no perceptible change in their ability of communication. Their unfamiliarity with analogies and with the use of figurative language can be considered the most likely causes.

Given the results of the study, it was concluded that student-generated analogies are a beneficial tool to help nursing students gain a better understanding of topics in biological sciences related to their professional role.

RÉSUMÉ

Plusieurs études démontrent la difficulté qu'ont les étudiants à apprendre les sciences biologiques dans le contexte de leur formation en soins infirmiers. De ces études découle une liste de stratégies recommandées afin d'adresser ce problème, et d'aider les étudiants en soins infirmiers à surmonter leurs obstacles d'apprentissage. Certains auteurs suggèrent une meilleure cohésion entre les cours de sciences biologiques et les cours en soins infirmiers en développant des outils interdisciplinaires. D'autres suggèrent une analyse approfondie des compétences ciblées pour l'enseignement des cours en sciences biologiques, et un choix d'enseignant qui répond à ces compétences.

Dr. Justus Akinsanya (1984; 1987) était un éducateur et chercheur en soins infirmiers avec une formation en sciences biologiques, et sa recherche en éducation l'a mené à critiquer la façon dont les sciences biologiques sont introduites aux étudiants en soins infirmiers. Ses recherches démontrent que l'enseignement des sciences biologiques en soins infirmiers a longuement été basé sur les programmes en sciences médicales, avec une approche approfondie aux niveaux cellulaires et moléculaires, tel que requis pour les étudiants en médecine. Les rôles et tâches de médecins et professionnels infirmiers ont des fondations différentes, et l'étude approfondie des sciences biologiques ne reflète pas la réalité de la profession infirmière. En fait, les besoins en connaissances biologiques pour les étudiants en soins infirmiers diffèrent grandement de ceux des étudiants en médecine; ils nécessitent une plus grande vision des soins corporels quotidiens et non pas des soins aux niveaux cellulaires et moléculaires. C'est pourquoi Akinsanya a émis un modèle intitulé « Bio-nursing », sur lequel la fondation de l'éducation en sciences biologiques devrait reposer, avec une emphase sur les soins conférés par les professionnels infirmiers.

Une orientation vers des stratégies qui se basent sur le modèle « Bio-nursing » d'Akinsanya a mené la chercheure de cette étude à cibler comme objectif une formation en sciences biologiques qui prépare les étudiants en soins infirmiers pour leur rôle en éducation des patients, une tâche qui dépend souvent des professionnels infirmiers. L'évaluation de diverses stratégies d'enseignement a suscité une attention particulière sur l'analogie en tant qu'outil d'apprentissage. L'analogie est une stratégie souvent utilisée en enseignement et permet aux enseignants de faires des liens entre les « savoirs » des étudiants et « l'inconnu ». Cette stratégie est utile dans le domaine des sciences, où les concepts abstraits et obscurs sont des obstacles d'apprentissage pour la plupart des étudiants.

Afin d'inciter la participation active des étudiants, la chercheure a ramené sa recherche sur les analogies conçues par les étudiants, plutôt que celles des éducateurs. Cette stratégie permet aux enseignants d'accompagner les étudiants dans leur

apprentissage des sciences biologiques, et de leur proposer un outil pour leur rôle en tant qu'éducateurs aux patients. L'objectif de la recherche est l'analyse de l'analogie conçue par les étudiants dans un cours de sciences biologiques en soins infirmiers en tant qu'outil d'apprentissage, afin d'améliorer leurs connaissances et leur facilité en communication de sujets en sciences biologiques.

Le projet de recherche a pris place au Collège Champlain de Lennoxville en automne 2015, et l'échantillon comportait le groupe complet d'étudiants inscrits au cours d'anatomie et physiologie III; un total de 23 étudiants. La chercheure a conçu des outils afin de susciter des données quantitatives et qualitatives. Trois rubriques ont été exploitées afin de recueillir des données quantitatives sur l'évaluation des connaissances, l'évaluation de la communication et l'évaluation de la création d'analogies (pour la deuxième tâche seulement). Des questionnaires ont été distribués aux étudiants afin d'amasser des données quantitatives et qualitatives sur la perception des étudiants face à leur acquisition en connaissances et à leur capacité en communication.

Les étudiants ont eu à réaliser deux tâches dans le contexte du cours d'anatomie et physiologie III, desquelles les résultats ont été recueillis pour le projet de recherche. Les étudiants ont reçu une liste de scénarios basés sur un patient avec un trouble médical spécifique, et de cette liste, ils devaient choisir un scénario sur lequel leurs deux tâches devaient s'appuyer. Une première tâche consistait d'une courte production vidéo démontrant l'instruction du patient du scénario de leur choix en utilisant une approche traditionnelle avec langage scientifique. Après une courte formation en création d'analogies, les étudiants avaient à répéter cette même tâche à nouveau, mais cette fois-ci, en utilisant une analogie dans l'instruction de leur patient. La première tâche a été évaluée avec les rubriques sur l'acquisition de connaissances et la capacité de communication des étudiants, tandis que la deuxième tâche a été évaluée avec les rubriques sur l'acquisition de connaissances, la capacité de communication et la création d'analogies. Les résultats des étudiants ont été analysés quantitativement à l'aide de tests t dépendants qui démontrent une amélioration significative au niveau de l'acquisition de connaissances entre la première tâche et la deuxième tâche. Toutefois, aucun changement n'a été démontré au niveau de la capacité en communication des étudiants. À noter que les résultats provenant des rubriques sur la communication étaient élevés, et que la création des analogies aurait amené un défi supplémentaire.

Après la première tâche, les étudiants ont répondu à un questionnaire qui sollicitait, entre autres, leurs impressions face à leur acquisition de connaissances et leur capacité en communication découlant de la première tâche. Un deuxième questionnaire a été distribué après la deuxième tâche qui sollicitait leurs impressions face à leur acquisition de connaissances et leur capacité en communication découlant de la deuxième tâche. Les questionnaires ont généré des données quantitatives et qualitatives. Quatre étudiants ont accepté de prendre part à des entrevues quelques semaines plus tard afin d'approfondir les données qualitatives découlant de l'étude. Les

données quantitatives ont démontré que les étudiants ont perçu une amélioration au niveau de l'acquisition de leurs connaissances entre la première tâche et la deuxième tâche mais qu'ils n'ont perçu aucun changement au niveau de leur capacité en communication. Les données qualitatives appuient ces conclusions.

Les données de l'études suggèrent que la création d'analogies dans un cours de sciences biologiques par des étudiants en soins infirmiers incite une amélioration dans leur acquisition de connaissances, sans pour autant avoir d'effet d'amélioration sur leur capacité en communication. Considérant l'objectif de l'étude, cet outil représente une stratégie idéale pour les cours en sciences biologiques en sciences infirmières, ainsi qu'un outil intéressant pour ces futurs professionnels infirmiers.

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INTRODUCTION

One of the great challenges of the 21st century is the need to address the impacts of a rapidly-growing aging population. Our healthcare system is enabling individuals to live longer and healthier lives, giving credence to the quality of care currently being offered. However, as the demands for care increase, and as we face new health challenges, maintaining this quality care for the current and future generations is crucial. A key to this dilemma lies in continuing to offer superior medical, nursing and allied healthcare education, and to do this, we must continue to produce capable and knowledgeable healthcare practitioners.

Biological sciences have a crucial role in nursing education; along with psychology and sociology, they are part of the foundation for current nursing practice (Davis, 2010; Thornton, 1997; Wharrad, Allcock & Chapple, 1994). Not only are they necessary for the nurses' understanding of care and the human body, but a thorough knowledge of biological sciences is also necessary in patient education. Unfortunately, research shows that nursing students, as well as nursing professionals and educators, often struggle with understanding biological sciences (Akinsanya, 1984; Clancy, McVicar & Bird, 2000; Jordan, Davies & Green, 1999; Trnobranski, 1993). Biological science educators within nursing programs are faced with the challenge of ensuring that their students are acquiring the knowledge necessary to exercise their profession.

In Québec, all nursing students are trained in a mandatory three year cégep nursing program, followed by optional training at the university level. Both cégeps and universities need to adapt their programs to meet an increasing demand for biological knowledge in their nursing graduates. The DEC in nursing offered by the Québec cégep system requires that students complete courses in Anatomy and Physiology, Microbiology and Immunology, and Pharmacology -- the disciplines of biological sciences that are generally associated with nursing.

Science educators use a variety of different tools to help their students understand what are sometimes seen as difficult and abstract concepts, and one of the tools in this arsenal is the use of analogies. An analogy is a comparative strategy used to show parallels between two concepts, often used to help explain an unfamiliar concept (target) by using a familiar one (analog) (Glynn, 2008). Analogies have been used in the context of science courses for decades with varying levels of success, and are often used by nurses in the context of patient education, but the use of analogies in biological science courses for nursing has yet to be formally investigated (Bean, Singer & Cowan, 1985; Glynn, 2008; Whaley, Stone, Brady & Whaley, 2014).

The aim of the following research project was to explore the use of analogies as a learning tool in a biological science course for cégep nursing students. To meet the short-term needs of improving understanding of biological sciences, the researcher investigated the efficacy of using student-generated analogies for improving understanding and communication of difficult topics in biological sciences in the context of nursing education. With the longer-term objective of providing nursing students with the tools necessary for creating and communicating analogies in the context of patient education, both in the present and in their future practice, the researcher also investigated the students' perception of this tool in improving their understanding and communication skills. It is assumed that the data collected will be instrumental in determining the efficacy of promoting student-generated analogies as an effective tool in biological science for nursing education.

CHAPTER ONE
STATEMENT OF THE PROBLEM

Nursing research indicates that knowledge of biological sciences leads to higher quality care, and is considered one of the important subjects upon which nursing is founded (Akinsanya, 1984; Clancy et al., 2000; Larcombe & Dick, 2003; McKee, 2002; Trnobranski, 1993). Without a sound understanding of the healthy human body, which involves the awareness of the biological basis of body functions, nurses would struggle to understand the basis for illness. Not only is this knowledge important to their patients and their colleagues, it is important to the nurses, as the confidence they feel in their biological knowledge allows them to face the challenges that they inevitably experience in their careers as nurses. And as nursing roles are expanding into new horizons, such as prescribing medication, communicating complex information about pathologies and associated treatments, basic diagnoses, and other medical tasks that have formerly been done by physicians, they will require greater biological science knowledge (Larcombe & Dick, 2003).

Despite their importance, biological sciences have generally been portrayed as a difficult and often unpopular component of the nursing sciences (Akinsanya, 1984, 1987; Caon & Treagust, 1993; Clancy et al., 2000; Jordan, 1994; Jordan et al., 1999; Larcombe & Dick, 2003; McKee, 2002; Nicoll & Butler, 1996; Trnobranski, 1993). Though nursing students and nursing educators generally acknowledge the importance of biological sciences in their education, both groups recognise that the process of learning in this discipline is fraught with tension and obstacles, and student anxiety often leads to difficulties in learning these topics (Clancy et al., 2000; Jordan et al., 1999). Nursing students, newly graduated nurses, and even some nursing educators often express fear and low self-efficacy when biological science knowledge is required in their role (Akinsanya, 1984; Clancy et al, 2000; Jordan, 1994; Jordan et al., 1999;

Trnobranski, 1993; Wharrad et al., 1994). This is a situation that is repeatedly noted by the researcher, as colleagues in nursing education and nursing students often express a lack of confidence in their biological science knowledge. Unfortunately, this lack of knowledge and poor confidence in nursing professionals can negatively affect patient outcome, as the communication of medical information to patients and caretakers involves a thorough knowledge of the biology of the human body (Akinsanya, 1984; Clancy et al., 2000; Friedel & Treagust, 2005; Jordan & Reid, 1997).

Recent changes brought to nursing curriculum have condensed the biological science component in nursing education. The change resulted in adding psychological and sociological sciences, while decreasing the amount of biological sciences, a decrease that undoubtedly affects biological science knowledge and confidence in the nursing professional (Jordan, 1994; McVicar & Clancy, 2001; Trnobranski, 1993; Wharrad et al., 1994). Though these changes have addressed the need for a more holistic approach to nursing, it has brought a new complexity to teaching biological sciences in this context. This situation challenges teachers in that discipline to address complex concepts within a stricter timeframe, which further limits student learning.

Researchers have explored a variety of approaches to address the difficulty nursing students have in learning and communicating knowledge of biological sciences. Most studies call for new approaches in the way biological sciences are presented to nursing students and discuss the importance of making biological sciences relevant to the role of the nurse, rather than rely on the age-old method of teaching biological sciences to nursing students as they do to medical students. Not only is this longstanding approach ineffective in relating biological sciences to nursing practice, it also creates undue difficulty for students who are not prepared for that level of complexity. In response to this, Akinsanya (1984, 1987) presented a model for bio-nursing which promotes the teaching of biological sciences as it relates to the reality of nursing practice rather than medical practice (bio-medicine). He argued that by focusing on the role of the nurse in establishing learning criteria, and allowing students

to explore biological sciences as they relate to nursing practice rather than medical practice, the probability for more thorough understanding of biological sciences in nursing students increases.

Alternative teaching methods in biological sciences for nursing (some of which follow certain aspects of the bio-nursing model) include the involvement of interdisciplinary work between nursing and biological sciences educators; the use of different technological tools, such as podcasts and clickers; problem-based classroom strategies; and tutorial activities (Akinsanya, 1984, 1987; Friedel & Treagust, 2005; Gresty & Cotton, 2003; McVicar, Andrew & Kemble, 2014; Mostyn, Jenkinson, McCormick, Meade & Lymn, 2013; Smales, 2010). Though some of these alternative teaching methods have been useful in helping students learn biological sciences, some challenges remain difficult to overcome.

Nursing programs face difficulties in finding educators who are capable of understanding both biological sciences and nursing, while providing students with appropriate and useful links between the two disciplines. There is an ongoing discussion in nursing education as to whether biological science educators or nursing educators are best trained to teach biological sciences to nursing students. Though biological science educators are best trained to teach biological sciences, their lack of understanding of nursing practice can make courses irrelevant to the nursing students. In contrast, nursing educators understand the reality of nursing practice and can make courses relevant, but their probable limitation in knowledge of biological sciences is an important drawback (Larcombe & Dick, 2003; Smales, 2010; Thornton, 1997; Trnobranski, 1993). An ideal situation would be educators with degrees in both disciplines, but finding multidisciplinary educators is not always possible.

Interdisciplinary work involving biological sciences and nursing educators is a noteworthy strategy and is a good representation of the bio-nursing model proposed by Akinsanya (1984, 1987). Improving communication and collaboration between

educators of these two disciplines is key to the development of interdisciplinary work. This approach, which includes well-known problem-based learning (PBL) using case studies or scenarios, highlights the relevance of biological sciences for sound nursing practice and helps students to contextualize difficult biological sciences concepts. Unfortunately, time constraints can be limiting for educators wishing to work with colleagues to design interdisciplinary work for their students (Gresty & Cotton, 2003; Friedel & Treagust, 2005; Thornton, 1997).

Science educators often use analogies to teach complex or abstract topics such as the cell, movement of electrons, movement of complex molecules, and genetics (Coll, 2009; Cosgrove, 1995; Dilber & Duzgun, 2008; Seipelt-Thiemann, 2012). Glynn (2007), a long-time advocate of the use of analogies in the classroom and the creator of the Teaching With Analogies (TWA) model, defines analogies as similarities between concepts, allowing individuals to make associations between what is known and what is new. This strategy has been used repeatedly by the researcher, and she has observed that this strategy is well received by students, and effective in improving their understanding of abstract concepts. For example, she has used the well-known "cell city" analogy, whereby the cell is compared to a city, and organelles within this cell (cell membrane, mitochondria, endoplasmic reticulum, nucleus, etc.) are likened to various components of a functional city (walls, city hall, factories, public works, transportation, etc.). The microscopic structures and abstract functioning of a cell are often better understood when compared to the concrete example of a city.

Research shows that analogies can be useful in the classroom, as students struggle to learn new concepts, building upon a foundation of previously-acquired knowledge (Bean et al., 1985; Glynn, 2007, 2008; Treagust, Harrison & Venville, 1998). Some studies have explored the use of student-generated analogies as an effective way to increase student involvement in the process of learning (Pittman, 1999; Wong, 1993). The use of analogies -- and more specifically student-generated

analogies -- lends itself well to the challenges in the biological science classroom within nursing education, yet this tool has not been explored in this setting.

Not only are analogies effective in the classroom for student education, but the healthcare setting also lends itself well to the use of analogies for tasks involving patient education. Nurses are often required to communicate complex medical information to individuals with limited understanding of medical or biological topics, conveying the necessary medical information to the patient, as a teacher would to a student (Elsberry & Sorensen, 1986). In this context, the use of analogies is a powerful tool that allows the healthcare professional to communicate crucial information to a patient or their caregiver about the patient's situation and care (Elsberry & Sorensen, 1986; Whaley et al., 2014).

The objective of this study was to explore the use of student-generated analogies as a tool for nursing students learning biological sciences, an innovative approach that embodies the bio-nursing model proposed by Akinsanya (1984, 1987). Given that nursing students have to take an active part in patient education as part of their everyday work responsibilities, teaching these students to produce their own analogies provides them with an invaluable tool for their future practice. The use of analogies is effective in addressing abstract topics in biology, and this same strategy could prove to be useful in addressing difficult topics for patient education.

Analogies are of special interest as a bio-nursing strategy and skill to develop, as they might benefit both their current patients in clinical stage and those in their future nursing practice. By creating their own analogies in biological sciences, not only will students expand their own conceptual knowledge of the topic, but they learn to use a well-known instructional tool for future reference (Whaley et al., 2014; Wong, 1993).

CHAPTER TWO
CONCEPTUAL FRAMEWORK

Educational research has produced a wealth of concepts and theories on the acquisition of knowledge and the process of learning. The exploration of student-generated analogies as a strategy for learning biological sciences within nursing education is set within several conceptual frameworks, the main ones being the bio-nursing model, constructivism, situated learning, and the Teaching With Analogies (TWA) model.

1. BIO-NURSING MODEL

In the early 1980s, a new pattern of thinking emerged in the field of biological sciences for nursing education: the concept of bio-nursing. Dr. Justus Akinsanya, a nurse, biologist, nursing educator and researcher coined the term to contrast biological science requirements for nursing education with those of medical education. Biological science in nursing education had typically been based on the study of bio-medicine, the application of biological science to the curriculum of medicine, which came with the complexity required in the training of physicians. Akinsanya (1984) argued that though "the goals of medicine and nursing are not mutually exclusive, … their orientating perspectives may differ". His writings have been instrumental in distinguishing the study of biological science to nursing students apart from that of medical students, and in establishing teaching and learning approaches specific to bio-nursing.

1.1 Bio-medicine

Akinsanya (1984; 1987) explains that bio-medicine focuses on the micro-levels of biological sciences, a level which is relevant to physicians, but not for nurses.

The micro-level of biological sciences is the study of physiology (defined as the study of functions of living systems) at the molecular and cellular levels -- knowledge appropriate to the realities of medical practice. Medical students are taught biological sciences in such a way as to provide future medical practitioners with the knowledge necessary to cure rather than care, the latter of which is the goal of the nursing professional (Trnobranski, 1993).

1.2 Bio-nursing

Medical professionals have traditionally taught biological sciences for nursing education, typically giving a watered-down version of biology to nursing students (Akinsanya, 1984). The downfall of this practice of simplification has been the teaching of either an overly-simplified and often inaccurate version, or a confusing and complex version of biological sciences (Wharrad et al., 1994). This conflicts with the fact that nursing has generally been more concerned with a holistic view of the human body, and focuses on the macro-level of biological sciences as the study of physiology at the systemic level (systems and organs). Akinsanya (1984; 1987) argues that in order to encourage reflective practice, biological sciences taught to nursing students should clearly link biological sciences to nursing practice, rather than with medical practice. McCarthy (1972) went a step further, expressing the "over-reliance on the medical profession for the teaching of nurses and a system which he described as ineffective, inefficient and, in some ways, harmful to the progress of nursing."

To better understand the distinction between the two professions and their specific need in biological knowledge, we will explore the example of the needs of a patient in respiratory distress. Physicians require in-depth knowledge of the cellular factors at play to diagnose and treat at the cellular level. Nurses need to understand the role of posture, oxygen delivery and physical comfort of patients in order to respond to their needs. The biological knowledge required to understand issues at the cellular level

is significantly different than the knowledge required to understand issues at the broader physical level (Akinsanya, 1984).

Akinsanya (1987) presented the bio-nursing model to "focus and provide a rational, structured and distinctive scientific basis for curriculum development in the professional education of the nurse". He relies on two theories of skill development to produce the bio-nursing model: Fitts & Posner's three phase theory and Demaree's skill acquisition requirements. Drawing upon these theories, he proposes four levels of task performance which reflect the association between biological science theory with nursing practice:

1. Task operational: Nurse-performed activities that do not require a specific level or depth of knowledge. Example: keeping a clean environment;
2. Task specific: Activities that require understanding of basic life science concepts, terms, and principles. Example: noting observations of patient physiology;
3. Task contextual: Activities that require detailed and in-depth knowledge of biological sciences for decision-making. Example: assessing and planning nursing interventions;
4. Personal and Professional Development: Biological sciences knowledge required for a wide range of skills, necessary for professional practice.

Though the frameworks behind Akinsanya's theory have been replaced with more recent ideas like Brenner's work on transitions, establishing a bio-nursing model is still an important goal to attain in nursing education (Casey, 1996). In a perfect balance of biological science and nursing science, Akinsanya (1984; 1987) argues that the nursing students should be presented with biological science knowledge that will allow them to understand the scientific basis for nursing intervention while also addressing the importance of practical application and skill development, thereby ensuring safety and well-being of the patients. In return, biological science research

should strive to answer the questions brought forth by the nursing discipline, and not only those produced by the medical profession (Akinsanya, 1984, 1987; Casey, 1996; Trnobranski, 1993). The establishment of more strategies within biological sciences that will connect directly to the reality of nursing practice, such as the exploration of analogies as a learning approach, is an expression of the ideology of the bio-nursing model.

2. CONSTRUCTIVISM

Constructivism is a philosophy of knowledge acquisition based on the idea that there is no absolute truth, no absolute knowledge to be passively gained from the world. Rather, knowledge is created in the individual, not as discovery of an absolute truth, but rather as construction within the mind as individuals interact with their environments (Yilmaz, 2008). Constructivism is a popular theory of learning upon which a large number of teaching approaches are founded, and the use of analogies is a clear example. Two important forms of constructivism are at play in this study: social constructivism and psychological constructivism.

2.1 Social Constructivism

Social constructivism is a concept based both on Piaget's cognitive development theory, which describes the different steps of the adaptation processes involved in intellectual growth, and on Vygotsky's social development theory which explains the crucial role of social and cultural aspects of cognitive development. Social constructivism describes how individuals create meaning or gain knowledge based on their interactions with others and the spheres around them (social, political, economic, etc.). In the educational setting, social interaction within groups, with colleagues, or with teachers helps students enhance their knowledge of a discipline. As individuals listen, discuss and exchange ideas, they are adapting their knowledge to new information they gain from those around them (Richardson, 2003; Yilmaz, 2008). As

a strategy requiring oral expression, the creation of an analogy requires social interaction and, in this exercise, is meant to direct students communication of information to others.

2.2 Psychological Constructivism

Psychological constructivism focuses on the idea that individuals create meaning or gain knowledge from what they have previously assimilated (Richardson, 2003). Individuals who are acquainted with a specific subject add to their knowledge every time they interact with new phenomena that relates to it (Richardson, 2003; Yilmaz, 2008). Analogies require the learner to blend new knowledge into previously acquired knowledge and they are a compelling example of a psychological constructivist activity.

In the classroom, constructivist theory implies that learners are capable of creating individual meaning, of using their intelligence to learn from the environment. The knowledge of individuals is distinct, based on their personal experiences, and is temporary, as it can change and adapt based on the individuals' interactions with the world (Yilmaz, 2008). Learner-centered activities are activities that implicate active participation of students in their own learning process. Active learning has a strong basis in constructivist theory.

The use of analogies in the classroom allows individuals to associate the knowledge they possess from previous experiences and their general knowledge foundation with the new information being presented (Bean et al., 1985; Glynn, 2007). By drawing upon previously-acquired knowledge typically possessed by students, and linking this knowledge to new material, educators are helping students create meaning from new topics. By encouraging students to generate their own analogies, educators are supporting a form of active learning that nurtures the development of individuals' distinct knowledge foundation (Middleton, 1991; Wong, 1993).

3. SITUATED LEARNING

The gap between learning in the classroom and being able to use knowledge in practice, often designated as the difference between "know what" and "know how," is a challenge for educators. This concern is especially difficult for educators of subjects that support the main focus of a program, such as biological sciences within a nursing program. Addressing this issue is one of the important objectives behind the concept of the bio-nursing model. Situated learning addresses the need to create authentic learning experiences for students by creating a setting in which students will gain knowledge in a situation similar to where they will be applying this knowledge (Anderson, Reder & Simon, 1996; Brown, Collins & Duguid, 1989). In this way, students learn concepts in real-world settings in order to better draw upon this knowledge when they step out of the classroom. Situated learning is an important basis for the movement of taking students out of the classroom and into authentic learning experiences in the workplace (Cobb & Bowers, 1999). They continuously engage new information by drawing from the pool of previously acquired knowledge. As such, it falls within the scope of constructivist designs, whereby students engage with new information within a realistic environment in order to better access this knowledge in their future practice. Situated learning is the foundation for all clinical practicum, and is an important component of nursing education. The following is a fitting illustration of the importance of situated learning:

> Authenticity in activity is paramount for learning if conceptual knowledge is not self-contained but, rather, if it is the product of and structured by the activity in which it is developed and deployed; if, in short, not just learning but knowledge itself is situated. (Brown et al., 1989, p.15).

This challenge in nursing education is addressed in the concept of the theory-practice gap: the difficulty nursing students have in bridging the gap between the theory they learn in the classroom and the practical side of nursing (Rolfe, 1993). The theory of situated learning, or the theory-practice gap in nursing education, helps

clarify why students have difficulty blending the knowledge acquired in the biological science classroom into the practical aspect of nursing practice (Friedel & Treagust, 2005). Though nursing deals with this issue by incorporating theoretical knowledge into student clinical practicum, the acquisition of biological science knowledge is set in the classroom or laboratory, and has very little association with the hands-on nature of nursing.

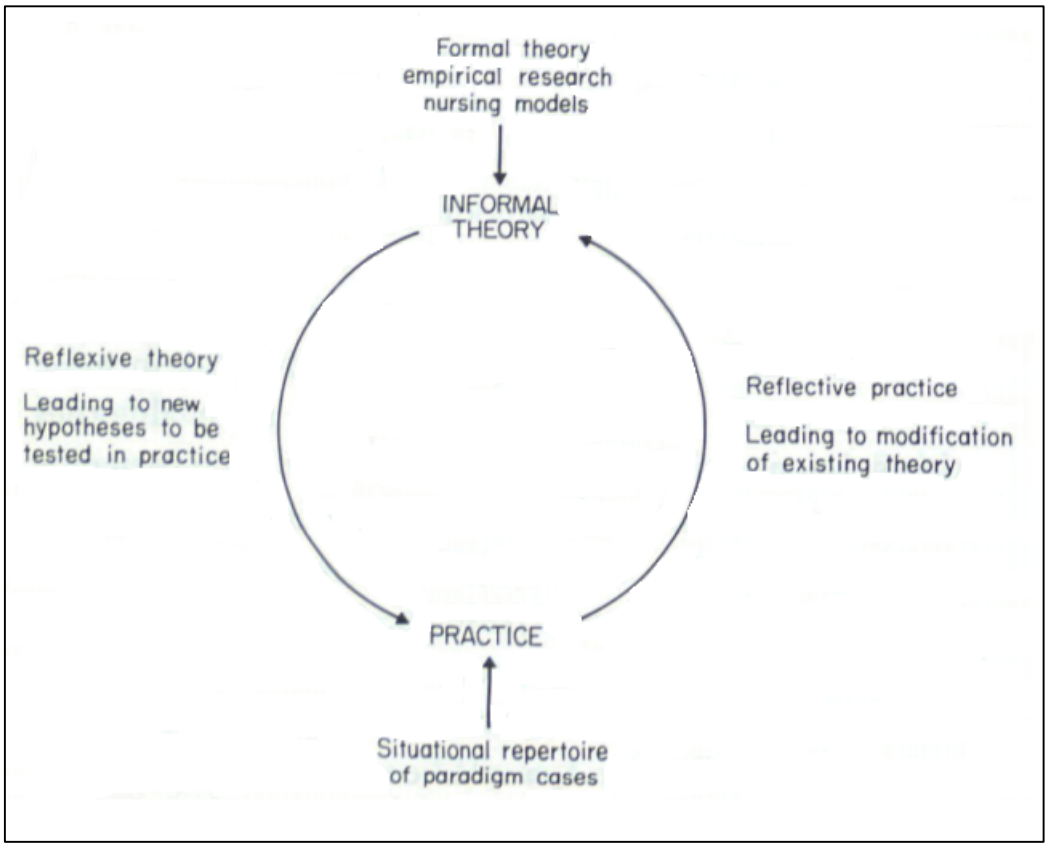

Figure 1: The Nursing Praxis (Rolfe, 1993)

In the *Journal for Clinical Nursing*, Rolfe (1993) proposed an approach to dealing with the theory-practice gap which was the nursing praxis, defined as "the bringing together of theory and practice which involves a continual process of hypothesizing and testing out new ideas, and to modify practice according to the results." As seen in Figure 1, the key is reflection, allowing practice to generate theory

and theory modifying practice, forcing interaction between theoretical knowledge and authentic nursing practice (Rolfe, 1993).

4. TEACHING WITH ANALOGIES MODEL

Analogies have long been a key instructional strategy in the arsenal of the constructivist framework; the creation of an analogy attempts to make a link between what is known (previous knowledge) and what is being presented (new information). "Analogies are used because they have the power to evoke rich, almost instantaneous, mental pictures that serve to challenge the hearer to transfer knowledge from a familiar to an unfamiliar domain" (Harrison & Treagust, 1993, p. 1291). They can be a motivational tool for some, a way for the teacher to make connections between the real world of the student and the concept to be learned. Effective analogies simplify complex and often unobservable phenomena; they act as a bridge between what students understand and what they are struggling to grasp (Treagust, 1993; Treagust et al., 1998).

By using analogies, educators provide students with the tools necessary to address new information in the light of previously-acquired knowledge, simplifying the concept to be gained to a level that is approachable to students. Analogies are especially useful when information is complex and requires a thorough knowledge of the discipline, but the receivers of the information have limited understanding of this discipline (Glynn, 2007; Middleton, 1991). When establishing new information, analogies can act as a foundation for this knowledge. Even if analogies are imperfect representations of a concept, they can later be modified to draw students closer to reality. Analogies are often memorable and may increase recollection of new information (Else, Ramirez & Clement, 2002).

Although analogies have had great results in educational settings, several authors have remarked on the analogy as "a double-edged sword" (Glynn, 2008;

Harrison & Treagust, 2006; Venville & Treagust, 1997). Analogies have both enriched and harmed the learning process of students, despite the best intentions of their educators. Several errors are possible if not probable, depending on the student: some focus on aspects of the analogy while ignoring others, some add components to the analogy that should not be present, some remember the analogy without recalling the concept itself, and some analogies are inconsistent with the real phenomena being presented (Coll, 2009; Dilber & Duzgun, 2008; Harrison & Treagust, 1993, 2006; Venville & Treagust, 1997). According to Glynn (1994), teachers are often ill-prepared to produce effective and well-designed analogies, de-valuing their use in the classroom and opening the possibility of students developing misconceptions.

To address these difficulties and assist educators in their use of analogies, Glynn (1994, 2007, 2008) created a Teaching With Analogies (TWA) model with six basic steps to assist educators wishing to teach with analogies. He defines both the "analog" as the concept that is known, the item the story is built with, and the "target" as the unfamiliar concept, the one the analogy is built to understand. The six steps of the TWA model used to create an effective analogy are as follows:

1. Introduce the target concept (what is not yet known);
2. Remind students of what they know of the analog (what is known);
3. Identify relevant features of the target;
4. Connect or map the similar features of target and analog;
5. Indicate where the analogy breaks down; and
6. Draw conclusions about the target.

It is important for the teacher to choose an analog that is readily understood by most students, and whose similarities with the target is extensive (Glynn, 1994, 2007, 2008). The similarities shared by the analog and the target must be clearly defined, and the characteristics where they diverge must also be clearly identified and explained to the students (Glynn, 1994, 2007, 2008; Harrison & Treagust, 1993, 2006;

Middleton, 1991). Failure to clearly explain an analogy often leads to the issues described above and the creation of misunderstanding of the new concept.

Treagust, Harrison & Venville (1998) propose an alternative to this model. They reverse steps 5 and 6, because this change allows more students to be involved in an activity. Both models have been used in classroom settings and have proven to be effective in generating greater understanding of difficult concepts (Cosgrove, 1995; Harrison & Treagust, 1993, 2006; Oliva, Azcárate & Navarrete, 2007; Seipelt-Thiemann, 2012).

Nurses are often on the first line of patient care. Given the difficulty accessing their physicians, most patients rely on nurses for explanation of their illness and the treatments associated. By engaging students in producing their own analogies using the model presented by Glynn (1994, 2007, 2008), the researcher is giving them an opportunity to experience authentic learning by relating to a practical aspect of nursing: patient education (Brown et al., 1989). Analogies have been useful in nursing practice to communicate complex medical information to patients, and so it is a tool which is needed in nursing education. Given that most patients and their caretakers have little-to-no science or medical knowledge, the use of analogies is an effective tool to simplify information about situations and required care (Elsberry & Sorensen, 1986; Whaley et al., 2014).

Student-generated analogies unite biological science with the practical side of nursing by addressing the importance of patient education while also helping students learn. Because the experience of producing their own analogies is an active form of learning, students are more likely to recall the knowledge acquired than if they passively received it from their educators. Focusing on student-generated analogies with nursing students allows for deeper and longer-lasting knowledge by creating an authentic, student-centered experience.

CHAPTER THREE
LITERATURE REVIEW

This project focuses on the perceived difficulty of biological science by nursing students, and the use of student-generated analogies as a possible solution to this problem. Supporting this project are numerous studies from different countries (New Zealand, UK, Australia, Ireland), which explore the perceived learning difficulty of biological sciences by college nursing students -- situations that are closely associated with what is observed in Québec's cégep nursing programs. Moreover, wide-ranging literature exists on the use of analogies in the classroom, with some specifically focused on student-generated analogies as reported in previous studies. This review will analyze strengths and weaknesses of student-generated analogies. Few articles exist on the use of analogies in nursing practice, yet the anecdotal evidence found is can help establish the possible teaching of analogy creation in nursing education. The following themes have emerged from a review of literature on the subject of biological sciences in nursing education: 1) issues related to the importance of biological sciences in nursing, 2) perceptions of the difficulties of learning biological sciences, 3) analogies as a strategy for learning, and 4) analogies in patient education.

1. BIOLOGICAL SCIENCES AND NURSING EDUCATION

1.1 The Importance of Biological Sciences in the Nursing Curriculum

Before approaching the issues and possible solutions related to the difficulty in learning biological sciences, there needs to be a frank examination of the importance of this discipline within nursing education. Recent changes to nursing curriculum have challenged the importance of biological sciences within the program, as the need for psychological and social sciences have been added to fulfill a demand for more holistic

approaches to nursing (Jordan, 1994; McVicar & Clancy, 2001; Trnobranski, 1993; Wharrad et al., 1994). The increased demand for more time allocation in the various sciences has created tension and reflection on the importance of these disciplines in the education of future nurses. These changes have brought about a frank discussion about the importance of supporting non-nursing disciplines in the education of nurses, and biological sciences are not an exception. Some nursing professionals and educators feel that biological sciences should have less time allocation in the nursing curriculum, while others believe there should be more importance given to biological sciences than previously set (Jordan et al., 1999; Thornton, 1997). Biological science time allocations are declining in nursing education to make room for these new disciplines, but at the same time, more reflective nursing practitioners with greater depth of biological knowledge are in rising demand (Clancy et al., 2000; Jordan, 1994; Larcombe & Dick, 2003; Trnobranski, 1993). The Québec cégep system faces similar issues because the increasing demand for healthcare practitioners and the increasing complexity of health problems today are forcing educational institutions to produce more students with a more extensive knowledge base. This is challenging biological science educators to maximize their time. The solution is using strategies that engage students in deeper and more authentic learning.

According to the literature, a significant number of nursing students, nursing educators, and nursing professionals feel strongly about the value of biological sciences in nursing practice, and many feel their knowledge base is insufficient for their practice (Caon & Treagust, 1993; Clancy et al., 2000; Davis, 2010; Jordan et al., 1999; Jordan & Reid, 1997; Thornton, 1997). In the past, nurses were seen as caring professionals, generally female, with limited understanding of human physiology, and they were expected to be fully subordinate to physicians. However, as nursing roles have expanded, nurses are moving away from this trope of the handmaiden to that of an intelligent practitioner, male or female, capable of autonomous and reflective practice (Trnobranski, 1993). In order to be seen as intelligent practitioners and to remain credible in their profession, nurses must have the foundation of knowledge necessary

to be involved in medical intervention, and this basis must be deeply rooted in biological sciences (Akinsanya, 1984, 1987; Clancy et al., 2000; Jordan, 1994; Trnobranski, 1993).

In response to the curriculum changes in nursing education, Jordan and Reid (1997) use action research to investigate the impact of physiological knowledge on patient care. These researchers analyzed and coded academic diaries from pre-registration nursing students in the workplace (n=52) over a 6 months' period. The researchers required students to compile an explanation of their actions along with incidents where knowledge of applied physiology was used to improve patient care. Jordan and Reid also used questionnaires, before and after the course, and a few students were asked to participate in follow-up interviews. The results indicated that the nursing students had to frequently (58.3% of decisions) rely on their physiology knowledge in decision-making and care delivery, in situations of dehydration, oxygen therapy, and cardiovascular disorders. This included crucial decisions such as needing to call a physician, where a failure to follow through may be fatal to the patient. Altogether, a high number of incidents were reported in diaries where biological science content led to improved patient care. This preliminary study has shown that biological science knowledge is a strong basis for the quality of patient care.

1.2 Perceptions of Nursing Students, Educators and Practitioners Regarding the Difficulty of Biological Sciences

The studies that address the perceived difficulty of biological sciences in nursing are unanimous in stating that nursing students generally find biological sciences difficult, if not the most difficult course of their nursing education (Caon & Treagust, 1993; Jordan et al., 1999, McKee, 2002; Wharrad et al., 1994). Not only are nursing students identifying biological science as a significant reason for anxiety in their nursing education, but nursing educators and nursing professionals also acknowledge low self-efficacy in biological science (Clancy et al., 2000; Friedel & Treagust, 2005; Jordan et al., 1999; Thornton, 1997).

Some of the behaviours exhibited by nursing students when faced with biological science are fear, anxiety, lack of confidence, and lack of motivation (Caon & Treagust, 1993; Jordan, 1994; McKee, 2002). This is not surprising when we consider the outcomes required of bio-medicine, which is the approach often used in nursing programs, and the complexity of this approach for nursing students. Nurses often cite a lack of relevance or association between biological science and nursing (Akinsanya, 1984, 1987; Caon & Treagust, 1993; Clancy et al., 2000; Jordan, 1994; Jordan et al., 1999; McKee, 2002; Nicoll & Butler, 1996; Trnobranski, 1993). Thus, the challenge lies in bringing a greater depth of biological understanding to nursing education, while also staying away from the complex and often irrelevant bio-medical approach.

In the journal *Nurse Education Today*, Jordan et al. (1999) explored nursing student and nursing lecturer perceptions of biological sciences. Their sample consisted of a cohort of nursing students (n=339) and nursing lecturers (n=73) from a single university department. They collected both qualitative and quantitative data from their sample group, using a postal questionnaire. A set of questions comparing different courses generated quantitative data, and open-ended questions led to qualitative data. The questions were constructed around a set of themes found in literature on the subject: difficulties in biological sciences, the value of biological sciences in nursing, theory-practice links and allocation of curriculum time and resources. Researchers compared responses provided by students and staff, using the Kruskal-Wallis one-way analysis of variance. They used univariate techniques to summarize collected data, and bivariate techniques to explore causality and links between data sets. Results showed that the majority of surveyed students and nursing lecturers felt that biological sciences are the most difficult disciplines in nursing education in comparison to other courses. Some students felt that greater time allotment would help solve this issue (74%), while others felt that the level of knowledge required was excessive, and interestingly, few nursing lecturers (10%) felt that biological sciences should have increased time allotment. It is surprising that few students felt the lack of relevance of biological

sciences in their nursing studies (5%), compared to many nursing lecturers who did (33%). Jordan et al. (1999) speculated that students have a better awareness of current nursing realities and expectations than nursing lecturers, who are often found supervising instead of practicing, and may be biased towards their own discipline at the expense of biological sciences.

More recently, in *Learning in Health and Social Care*, Friedel and Treagust (2005) explored the perceptions of nursing educators and nursing students regarding biological sciences and investigated differences between the two groups. They were specifically looking for data on self-efficacy, as well as a variety of other perceptions relating to biological sciences. Their study used both quantitative and qualitative methods, with the tools of documents, questionnaires (Likert scale questions and open-ended questions), and focus group interviews. Their sample population was the entire community of nursing educators (n=29) and nursing students (n=155) from one institution in New Zealand. The researchers used the Bioscience in Nursing Questionnaire (BIIN) with four parts: the first part collected demographic data, the second part was an instrument developed by Krynowski (1988), measuring attitudes about science in school, biosciences in nursing, and biosciences in nursing practice, and the third part contained a previously-published instrument to measure self-efficacy in biosciences (Harvey & McMurray, 1994; Dalgety, Coll & Jones, 2001). The fourth part consisted of a set of statements about biosciences on a 5-point Likert scale, and a few open-ended questions. Researchers contacted individuals, both students and educators who agreed to participate in further investigation which used focus group discussions set around predetermined themes. The discussions were analyzed around various themes. The results from the questionnaire in the second part (attitude measurements; score of +5 is an extremely positive attitude) showed that the nursing students had a more positive attitude (mean=4.30) to science in nursing education than nursing educators (mean=3.88) -- results that are statistically significant. Results from the third part (self-efficacy in biosciences; score of 5 is totally confident in their knowledge) show that nursing students (mean=3.47) and nursing educators

(mean=3.70) did not have statistically significant differences in self efficacy. The researchers did not expect these results; they expected educators to achieve significantly higher scores than the students due to more extensive academic and clinical experience. Results from the fourth part demonstrated that most nursing educators find bioscientific knowledge important for nurses (97%). Many (both educators and students) would like to have better bioscience knowledge (69%), and many felt they did not have sufficient science background to understand all the bioscience in nursing practice (45%). On the other hand, nursing students expressed difficulty in learning bioscience vocabulary (45%), found it time consuming (67%) and anxiety producing (58%), but found it important for nursing practice (97%). Most students (79%) and educators (76%) disagreed that there is too much biosciences in nursing education. Nursing educators (93%) were more likely to find biosciences relevant to nursing practice than nursing students (73%). Friedel and Treagust (2005) concluded by recommending co-operative teaching by nursing and science teachers, and shared mentoring of nursing students. We learn from this study that encouraging graduate nurses to continue their bioscience education to enrich their practice and their future endeavours as nursing educators is necessary.

In the *Journal of Advanced Nursing*, Thornton (1997) used qualitative methods to investigate the perceptions of nursing and supporting science educators and nursing students regarding supporting sciences within nursing education. The researcher built a staff questionnaire from informal discussions with staff and students. Questions addressed how the participants perceived the relevancy and practical applicability of subjects included in nursing education, and how the students' learning approaches depended on the teaching methods used by the educators. She used curriculum evaluation forms on a convenience sample of first and second-year nursing students in a Bachelor of Nursing degree program (n=108), and the questionnaire with teaching staff (n=10), followed up with classroom observations. Thornton analyzed the qualitative data by identifying recurring themes, coding, and categorizing. The key themes recorded were that perceptions about nursing can influence content selection

and depth of study; students adopt superficial approaches to learning in responses to certain teaching and assessment methods used; and relevance and applicability of content is based on perceptions of the reality of nursing practice. The recurring ideas from the study showed that students, especially first year students, struggled to see the relevance of some supporting science content in their nursing practice, and instead focused on wanting to learn nursing skills. Second-year students were more apt to find relevance of the supporting science content due to their greater awareness of clinical practice. On the other hand, nursing and supporting science educators felt challenged to reduce content in supporting science and nursing science, but expressed concern at limiting general knowledge. In her concluding remarks, the author urged for more communication and greater collaboration between nursing and supporting science instructors to demonstrate the relevance and applicability of supporting sciences to nursing practice. She recommended that career advice given to prospective nursing students encourage them to reflect on the need for knowledge, critical thinking, and problem-solving abilities rather than only technical skills.

Nicoll and Butler (1996) explored the causes of anxiety related to biological science courses in nursing student and aimed at finding ways to reduce this anxiety. They initiated action research on a group of first year nursing students enrolled in a 3-year nursing course. They used the Delphi technique on their sample group (n=66) to identify sources of anxiety. They followed this activity with a modified quality circle (small group responsible for problem solving) consisting of 10 volunteer students willing to discuss ways to reduce this anxiety identified during the Delphi technique. These students presented their ideas to the biological sciences teachers for implementation in the classroom. The changes brought to the classroom were then evaluated using a focus group made up of seven volunteer students (only one student from the quality circle also participated in the focus group.) The focus group assessed the changes made in the classroom and the impact of anxiety levels. The Delphi technique discussion showed that students associated their anxiety with a heavy workload (23%), inadequate resources (20%), student preparedness for class (10%),

and curriculum planning (22%). Based on the results, the researchers recommended improving communication between students and professors, offering a greater variety of resources, using varied instructional strategies in the classroom, and initiating introductory science courses for students with limited scientific background. Regardless of the strategies implemented, Nicoll and Butler (1996) strongly recommended following up with the students for feedback and evaluation on the changes implemented.

Despite questions about the importance biological sciences should have within nursing education, what is clear is that biological sciences have a key role to play in nursing practice. The tension found between the struggle nursing students have in learning this discipline and the need for biological knowledge in their practice needs to be addressed by developing new instructional methods. As mentioned above, an interesting approach found in science education literature is the use of analogies. They appear useful for learning complex or abstract scientific concepts. The exploration of this tool in biology for nursing is a worthy avenue for research.

2. ANALOGIES AS A STRATEGY FOR LEARNING

Analogies have been used in education with varying levels of success, and the struggle brought forth by these experiences has led to varied research on the subject. Shawn Glynn (1994, 2007, 2008) is a proponent of analogies in the classroom, and the author of the Teaching With Analogies (TWA) model discussed in the previous chapter. His proposed model and research on the use of analogies in science classrooms have instigated the researcher's interest in investigating the use of this tool in biological sciences for nursing education.

2.1 Analogies in Science Education

Analogies have been used in education to help students engage with ideas and concepts, allowing them to integrate new knowledge into what they already know about a topic. Analogies are particularly useful in science disciplines for teaching complex, abstract or unobservable phenomenon (Bean et al., 1985; Harrison & Treagust, 1993, 2006; Middleton, 1991; Pittman, 1999; Venville & Treagust, 1997). Given that students learning the basics of science must contend with unobservable elements such as particles, cells, obscure formulas and energy, the use of analogies can be a useful tool to help with visualization. Analogies can also help students learn about scientific concepts for which they may not be prepared. For example, a student having to learn about the anatomy of the body and understand how the body is organized may not be ready to learn about the concepts of tissues and cellular cohesion. Analogies about bricks and mortar, for example, can be useful in that situation to fill in the gaps of knowledge until students are capable of understanding the more complex principles at play.

Analogies are also useful where the *in situ* exploration of complex concepts, like cellular respiration or blood flow, are not possible in real time. Students are often left to use their imagination to understand these topics, so analogies can be useful in prompting appropriate visual imagery and avoiding the creation of misconceptions (Else et al., 2002). Research in science education shows that not only are analogies useful in helping students understand difficult concepts, but this learning itself is profound, and helps students overcome misconceptions (Dilber & Duzgan, 2008).

Else et al. (2002) described their experiences using analogies for middle school students in the context of a human biology curriculum. Their article titled "When are Analogies the Right Tool?" explored curriculum change in three middle school human biology classrooms. Observations were noted during the first year of the curriculum change. Examples of analogies in use included the comparison of a cell and

its parts to a school, the comparison of blood vessels to a river, and the comparison of inner lung structures (bronchi and alveoli) to grapes. Else et al. (2002) observed that students were able to recall the analogies easily, had a better understanding of the concept itself instead of only memorizing the names, and found the experience engaging and motivating. Interestingly, some students spontaneously generated analogies during class discussion. The authors noted that teachers who drew connections between the analog and target (mapping analogies) were more successful than others, and that teachers needed explicit instructions on how to assist students in mapping analogies. Some students appeared to struggle with overmapping (applying the analogy to elements that were not appropriate to the target), some confused visual and functional analogies (where some analogies to explain visual concepts were also taken to explain functionality of the target), and some has difficulty understanding analogies with unfamiliar analogs. Despite these challenges, the authors concluded that analogies -- when appropriately used and guided -- can be a useful tool to learn human biology.

Dilber and Duzgun (2008) recently investigated how analogies affected student success and understanding in a Turkish high school physics course. Two groups made up of students with similar knowledge (n=78) taught by the same teacher were chosen for the experiment. The groups were randomly selected as either an experimental group or a control group. Both groups received the same amount of instructional time, materials, and assignments, apart from the analogical instructions for the experimental group, during a four-week-long unit, during which time the control group received traditional instruction. Both groups were given the same pre-test before the intervention and the same post-test after the intervention; the pre-test and the post-test contained the same questions. The authors used independent group t-tests to compare the two pre-test scores with the two post-test scores. Results for the pre-test score comparison showed no significant difference between the results of both groups: the control group had a group mean of 65% and the experimental group had a group mean of 58.25% ($t = -0.77$, $p > 0.05$). The results for the post-test score comparison

showed a significant difference between the two groups: the control group had a group mean of 72.5% and the experimental group had a group mean of 90% ($t = 9.12$; $p < 0.05$). Also, the students from the experimental group displayed a greater understanding of the physics concepts taught with analogies compared to the control group who received these same concepts by traditional instruction. Dilber and Duzgun (2008) also compared individual students' pre-tests and post-tests and noted that students with analogical instructions had more success in overcoming any misconceptions.

Basing their study on the Teaching With Analogies (TWA) model, Harrison and Treagust (1993) evaluated the implementation of a modified Teaching With Analogies model from Glynn (1994, 2007, 2008) and gauged its effectiveness in student learning. They chose a qualitative case study format with added quantitative data collection, using classroom observations, taped recordings, and teacher and student interviews. The researchers worked with a purposive sample of six science teachers who used analogies, with a focus on one teacher who was known for her teaching experience and innovative approaches, and who received additional training on using analogies in the classroom. The class that was the focus of the study consisted of 29 female students in a grade 10 science course during its four-week optics unit. The authors evaluated the implementation of the modified TWA model in the class, and followed up with the teacher and the students to gauge the method's effectiveness. Results show that the use of analogies in the classroom is a practical and achievable strategy when using a systematic presentation. Both the teacher and students showed enthusiasm for the strategy and felt that it enhanced student comprehension. Factors that were crucial in ensuring the success of the strategy were the experience of the teacher, a systematic presentation of the analogies, the choice of an analog familiar to students and discussions with students about unshared attributes between the target and analog.

2.2 Student-generated Analogies

Most studies describing the use of analogies in education explore teacher-generated or textbook-generated analogies (Coll, 2009; Glynn & Takahashi, 1998; Harrison & Treagust, 1993, 2006). However, this project explores the effectiveness of student-generated analogies as a learner-centered activity that enhances the learning experience.

Student-generated analogies are a tool by which individuals can use their previous knowledge to construct new understanding of phenomena (Wong, 1993). Involving students in the creation of the analogies allows them to restructure their conceptual understanding of the phenomena in question (Duit, 1991; Wong, 1993). By exercising their imagination and creativity, students actively engage in acquiring new knowledge (Else et al., 2002; Wong, 1993). While generating analogies themselves can help overcome some of the problems of teacher-generated analogies discussed above, other issues can also appear when students produce their own analogies: difficulty understanding the concept well enough to produce an analogy, and misconceptions produced during the elaboration of the analogy (Glynn, 1994, 2007, 2008). However, for those who have succeeded in incorporating student-generated analogies in their classrooms with appropriate training, feedback from the students included improved meaningfulness, integration of fragmented knowledge and accessibility (Middleton, 1991; Spier-Dance, Mayer-Smith, Dance & Khan, 2005; Wong, 1993). Developing analogies creates familiarity, ownership, and a better understanding of the concept (Cosgrove, 1995; Spier-Dance et al., 2005). It is a strategy that reveals student thinking and highlights areas of misunderstanding (Lancor, 2012; Middleton, 1991; Wong, 1993).

Pittman and Beth-Halachmy (1997) compared the effectiveness of teacher-generated analogies, student-generated analogies and traditional instruction in a high school science course. They used six different groups of 8^{th} graders (n=269) from a

public high school in Chicago. Three classes were taught by a researcher and three were taught by a colleague. For each teacher, Pittman and Beth-Halachmy (1997) chose a control group, a teacher-generated analogy group and a student-generated analogy group. All groups received the same two days of traditional teaching of the topic, followed by a third day with different instruction (an activity for the control group, textbook or teacher-generated analogy for discussion in the second group, and instructions on analogy creation for the third group) and a final day for review. Student performance was measured with a pre-instruction test, a post-instruction test, and a test one month after instruction. Tests for correlation were performed to analyze relationships between the variables and student success on post tests. Several regressions were completed to analyze the contribution of prior knowledge and treatment, and post-test scores. Results show that prior knowledge was an important factor in students' success in using analogies (both teacher-generated and student-generated). It was unclear whether teacher or student-generated analogies were most effective.

In *Research in Science & Technological Education*, Spier-Dance et al. (2005) describe their study of student-generated analogies in a college chemistry classroom. Their study explored the effectiveness of student-generated analogies on student understanding, student improvement of conceptual understanding, and student test performance when compared with groups instructed with teacher-generated analogies. They compared a group of 19 students in an introductory chemistry course with three control groups (n=50) enrolled in sections of the same course with the same instructor. The control groups received a teacher-generated analogy instead of an analogy of their own. Prior to instruction on a complex topic in the course to the experimental group, one of the authors of the study gave a presentation on analogies and the procedure for creating an analogy. Students were then asked to create an analogy, discuss it in groups and choose a group analogy. The analogies presented to the class were discussed and analyzed. The students compared halogen oxidizing power to pirate ships, a beauty pageant, and cruise ships. Qualitative data was gathered from classroom observation

and video recording, as well as student and teacher interviews. Quantitative data was collected from a two-part question on a final exam (on halogen oxidizing power). The students were given a multiple-choice question and were required to give a rationale. The students received a grade for their answer, and their rationale was further analyzed for conceptual understanding using a five-point system. Students were separated into four achievement levels based on their midterm grade and final grade, and then the researchers performed a two-tailed independent t-test analysis. Regardless of their achievement level, students in the experimental group performed better on the question (student grade) regarding halogen oxidizing power (mean = 2.73/4.00) than the control groups (mean = 1.52/4.00). Interestingly, the lower-achieving experimental group had a significantly higher mean grade than the lower-achieving control groups ($p = 0.035$), while the higher-achieving experimental group did not show a significantly higher grade than the higher-achieving control groups ($p = 0.11$). Students' conceptual understanding detailed in their rationale was assessed using the five-point indicator. The lower-achieving experimental group showed a significantly higher conceptual understanding (1.67/5.00) than the lower-achieving control groups (0.21/5.00) ($p = 0.0049$). The higher-achieving experimental group showed a significantly higher conceptual understanding (2.00/5.00) than the higher-achieving control groups (0.94/5.00) ($p = 0.021$). The authors conclude that the use of student-generated analogies benefits all students, but mostly low achievers, and Spier-Dance et al. were especially pleased with the students' gain in conceptual knowledge. This study clearly indicates the potential for student-generated analogies to encourage critical thinking and deeper learning.

A well-known study entitled "Understanding the Generative Capacity of Analogies as a Tool for Explanation" was conducted by Wong (1993), who examined whether student-generated analogies bring about change in student understanding. He recorded the nature of any change. He recruited 11 participants from a teacher education program from a variety of different subject-matter areas, and the sessions were video and audiotaped for qualitative data collection. The participants were asked

to explain and self-evaluate the concepts behind three air pressure phenomena of a piston-cylinder device and then create analogies to better understand the concepts of particle motion, pressure, vacuum, and force. Participants explored analogies of rubber balls to represent particles, people in a room to represent air and a tug-of-war game to represent pressure. Wong took note of a significant change in most participants' explanations, with improvements in recognizing relationships, asking increasingly difficult questions, making distinctions between concepts and better understanding different concepts. Wong (1993) concluded that 1) generating analogies can improve understanding even if prior knowledge of a topic is limited, 2) understanding is constructed when the learner generates analogies based on their own knowledge base, 3) analogies are the means to an end (greater understanding) and 4) analogies can be modified or discarded as understanding develops.

Lancor (2012) explored what student-generated analogies tell us about how students understand and whether the analogies/metaphors used by the students depend on disciplinary context. She recruited students from graduate introductory courses in physics (n = 109), biology (n = 49), and chemistry (n = 36) from two colleges over a two-year period. The researcher required students to write or draw an analogy explaining the role of energy, a context associated with their discipline. They also had to evaluate the strengths and limitations of their analogy, to link the analog and target concept, and to give their current definition of energy. She analyzed the data qualitatively by categorizing the analogies under seven conceptual metaphors about energy, based on methodology used by Lakoff and Johnson (1980, 1999). Results show that students represented energy in different ways, some which of were accounting metaphors (substances that can be divided and reattributed, but not lost) and analogies of substances that change form (components used in various situations). Lancor (2012) noted that the analogies showed more complexity than energy definitions. The creation of analogies both required critical thinking and generated student discussion. She found that they were also an effective way to gain awareness of what students do and do not understand.

3. ANALOGIES IN PATIENT EDUCATION

Whether it involves the education of children about their health, or an elderly patient and their caretaker, analogies can help individuals tie new knowledge about health and medicine to what they commonly know (Elsberry & Sorensen, 1986; Whaley et al., 2014). Like students addressing new knowledge in a course, patients or caretakers can often be challenged with information about concepts about which they have no base knowledge. Given the success of using analogies in educational settings, using analogies for patient education is a feasible strategy. Analogies are used in patient education by medical professionals, but most of the information previously reported is anecdotal, and little has been peer-reviewed. Interestingly, some branches of medicine (e. g.: pathology) now commonly use analogies and metaphors, though often in discussion with other physicians and not with patients (Batistatou, Zolota & Scopa, 2000; Masukume & Zumla, 2012). The few reliable studies found on the subject provide little information and have arguably weak methodologies.

An important point to consider in the use of analogies for patient education is the importance of addressing an appropriate analogy to the patient. Also of importance are knowledge of a patient's age and understanding, culture and experience, all of which are crucial in choosing an analogy that is appropriate (Elsberry & Sorensen, 1986). For example, Elsberry and Sorenson discuss woodburning stoves, and fireplaces with their rural Native American adults suffering from diabetes to explain the concepts of carbohydrate metabolism. Other interesting analogies used to explain diabetes are the lock and key model, and the driveway analogy (described below) (Whaley et al., 2014). Olweny (1997) explains that most patients appreciate the use of simple language and that analogies are a useful tool to which patients are able to relate.

Whaley et al. (2014) conducted a small study on a group of 300 undergraduate healthcare students, exploring whether analogy-aided explanations of diabetes would be rated higher for communication, message, and attitude than a literal explanation of

diabetes. Two experimental groups were given written analogy-aided explanations, one with lock and key, and one with driveways. A control group received a written literal explanation. In the lock and key model, students were told that insulin is the key that unlocks a cell to let in glucose to provide energy for the cell to function. In the driveways model, students were told that glucose is like cars travelling on streets (blood vessels), needing to park in garages (cells), but for this to happen, driveways (insulin) is necessary. All groups were asked to rate the messages for attitude (13-point scales), message organization (9-point scales), and author competency (9-point scales). A one-way ANOVA indicated a significant difference between the analogy groups and the control group for the following: effectiveness of the message, trustworthiness of the author, credibility of the author, friendliness of the author, likeability of the author, and attitude of respondents to diabetes. Further t-test analyses showed that the two analogy groups felt that the authors of the analogies were more effective and seen as more trustworthy than the control group. Whaley et al. (2014) concluded that there was a slightly higher rating given by the groups receiving analogies than the control group, confirming the value of using analogies to explain complex medical information.

Another study exploring the use of metaphors and analogies in improving communication was conducted by a team of physicians (Casarett, Pickard, Fishman, Alexander, Arnold, Pollak & Tulsky, 2010). The team investigated how metaphors and analogies are used in conversations between physicians and severely ill patients and whether patient perceptions of physician communication were improved by their use. The sample included 94 patients from 52 consenting physicians in three different medical centers, and a total of 101 conversations randomly selected. Casarett et al. (2010) used telephone interviews and audiotapes of conversations between physicians and their patients for analysis and coding. Examples of analogies include the comparison of a rash to a sunburn, depression to physical pain, cancer to pregnancy, bone marrow to an elephant, and many more. The authors used correlation analysis (Spearman Rho) to analyze the collected data. Results showed that patient perception of communication improved with the use of analogies ($\rho = 0.34$; $p = 0.001$) and

metaphors ($\rho = 0.27$; $p = 0.006$) and patients had less trouble understanding their physician with analogies ($\rho = 0.29$; $p = 0.003$) and metaphors ($\rho = 0.22$; $p = 0.028$). Patients also reported that their physicians made sure they understood their health problems when using analogies ($\rho = 0.25$; $p = 0.010$) and metaphors ($\rho = 0.24$; $p = 0.017$). The authors conclude that analogies and metaphors may be an easy and simple way to improve patient education. However, given the potential for misunderstanding and the limits of the study, the authors warned that these strategies be part of the physician's toolbox, not the only tool.

4. CONCLUSION

A number of articles present convincing evidence that nursing students struggle to learn biological sciences or to put this knowledge into practice. The model of bio-nursing presented by Akinsanya (1984, 1987) has inspired a variety of strategies for addressing this problem, from choosing an appropriate educator to evaluating different interdisciplinary approaches. Exploring the use of student-generated analogies to help students deal with difficult biological topics is an innovative approach that fits the criteria of the bio-nursing model. Though the use of analogies has produced some concerns in the education community, the clear guidelines of the Teaching With Analogies model created by Glynn (1994, 2007, 2008) lends itself well to addressing the issues of teaching biological sciences to nursing students. This project draws upon the literature presented in this section as it relates to this new strategy for biological sciences in nursing education. Based on the literature presented above, this study addresses the following research questions:

Research question 1: Does the integration of an activity involving self-generated analogies in biological sciences assist in the understanding and communication of difficult biological science topics by cégep nursing students?

Research question 2: Do cégep nursing students perceive that understanding and communication of difficult topics in biological science improves with the use of self-generated analogies?

The research questions explored whether or not student-generated analogies might be a useful bio-nursing teaching approach to use for cégep nursing students. In Research Question 1, the independent variable is the use of student-generated analogies, and the dependant variables are (a) the improvement of student understanding of a difficult topic, and (b) the improvement of the quality of communication regarding this difficult topic. The improvement of student understanding was ascertained with the analysis of student grades established with the appropriate rubric for subject knowledge and by comparing the grades from the assignment without analogy with the grades from the assignment with analogy. The improvement in the quality of communication was ascertained through the analysis of student grades established using a rubric for communication skills, comparing the grades from the assignment without analogy with the grades from the assignment with analogy. In Research Question 2, the students' perception of the usefulness of using analogies was ascertained using quantitative data from the pre-intervention and post-intervention questionnaires containing adapted semantic differential questions. Qualitative data was collected from the open-ended questions in the post-intervention questionnaire and follow up interviews. In this research question, the independent variable is the use of student-generated analogies, and the dependant variables are (a) the perception of students of their improvement in understanding a difficult topic, and (b) the perception of students of their improvement in communicating this difficult topic.

CHAPTER FOUR
METHODOLOGY

1. PARTICIPANTS/SAMPLE

The population for this study is the student body enrolled in a cégep nursing program in the province of Québec. This population is spread over a large territory and with the laws governing confidentiality, difficult to access. Furthermore, there is a high degree of complexity in drawing a random sample from this difficult to reach population given that approval needs to be obtained from ethics board for each individual cégep. Due to the constraints in attaining a random sample in the population, the sample used for this study was a non-random convenience sample. This group was comprised of 26 second-year nursing students from Champlain - College in Lennoxville in the fall of 2015, which was of 26 students. Of these 26 students, two did not finish the course and one student chose not to participate in the study, leaving a sample of 23 students.

The non-randomization of the sample introduces sampling bias in the study because the researcher was not able to draw a random sample from a large group of varied individuals. The group of second-year students in the nursing program at Champlain - College in Lennoxville is a small sample within the population of nursing students in the province of Québec, and a distinct group given that the college is a small English rural college with a new program in nursing. Consequently, the results of this study cannot be generalized to the population of cégep nursing students, which include students from various cégeps in rural and urban centers, and from both French and English cégeps.

2. RESEARCH DESIGN

The intervention proposed in this study required some prior knowledge of biological sciences, so the study was performed on a group of second-year nursing students with one year of biological education successfully completed. The nursing students from Champlain - College in Lennoxville must complete three consecutive courses in Anatomy and Physiology, followed by one course in Microbiology and Immunology as part of the first two years of their nursing education. The intervention was prepared for the Anatomy and Physiology III course in fall of 2015 as a wrap-up activity. The students had to review topics taught during the three consecutive Anatomy and Physiology courses to complete their activity.

2.1 Methodological approach

The data collected involved mixed research methods; the researcher collected both quantitative and qualitative data to lend greater depth to the study, especially given the limitations associated with the sample. Quantitative data was collected using student feedback from a pre-intervention questionnaire and a post-intervention questionnaire, as well as grades from a pre-intervention video assignment and a post-intervention video assignment. Qualitative data was collected using data from the post-intervention questionnaire as well as from student interviews.

Due the small size and the non-randomization of the sample, the design chosen for this research project was an experimental design, more specifically a one group pre-test/post-test design, whereby one group is pretested, exposed to an intervention then tested a second time (Gay, Mills & Airasian, 2009). Unfortunately, the use of this design and the characteristics of the sample raise questions for both internal and external validity, and limits the effectiveness of this study. These are discussed in greater detail in the section on data analysis.

3. PROCEDURE

At the beginning of the fall 2015 semester, the Anatomy and Physiology III students targeted as the sample for the study were presented with a short overview of the project by the researcher. Following this presentation, the researcher, who is also the teacher for the course, left the classroom and a non-teaching staff member of the College distributed, explained and collected the consent forms to the students (see student information and consent form in Appendix A). The staff member provided random participant numbers to the students for identification of their questionnaires.

In the final few weeks of the semester, the students were provided with instructions on the project initially presented by the researcher at the beginning of the semester. The project, which included two video assignments, was integrated within the course assessment and all students were required to participate in the assignments. The document included instruction for a first video assignment and a second video assignment, which was to take place a few weeks after the first video assignment. The students were asked to prepare a two-minute video presentation of themselves explaining a topic commonly found to be difficult in biological sciences for nursing, a topic which was presented in the form of a clinical scenario. The presentations were to be prepared as if they were given to their target patient. The students could choose from a list of six difference scenarios (see video assignment instructions in Appendix E), and each scenario included patient demographic (the target patient), a specific disorder and guiding question(s). These scenarios were produced by the researcher using topics that were found to be difficult (ex: X-linked recessive disorder, HDL and LDL cholesterol levels and left-sided heart failure) and were based on knowledge gained from past experiences teaching similar groups of students. Due to extensive timeframes associated with oral presentations, these short oral presentations were provided to the researcher using cell phone video technology. The videos were uploaded on flash drive devices or private YouTube channels and transmitted to the researcher. The researcher graded this first video assignment with the help of the first two rubrics, one for

understanding of the subject and one for communication skills (see rubrics for video assessments in Appendix F).

After the first video assignment, the researcher distributed the pre-intervention questionnaire (see pre-intervention questionnaire in Appendix B) to the students, which were identified with the participant numbers only. The questionnaires were collected and placed in a sealed envelope for data analysis after the distribution of final grades for the course.

Following this first video assignment and the associated pre-intervention questionnaire, the researcher provided a presentation on the creation of analogies using the Teaching With Analogies model (Glynn, 1994, 2007, 2008) (see presentation of analogies in biology in Appendix G). This presentation included a brief introduction of the reasoning behind the use of analogies in biological sciences, the advantages and disadvantages of using analogies in teaching, and the steps to developing effective analogies (introducing the target concept, choosing an appropriate analog, connecting the target and analog, identifying the breakdown of the use of the analog and the conclusion). The presentation document was made available to all students as a reference and guide to the preparation of their analogies for the second video assignment.

The students were then required to generate an analogy for the topic they had chosen previously (the first video assignment) and to produce a second video assignment (see video assignment instructions in Appendix E). The guidelines were similar but the length of the video recording was doubled to 4 minutes to accommodate the more complex nature of the second video assignment. The videos were also uploaded on flash drive devices or private YouTube channels and transmitted to the researcher. The researcher graded this second video assignment with the help of the three rubrics, the first rubric assessing understanding of the subject, the second rubric

assessing communication skills and the third rubric assessing the development of the analogy (see rubrics for video assessment in Appendix F).

After the second video assignment, the researcher/teacher distributed post-intervention questionnaires to the students, which were identified with the participant numbers only. The questionnaires were collected and placed in a sealed envelope for data analysis after the distribution of final grades for the course (see post-intervention questionnaire in Appendix C).

The researcher conducted follow-up interviews in winter 2016 with four student volunteers willing to provide more information on the video assignments. The students had initially shown willingness to be contacted by the researcher for follow-up interviews by stating so in the space provided on the consent form. The interview questionnaire consisted of open-ended questions which were conveyed orally to the students by the researcher (see interview questionnaire in Appendix D). The interviews were recorded with audio only, with permission from the participants, and these interviews were then transcribed for data analysis.

Analysis of quantitative data was performed using the Statistical Package for Social Sciences student version 24 (SPSS, 2016) (see statistical analyses in Appendix H). Some of the data collected was presented in the form of frequencies, and provide descriptive information about the sample group. Chi square analysis of some of the data collected was performed to evaluate the association between different variables. Dependent t-tests were also performed on the mean grades for the video assignments, and allowed the researcher to compare these means and establish the statistical significance of the differences. Statistical significance was set at an alpha level of 0.05, which is an acceptable value for educational research.

Analysis of qualitative data was performed by analyzing the content of the student responses from the post-intervention questionnaire and from the student

interviews, and organizing these under common themes. The data collected and analyzed complemented the quantitative data.

The research proposal initially planned for the use of a confederate acting as a patient receiving information from the nursing student for the second video assignment. However, the researcher decided that this factor may have inserted a level of difficulty that would further reduce the internal validity of the study by having a negative influence on the results for the second video assignment. The researcher also planned to award the highest grade from the two video assignments, but this strategy was dismissed to ensure that all students produced both video assignments.

4. INSTRUMENTATION

The project proposed and completed by the researcher was original. Standardized instruments were not available so it was essential for the researcher to create instruments to meet the needs of the study.

All instruments including the questionnaires and rubrics were produced by the researcher. To counter the effect of un-tested instrumentation, the pre-intervention and post-intervention questionnaires were used in a pilot group made up of 1st year nursing students at Champlain - College in Lennoxville who provided feedback on clarity and organization of the questions. This pilot study was conducted in the beginning of the semester in Fall 2015.

4.1 Questionnaires

In the context of this study, the students had to answer two questionnaires regarding perceptions. One questionnaire was provided to the students following the first video assignment, and before the training on the creation of analogies. This pre-intervention questionnaire elicited the students' understanding of the topic chosen for

the video assignment and their ease in explaining this topic. The first 8 questions on the questionnaire were demographic inquiries designed to obtain general information about the sample population for future comparison, providing nominal and ordinal data for analysis. The remainder of the questions were designed to measure student perception using 5-interval semantic differential scale questions, providing ordinal data for analysis. The students were asked to provide their opinion on the difficulty and the relevance of biology for nursing, as well as to provide feedback on the understanding and communication of their chosen topic following the first video assignment.

A post -intervention questionnaire was distributed to the students following the second video assignment which was produced using analogies. The first 13 questions, also designed on 5-interval semantic differential scales, were intended to measure students' perception of the understanding and communication of their chosen topic following the second video assignment. The questions were similar to the questions from the pre-intervention questionnaire. This ordinal data was collected and analyzed to compare with data from the pre-intervention questionnaire. The remainder of the questions focused on the use of analogies in improving understanding and communication, the effectiveness of the Teaching With Analogies model in creating the analogies and the value of the analogies approach in patient education. The post-intervention questionnaire also contained five open-ended questions which were used to collect more information from the students following the intervention.

The quantitative ordinal data emerging from the rating scale responses was compiled and analyzed in SPSS and used to address the questions of student perception of understanding and communication in Research Question 2. A dependent t-test was conducted on the pre-intervention data to compare it with the post-intervention data. The open-ended questions in the post-intervention questionnaire provided qualitative data which was coded and analyzed per a set of themes. Relevant comments were set aside and displayed in the study results as part of the response to Research Question 2.

The researcher asked for student volunteers to participate in interviews to follow-up on the results of the questionnaires. The interview questionnaire consisted of 15 open-ended questions providing in-depth information to the researcher on the students' perception of the use of analogies in biological sciences and its potential as a tool for patient education. The interviews were recorded, with student consent, and the recorded interviews were transcribed into written form. This qualitative data was then coded and analyzed per a set of themes similar to the post-intervention questionnaire data. Relevant comments were set aside and displayed in the study results as part of the response to Research Question 2.

4.2 Rubrics

Rubrics were prepared by the researcher and used to assess student performance in the two video assignments. The researcher explored the effectiveness of the intervention in assisting student understanding and communication of biological science topics. The quantitative scale data arising from the students' grades was compiled and analyzed in SPSS and used to address the questions of student understanding and communication in Research Question 1.

Rubrics were designed to assess 1) student understanding of the topic, 2) student communication skills and 3) the quality of the analogy. All three rubrics had their own set of criteria graded with four different values: exemplary (4 points), commendable (3 points), acceptable (2 points) and revisit (1 point). The first rubric was designed to assess students understanding of the subject by exploring their general subject knowledge, the relevance of the information, the contextualisation of the theory within their chosen scenario, the organization of their information and the quality of their transitions. The second rubric was designed to assess the student's ability to communicate the subject by evaluating their elocution, their body language, their awareness of the type of listener (from their chosen scenario), their preparedness and their professionalism. The third rubric was prepared using the Teaching With

Analogies model from (Glynn, 1994, 2007, 2008) and was designed to evaluate the student's ability to produce an effective analogy by evaluating their introduction of the analogy, their choice and explanation of the analog, their examination of the analog's limitations and their conclusion.

The first video assignment was assessed using the first rubric for student understanding of the subject and the second rubric for student communication skills. The second video assignment was assessed using the first rubric for student understanding of the subject, the second rubric for student communication skills and the third rubric for quality of the analogy. Grades were compiled for both assignments, and a comparison of both grades allowed the researcher to evaluate the effectiveness of analogy creation in assisting student understanding and communication. The students received grades for both activities as part of their course evaluation. A dependent t-test was conducted on the pre-intervention grades in comparison with the post-intervention grades, both for the two individual and matching rubrics (the rubric for understanding and the rubric for communication), as well as on the final grades for the pre-intervention and post-intervention assignments.

5. ETHICAL CONSIDERATIONS

This study took all precautions necessary to protect the participants. Ethical approval was received from the Ethics Committee of Champlain Regional College. A full copy of the proposal and the tools to be used in the study was provided to the Ethics Committee and the researcher informed them of all changes brought to the research proposal after submission. Given that the study involved minimal risk, the researcher did not anticipate any issues arising from this research. There is no financial or material gain to be declared by the researcher.

At the beginning of the semester, the students were asked to fill out a consent form on a voluntary basis (see student information and consent form in Appendix A).

By choosing to participate in this study, they were allowing the researcher to use their grades from this exercise, their responses to the questionnaires and interviews, and their work produced as part of this activity. The information about the project and the consent forms were distributed and collected by a non-teaching staff member of the College, and any question or concern remained between the students and this staff member. Each consent form was assigned a random participant number that had to be recorded by the student, and the listing of these numbers with the student identification remained with this staff member to provide anonymity for the students. The staff member also kept the consent forms until final grades for the class were submitted, at which point the researcher was provided with the consent forms to get the necessary information for follow-up interviews.

5.1 Informed Consent

At the beginning of the fall 2015 semester, the students were informed of the research project and their implication as participants in this project, and the non-teaching staff member of the College was left alone with them to distribute and then collect the consent forms. The students were informed to leave their consent form blank if they chose not to participate in the study and all consent forms, filled out or not, were collected to avoid exclusion and social penalties that could result from not handing in a consent form. By signing the consent forms, the students were agreeing to allow the researcher to use their student work and grades from the two video assignments as well as their responses to the questionnaires and interview (if applicable). All the information collected during this study remains confidential.

By signing the consent form, the students were consenting to participate in the study and as such, were required to fill out a pre-intervention questionnaire, a post-intervention questionnaire and allowed the researcher to use their student work and grades for the research project. Students choosing not to participate in the study had to

participate in the video assignments, as it was part of their class assessments, but their grades were not used in the study, and their blank questionnaires were discarded.

5.2 Anonymity and Confidentiality

The consent forms were assigned random participant numbers and both the consent forms and the list of participants with their participant number were kept by the non-teaching staff member of the College during the fall 2015 semester until the final grades were sent to the College. This procedure was followed to maintain student anonymity during the semester and to limit researcher bias in grading. The consent forms and the list of participant numbers were provided to the researcher after the submission of final grades for the fall 2015 semester and the students who were willing to participate in follow-up interviews were contacted by the researcher in the winter 2016 semester.

The questionnaires collected during the study were only identified with the participant numbers provided by the staff member at the beginning of the semester, a number that the students had to keep record of to identify their questionnaires. All student information remains confidential and the data will remain in the possession of the researcher only, kept in a secure location, protected electronically with a password and protected physically under lock and key. The data will be destroyed following the ethical guidelines of Champlain Regional College no later than 5 years after the publishing of the final paper, and only when the data is no longer necessary for the study.

CHAPTER FIVE
PRESENTATION OF DATA AND DISCUSSION

1. CHARACTERISTICS OF THE SAMPLE

The target sample for this study comprised of 26 students of the Anatomy and Physiology III course taught by the researcher in fall of 2015. Two students did not complete the course and one student chose not to participate in the study, so the final sample size of the study amounted to 23 students.

On the assumption that demographic factors may have significant effects on the results of this study, questions pertaining to language, previous experience and perceptions of biological sciences were collected in the pre-intervention questionnaire (see pre-intervention questionnaire in Appendix B). A summary of the descriptive data is found in Appendix H (statistical analysis).

1.1 General demographics

Of the group of 23 students, 4 (17.4%) students were male and 19 (82.6%) students were female. As is common in the cégep setting, the majority of students, in this case 18 (78.3%) students, were between the ages of 17 and 24 years of age and only 5 (21.6%) students over 24 years old.

1.2 Language

As a small Anglophone community college, our student population is diverse, especially in matters of language. Of the sample population, 6 (26.1%) students considered themselves predominantly Anglophone and 17 (73.9%) students identified

as either Francophone or allophone. The mother tongue language of the participants may have had a significant effect on the results of the study, because the numbers of students whose mother tongue language is not English might impact the grades of the assignments, given the effort required in learning both the basics of the English language, and the intricacies of biological science vocabulary. The vocabulary in biological sciences is difficult to acquire, and the process of using the terminology appropriately could be compared to learning a new language. Furthermore, the creation of analogies (the intervention) is a skill that necessitates a thorough grasp of a language, so in this situation, a good understanding of the English language. It would be expected that students whose mother tongue is not English may struggle more with both the first video assignment which requires a thorough biological science vocabulary, and the second video assignment, which required the language skill necessary to generate an analogy. Despite the expectations, Chi-square analysis did not reveal any significant differences in the grades of students for video assignment 1 (X_2=36.337; p=0.086) or video assignment 2 (X_2=20.988; p=0.743) per their mother tongue language. The fact that the students could repeat the exercise several times before submitting their best video could explain these results.

1.3 Previous healthcare experience

Students who have previous experience working in healthcare (at the exclusion of any clinical stage setting in their nursing program) would have a better understanding of the reality of nursing practice than those with no experience. Their understanding of clinical realities and the possibility that they may have had experience working with patients might have an impact on some of the data collected for this project. From the 23 students in the sample, 3 (13.0%) students had previously worked full time in healthcare, 7 (30.4%) students had worked part time in healthcare and 13 (56.5%) students had never worked in healthcare. When asked what position they had and how long they practiced this position, those who had previous experience working in healthcare had worked as caregivers or nursing assistants from a few months to a

few years. The Chi-square analysis did not expose any significant differences in grades for assignment 1 (X_2=27.241; p=0.397) or for assignment 2 (X_2=29.951; p=0.270) between students with full time or part time healthcare experience and students without healthcare experience. This could be explained by the limited biological science required in their previous healthcare experience, which would most likely require only task operational knowledge (Akinsanya, 1987) (see Akinsanya's four levels of task performance in section 1.2).

1.4 Previous biological science education

Some students have previous biological science education when they enter the nursing program, either from high school, cégep, University or other institutions. This knowledge base often gives them an advantage in the class because they have a more extensive vocabulary and a basic understanding of main concepts, but also more experience in dealing with the challenges in learning this discipline. From past experience, the researcher/teacher has observed that these students not only perform better in their biology courses, but also have more confidence in their knowledge base. And of deeper relevance to this study, Pittman (1999) took note that students with prior knowledge of a subject performed better in analogy creation. She considers that the students with prior knowledge may have more cognitive function available for analogy creation or may find the exercise intellectually stimulating. From the 23-student sample group, 2 (8.7%) students had no previous biological science education, 16 (69.6%) students had high school biological science education and 5 (21.7%) students had biological science education from cégep or from another institution. Chi-square analysis reveals that there are no differences in grades for assignment 1 (X_2=53.188; p=0.064) or for assignment 2 (X_2=42.406; p=0.326) between students as per their previous biological science education. These values were surprising, given that previous biological science education should give some students an advantage in understanding. However, given that all the students were in a second year of biological sciences in nursing, it is plausible that all students had attained enough understanding

of the subject to minimize the effect of biological science education before entering the nursing program.

1.5 Student perception of their understanding of biological sciences

An important consideration for this study was the difficulty that the students perceived relating to biological sciences. Most of the studies explored and described in the literature review showed that nursing students find biological sciences difficult, but it was important to establish the perception of the students in this sample group when considering the data collected. The perception of the students to the question "Do you find biological science topics easy or difficult to understand?" was interpreted as follows: very easy (-2), easy (-1), neither easy nor difficult (0; neutral position), difficult (1) or very difficult (2). In the groups of 23 students, 4 (17.4%) students found biological sciences to be very easy, 3 (13.0%) students found them easy, 9 (39.1%) students found them neither easy nor difficult, 3 (13.0%) students found them difficult and 4 (17.4%) students found them very difficult. Though these results seem to contradict literature on the subject, the possibility of a relationship between this perception and the students' previous biological science education was explored. In this case, the Chi square analysis revealed a significant difference in the perception of the students and their previous biological science education (X_2=21.762; p=0.04). Though all students in the sample had completed one year in biological sciences in the nursing program, it is conceivable that the students who had previous biological science education felt more comfortable with the vocabulary and could more easily follow the fast pace of a college science course.

1.6 Student perception of difficulty in explaining biological sciences to others

Another factor to consider in this study was the level of difficulty the nursing students have in explaining biological science to others. The perception of the students

to the question “Do you find that explaining biological science topics to others is easy or difficult?” was interpreted as follows: very easy (-2), easy (-1), neither easy nor difficult (0; neutral position), difficult (1) or very difficult (2). Of the 23 students in the group, 2 (8.7%) students found it very easy to explain biological sciences to others, 3 (13.0%) students found it easy, 11 (47.8%) students found it neither easy nor difficult, 6 (26.1%) students found it difficult and 1 (4.3%) student found it very difficult. These results show a greater percentage of students uncomfortable with explaining biological science concepts to other. This begs the question: Is their understanding of the subject as significant as they considered it in a previous question given the clear relationship between understanding a topic and being able to explain it to another?

2. ANALYSIS OF THE DATA RELATING TO THE RESEARCH QUESTIONS

2.1 Research Question 1

Research Question 1: Does the integration of an activity involving self-generated analogies in biological sciences assist in the understanding and communication of difficult biological science topics by cégep nursing students?

The first research question investigated **the improvement of student grades** in understanding and communication after the intervention (analogy creation). To address the specific objective of the first research question, statistical analysis of the grades for student understanding from the first video assignment were compared to those of the second video assignment using dependent t-test analysis, and this same analysis was repeated for grades on student communication. The use of three separate rubrics allowed for a specific analysis of student understanding, student communication and analogy building (second video assignment only) (see rubrics for video assessment in Appendix F).

2.1.1 Rubric for Student Understanding

The videos produced by the students for the first and second assignments were both assessed for understanding by grading the students on five different criteria using four numerical values, depending on their performance. A numerical value was assigned to four different ratings: exemplary (4 points), commendable (3 points), acceptable (2 points) or revisit (1 point). A rating was allotted for each of the following five criteria: subject knowledge, relevance, contextualization, organization and transitions. The researcher viewed the videos, assigned grades for each of these criteria as per the rubrics, and calculated the total score for the video assignment. These grades and any relevant comments were provided to the students, and the grades were used in the analysis of research question 1.

A dependent t-test of the difference between the mean grades for student understanding from the first video assignment and the second video assignment was generated given the one group, pre-test/post-test design. The analysis revealed that there was a significant difference between the mean grades of the two assignments ($t = 2.356$, $p < 0.05$). In fact, the mean grade for the second video assignment was 77.1%, a value which represented a 7.2 % increase from the mean grade for the first video assignment at 70.0%. An overview of these results is found in table 1.

Table 1
Statistical data Associated with the Grades for Student Understanding

	Grade student understanding section of video assignment 1	**Grade for student understanding section of video assignment 2**
Mean	**70.0%**	**77.2%**
Standard deviation	17.2%	16.2%
Dependent t-test	2.356	
Confidence interval	0.86 - 13.5	
p-value	0.028	

These results, which are represented in figure 2, demonstrate that the exercise in creating analogies was helpful in improving student understanding of biological sciences in the sample group.

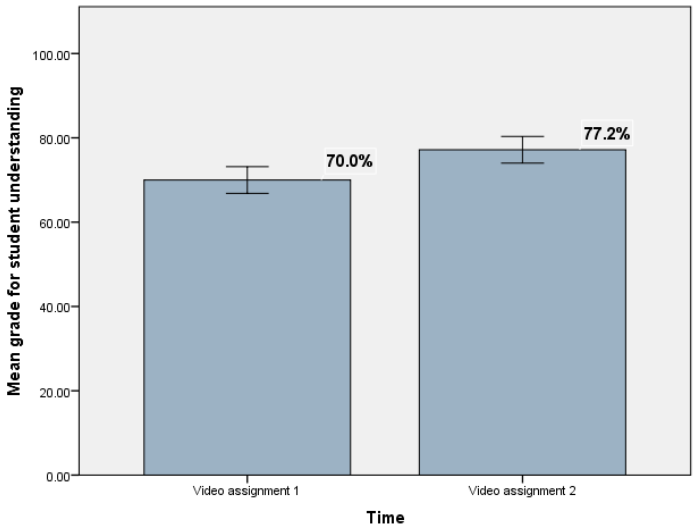

Figure 2: Mean grades for student understanding

Given that the students were required to produce both video assignments on the same topic with the same scenario, it begs the question as to whether the students' improvement could be due to the repetition of the same exercise. However, the students had the task of addressing the same topic and scenario, but with the added complexity of doing so by using an analogy. An analysis of the student questionnaires and interviews shows that the students found the analogy creation to be challenging, and this may have reflected on their grades for understanding and communication in the second video assignment.

2.1.2 Rubric for Student Communication

Using the same two videos assignments, the researcher assessed the students' communication by grading them on five different criteria using four numerical values, depending on their performance. The researcher assigned grades for these five criteria using the following values: exemplary (4 points), commendable (3 points), acceptable

(2 points) or revisit (1 point). These values were assigned on the following five criteria: elocution, body language, awareness of the listener, preparedness and professionalism. These grades and any relevant comments were provided to the students, and the grades were used in the analysis of research question 1.

A dependent t-test of the differences between the mean grades for student communication for the first and for the second video assignments was generated, following the same guidelines as the comparison between the student understanding grades discussed above. The results from the dependent t-test of the mean grades from the first video assignment and the second video assignment shows no significant difference ($t = 0.536$, $p > 0.05$). The mean grade for the second video assignment was 89.1%, which shows a 0.9% improvement from the mean grade for the first video assignment at 88.3%. Given the p-value of 0.597, a value exceeding the established threshold of 0.05, the difference between the results of the first and second video assignments is statistically insignificant. An overview of these results is shown in table 2.

Table 2
Statistical data Associated with the Grades for Communication

	Grade for communication section of video assignment 1	**Grade for communication section of video assignment 2**
Mean	**88.3%**	**89.1%**
Standard deviation	12.3%	11.4%
Dependent t-test	0.536	
Confidence interval	-2.50 – 4.24	
p-value	0.597	

These results, which are represented in figure 3, show that the creation of analogies does not improve communication of biological sciences in the sample group.

Though no significant difference was observed in communication skills from the first video assignment to the second video assignment, and despite the complexity of having to communicate with an analogy, the students generally obtained grades comparable to the first video assignment. The importance of communicating difficult information to patients is an important skill for nurses, and it is interesting to note that using analogies in patient education is not likely to affect nurses' ability to communicate effectively.

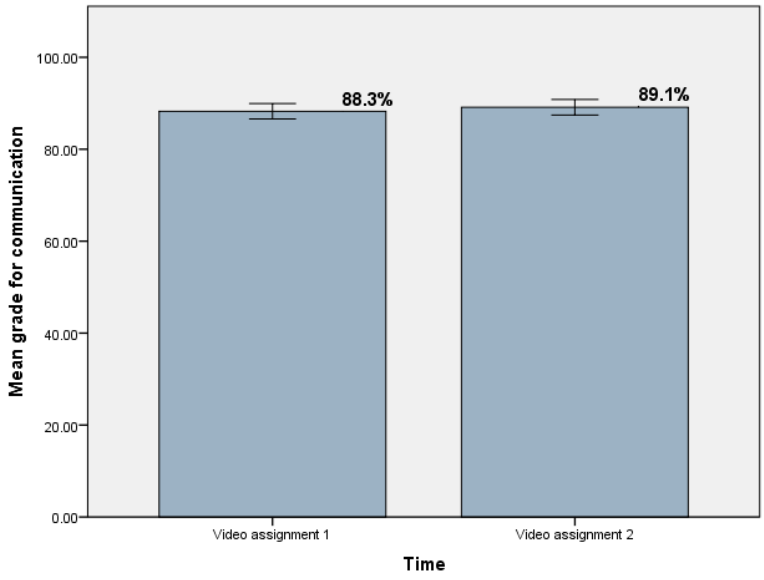

Figure 3: Mean grades for student communication

2.1.3 Rubric for analogy creation

The creation of the analogies was assessed using a separate rubric, so the researcher could compare the level of student understanding between the first video assignments and the second video assignments without considering the effects associated with analogy construction. The rubric used to assess the creation of the analogies is based on Glynn's Teaching With Analogies (TWA) model (Glynn, 1994, 2007, 2008). The students received instruction on analogies in general and how to create a functional analogy based on this model (see presentation of analogies in biology instruction in Appendix G). Though the grades associated with this rubric are

not representative of how well the students understand biological sciences, they do represent how well they understood and applied the instructions on analogy creation. The mean grade for analogy creation was 73.3%, while the mean grade for student understanding was 77.2% and the mean grade for communication was 89.1%. The researcher noted that lower grade for analogy creation was associated with the difficulty the students had in following the instruction for analogy creation, despite the fact that both a copy of the presentation and the rubric were given to them. Though the analogies were generally well done, most of them lacked important criteria (especially the limitations of the analog). Note: the instructions on analogy creation given by the researcher was briefer than planned due to the teacher strike and may have contributed to the student performance on this section of the assignment.

It is important to note that the analysis of the analogies was instrumental in identifying gaps in understanding, gaps that were not noticeable in video assignment 1. In her study, Lancor (2012) noted that student-generated analogies required more creativity, more critical thinking skills and were useful tools in revealing student thinking. In another study, Glynn (2008) remarked upon the difficulty in creating analogies when a topic is not well understood. It was evident that creating analogies demanded more of the students; they needed to delve deeper into their subject to explain the links between the analog and the target concept, and to identify the differences between the two. Thus, the findings in this study concur with findings of at least two other researchers.

In the post-intervention questionnaires and interviews, students commented that the creation of analogies required them to revisit the subject in more detail, to do more research, it helped them to clarify unclear information and to identify previous gaps in their understanding of the topic. These comments confirm that the work involved in creating the analogies for the second video assignment was more demanding than the first video assignment without analogies, but that this added effort may have contributed to the improvement in student understanding.

2.2 Research Question 2

Research Question 2: Do cégep nursing students perceive that understanding and communication of difficult topics in biological science improves with the use of self-generated analogies?

The second research question investigated the **improvement in the perception of the students** about their competence in understanding and communication after the intervention (analogy creation). The researcher compared quantitative data from the pre-intervention and post-intervention questionnaires, and evaluated qualitative data provided in the post-intervention questionnaires and the interviews. To address the specific objective of the second research question, statistical analysis of the student responses in the pre-intervention questionnaire were compared to their responses in the post-intervention questionnaire, both for student understanding and communication.

2.2.1 Perception of student understanding

Studies investigating the use of student-generated analogies in the classroom evaluated the improvement in student understanding by looking at grades but none of the studies explored the perception of the students about the usefulness of analogies in their learning (Pittman, 1999; Spier-Dance et al., 2005). Student perception can have an impact on the level of effort they put into doing work or using a specific tool, and this was particularly interesting to explore given the novelty aspect of this tool.

2.2.1.1 Results from Quantitative Data. Following their first video assignment, the students were given a pre-intervention questionnaire in which they were asked to provide feedback on various issues relating to biological sciences within nursing. Some of the questions were meant to assess their perception of the difficulty of biological sciences, the importance of this subject in nursing education and their skills in communication of biological sciences. Given that the literature was focused on

exploring the difficulty nursing students have in learning biological sciences, it was important to explore the perception of the sample group.

The students were asked to rate their level of understanding of their topic following the first video assignment (in the pre-intervention questionnaire) and their answers were interpreted as follows: very easy (-2), easy (-1), neither easy nor difficult (0; neutral position), difficult (1) or very difficult (2). The student responses (seen in table 3) were evenly distributed across the scale; 8 (34.8%) students found it very easy, 8 (34.8%) students found it easy, 5 (21.7%) students found it neither easy nor difficult and 2 (8.7%) students found it difficult. An overview of these results is shown in table 3.

Table 3
Student Perception of their Level of Understanding (Assignment 1)

Answer	**Frequency**	**Percent**
Very easy (-2)	8	34.8%
Easy (-1)	8	34.8%
Neither easy nor difficult (0)	5	21.7%
Difficult (1)	2	8.7%

Though these results show some differences with the results found in section 1.5, this question was more limited in scope. Rather than generating a response on general topics in biological sciences, it was focused on the specific topic that the student had chosen for their video assignment from the list provided by the researcher/teacher. And these topics were chosen from subjects that the students had learned about in their biology courses the previous year, so the complexity of learning a new subject was not at play. Though using new subjects may have been interesting to explore in this study, the creation of analogies is most successful when students have prior knowledge of the subject (Glynn, 1994, 2007, 2008; Pittman, 1997) and integrating new topics as part of these assignments would have been too difficult for most to manage.

After a short instruction on building analogies and after completing the second video assignment, the students were asked the same questions about the same topic. When asked to rate their level of understanding of their topic following the second video assignment the responses (seen in table 4) were as follows: 6 (26.1%) students found it very easy, 12 (52.2%) students found it easy, 4 (17.4%) students found it neither easy nor difficult and 1 (4.3%) student found it difficult. An overview of these results is shown in table 4.

Table 4
Student Perception of their Level of Understanding (Assignment 2)

Answer	**Frequency**	**Percent**
Very easy (-2)	6	26.1%
Easy (-1)	12	52.2%
Neither easy nor difficult (0)	4	17.4%
Difficult (1)	1	4.3%

There is a greater number of students who found their topic easier to understand after the second video assignment, though the values are very close to the results from the first video assignment. As discussed previously, this could be the effect of repetition, though given the added complexity of creating the analogy, and the limited time frame available at the end of the semester, this conclusion seems less likely. What is interesting to note is that their perception is somewhat consistent with the improvement of student understanding observed in the quantitative analysis of grades. Because it is not always the case, it is important to note that, in this situation, the students' perception of their improved understanding is in line with their actual improvement.

2.2.1.2 Results from Qualitative Data. When asked to expand on their responses by describing how the analogy creation helped or hindered their understanding of their topic, most students were positive about the intervention. Content analysis of the student responses show positive ("simplification", "clarification", "memorable", "different perspective" and "more detailed"), neutral and negative ("confusing",

"misleading") feedback. Positive comments about the effect of student-generated analogies included the effect of simplification (26.0%); creating analogies made it "easier to understand the topic", it "helped make it more simple". Some students noted that it brought clarification (13.0%); it helped to "clarify very obscure or difficult concept or idea", it gave "a more concrete example". Other answers included a greater ability to remember (8.7%), offered another perspective (4.3%) and gave more detail (4.3%). Some students agreed that it was helpful, but did not specify how it helped (17.4%). Others found that there was no effect to the creation of analogies (17.4%); that it "didn't help their understanding or that their understanding was good even without using an analogy". Few students found the experience to hinder their understanding of their topic, but one student (4.3%) found it confusing and another (4.3%) expressed that "it sometimes can create traps".

Four students consented to provide more depth to their answers by agreeing to be interviewed after the submission of final grades. When asked how the creation of an analogy helped or hindered their understanding of the topic, most of the students found it helpful. One student expressed that "finding a good analogy was difficult", and that the time limits of the assignment made it more challenging, but that the assignment "helped me because I had […]to think about my topic", "I had no choice but to do more research on my topic", because she realized that she had not understood it well in the first video assignment. Another student explained that some topics in biology are memorized, but when having to create an analogy, "you have to really know your subject", and that when she tried to push her analogy to bring as many comparisons between analog and target concept, she was more "intense" in her research. She also added that when doing more research, "you see other things that you did not see in the beginning, and it deepens your knowledge". Another student was excited to share that her choice of an analogy helped her in an exam later, because "she remembered everything, it all came back to [her] super easily". This same student explained that though she thought she had understood her topic well the first time around, by using an analogy "that correctly reflected what was actually going on, [she]

had to a little bit more digging" and it made her realize that she had not correctly understood the mechanism at play in the first video assignment.

The student comments are reflective of the research in the use of analogies in sciences. Dilber and Duzgun (2008) explain that analogies lead to conceptual change and new perspectives, but can also lead to incorrect ideas or impaired learning (2008). Harrison and Treagust (2006) acknowledge that student-generated analogies are difficult to create, but where there is success, there is meaningful learning. In most of the literature about analogies in education, we find both advantages to their integration in the classroom, but also some warnings about the possibility of creating misconceptions and misunderstanding (Dilber & Duzgun, 2008; Harrison & Treagust, 2006; Treagust at al., 1998).

2.2.2 Perception of Student Communication

This study was constructed to explore the possibility of encouraging the use of analogies in patient education, and to do this, the students must recognize the usefulness of the exercise. The perception that students had while creating this analogy was instrumental in developing awareness of this tool and the best ways to use it, as well as raising their levels of confidence in integrating it as a tool for patient education. As such, the creation of analogies falls under the personal and professional development task category from Akinsanya's four levels of task performance (Akinsanya, 1987) (see section 1.2).

2.2.2.1 Results from Quantitative Data. When asked if they found the topic difficult to explain in the first video assignment, the students were somewhat evenly distributed in their responses: 5 (17.4%) students found it very easy, 7 (30.4%) students found it easy, 6 (26.1%) students found it neither easy nor difficult and 5 (21.7%) students found it difficult. An overview of these results is shown in table 5.

Table 5
Student Perception of their Communication (Assignment 1)

Answer	**Frequency**	**Percent**
Very easy (-2)	5	21.7%
Easy (-1)	7	30.4%
Neither easy nor difficult (0)	6	26.1%
Difficult (1)	5	21.7%

When the question was repeated to them in the post-intervention questionnaire (following the second video assignment), the students answered as follows: 5 (21.7%) students found it very easy, 8 (34.8%) students found it easy, 5 (21.7%) students found it neither easy nor difficult and 5 (21.7%) students found it difficult. An overview of these results is shown in table 6.

Table 6
Student Perception of their Communication (Assignment 2)

Answer	**Frequency**	**Percent**
Very easy (-2)	5	21.7%
Easy (-1)	8	34.8%
Neither easy nor difficult (0)	5	21.7%
Difficult (1)	5	21.7%

These results are surprising, showing very little change in perception from the first to the second video assignment. This shows that though they had to explain the same topic twice, several students in the group did not find it easier to communicate, even the second time. These results support the idea that the analogy creation may have added a new level of complexity when the students had to explain the topic in the second video assignment. And yet, though the mean grade for communication did not improve with the use of analogies, it did not decrease (see table 6).

In her study exploring the use of student-generated analogies in the biology classroom, Salih (2008) notes that her students were initially fearful of creating their own analogies mostly because they found the task to be vague, they did not feel

confident in their knowledge of the target concept and they worried about not being able to generate an appropriate analogy for their topic.

Unfortunately, there was teacher strike during the semester. It may have affected the students. The anxiety levels at the end of the semester, added on to the loss of class time from the strike may have brought on more stress than expected. The fact is that few students felt well prepared to create their analogy, and this may have been expressed mostly in a lack of confidence in their communication skills. Many did not use or see the importance of using the Teaching With Analogies model, despite having received instructions to do so, and the rubric showing them that the assessment of their analogy would be based on this model.

One question in the post-intervention questionnaire asked the students whether the Teaching With Analogies model was helpful in generating their analogy. Not only was this model presented in class with examples, but it was also made available to them in a simplified format to guide them in the process. The rubric was also provided to them when the assignment instructions were distributed, and highlighted how the evaluation would consider their use of the steps of this model in their video assignment. Despite this information, the student answers (shown in table 7) are distributed as follows: 10 (43.4%) students found it very helpful or helpful, 6 (26.1%) students found were neutral (neither helpful nor not helpful) and 7 (30.4%) students did not find it helpful. An overview of these results is shown in table 7.

Table 7
Student Perception of the Usefulness of the Teaching With Analogies model

Answer	**Frequency**	**Percent**
Very helpful (-2)	5	21.7%
Helpful (-1)	5	21.7%
Neutral (0)	6	26.1%
Little helpful (1)	3	13.0%
Not helpful (2)	4	17.4%

2.2.2.2 Results from Qualitative Data. The students were asked to give more information about the improvement of their communication skills following the second video assignment, and whether the analogies helped them improve or not. Content analysis of the student responses show positive ("fresh perspective", "clarification", "simplification", "connection", "memorable"), neutral and negative ("more difficult", "confusing") feedback. Positive comments included the effect of a fresh perspective on explanation (8.7%); it offered "another way of explaining the subject". Some cited the effect of clarification (8.7%); it "made the topic more clear and an easier way to explain to a patient". Some students focused on simplification (8.7%); "it simplifies the subject". Other students claimed that patients could better relate to the subject (4.3%) and that analogies make it easier to remember the explanation by thinking about items used everyday (4.3%). Several students (21.7%) felt that the analogies did not contribute to improving their communication of the subject, mostly because they felt their communication was better served by using direct scientific explanations. Some students found that using the analogies had a negative impact on their communication, citing that it made it more difficult (8.7%), either to choose an analogy or to communicate, and some found it more confusing (8.7%). Here again we see a greater impact of the difficulties some students had in generating analogies on their perception of communication versus their earlier perception of understanding.

Although there was no direct question in the interview process on the effect of analogies on the communication of their topic, several students expressed the advantage of using analogies in patient education. Several mentioned how the analogies would be a helpful tool "when patients do not understand […] what you tell them in scientific terms or when patients are less educated (young patients or older patients)". One student shared an experience of how a physician explained to a mother about her child's heart condition using an analogy, and this student noted that mother could easily explain the condition to her husband later on, using this same analogy. The student assumed that she was better able to communicate the information because she understood what the physician has explained.

3. RESEARCH LIMITATIONS

3.1 Threats to internal validity

A province-wide teacher strike took place during the timeframe initially set aside for the research project, a situation that affected the internal validity of the study. The project had to be produced within a limited timeframe, and within an environment of tension and anxiety both for the researcher and students alike. The students' opinion on the teacher strike and the anxiety associated with the completion of their semester is an important factor to consider in the analysis of this study. This tension may have influenced the students' responses in the questionnaires and their performance in the video assignments.

As discussed above, the rubrics used to assess the second video assignment contained similar grading criteria except for the added criteria for the assessment of the analogy creation. This added criterion could mask the improvement that would be naturally noted in the post-intervention video assignment. However, this challenge was addressed by evaluating the video assignments with separate rubrics for student understanding, communication and analogy development and analyzing the data separately when needed.

3.2 Threats to external validity

The results of this study cannot be generalized to the population of cégep nursing students because the sample is both too small and non-random. Given the profile of the cégep and of the student population chosen for this study, the data that was collected offers a very limited picture of the reality of the target population.

Given the one group pre-test/post-test design, there is a distinct possibility that answering the questions in the pre-intervention questionnaire influenced the answers provided in the post-intervention questionnaire, especially given that many of the questions were similar on the two instruments. This same effect could also be observed in the assessment of grades, because the two video assignments were graded equally for student understanding and communication, though the second video assignment was assessed with an added component for the creation of the analogy.

Despite these limitations, the research revealed some valuable information that can be used in designing future research endeavours.

CHAPTER SIX
CONCLUSION

1. SUMMARY OF FINDINGS

The present study made use of student-generated analogies as a learning strategy for cégep nursing students in biological sciences, and explored the potential of this strategy in improving student understanding and communication. The researcher collected data not only on the actual improvement of student understanding and communication, but also on student perception of their own improvement. The mixed research method generated quantitative and qualitative data from the convenience sample of 23 students from Québec's Champlain - College in Lennoxville, a small rural English cégep. Given its relatively small size, a one group pre-test/post-test design was used. Hence, it should be noted that the data collected is not an accurate depiction of the population of nursing students in the province of Québec. The findings cannot be generalized to the population as a whole.

Data from this study shows that anxiety with learning biological sciences was not common in the sample group, which was unexpected given statistics found in the literature on the topic of nursing student anxiety. Statistical analyses of the data in relationship with previous biological sciences education suggests that prior knowledge and understanding of biological sciences may explain the discrepancies between this data and the literature on the subject. Depending on the location of the various studies on which this research is founded, the prior biological science knowledge of their participants may have varied from the sample group for this study. Most students attending cégep nursing programs have a Québec high school education, where most of them are likely to have enrolled in general science courses. Of particular import is the fact that these high school science courses provide an introduction to biological

science vocabulary and concepts. This introduction to biological sciences provides a strong basis for the biological science courses at the cégep level.

Quantitative analysis of the data collected from two video assignments shows that student understanding improved with the use of student-generated analogies. The mean grades for student understanding were significantly higher in a second video assignment, an assignment incorporating analogy, than in the first video assignment, in which students did not use analogy. The students had to prepare their two video assignments with the same scenario, so we can consider the effect of pre-test sensitization as a factor in challenging the internal validity of these results. However, given the complexity of these assignments, and especially the second video assignment with the added challenge of creating an analogy, pre-test sensitization is less likely to have a profound effect on the results. It is also worthy noting that the students' perception of their own understanding shows improvement as well. Comments from the students were predominantly positive, supporting the hypothesis that student-generated analogies help in improving understanding.

Close examination of the data shows that student communication neither improved nor worsened with the student-generated analogies, though in both assignments, the mean grades were high. Interestingly, student perceptions also remained steady between the two assignments, and in both instances, demonstrate that the students are not as confident in their ability to communicate as they are in understanding. Qualitative analysis of student comments also generated less enthusiasm in matters of communication than understanding. The lack of previous studies exploring this subject makes it difficult to establish a trend. However, several studies present issues relating to the use of analogies and the possibility for misunderstanding, both in the classroom and in the hospital setting (Casarett et al, 2010; Duit, 1991; Harrison & Treagust, 1993; Venville & Treagust, 1997).

2. RECOMMENDATIONS

A related area that deserves more attention is the exploration of co-generated analogies with teachers and students (Aubusson, Treagust & Harrison, 2009). Some studies have explored this strategy, but a new avenue would be the evaluation of student learning with teacher-generated analogies, student-generated analogies, and co-generated analogies.

This study, and most of the literature found on the subject, was focused on the use of student-generated analogies in sciences, and more specifically biological sciences. An noteworthy avenue would be the exploration of this tool not only in other science disciplines, but also in humanities and English, as well as the social science disciplines psychology and sociology, both of which include required courses for students in the cégep nursing program.

Given the lack of studies exploring the use of analogies in the nursing profession, the benefit of interdisciplinary communication/learning activities involving the biological science courses for nursing students and the nursing department courses has yet to be studied. Nursing students could create analogies in the context of the biological sciences courses and then consciously use them during their clinical stage in order to effectively communicate with real patients.

3. CONCLUDING REMARKS

An analogy is a comparison between two things that do not seem similar. The purpose is to explain or clarify something unfamiliar using familiar concepts. Analogies allow nurses to educate patients without relying exclusively on medical terminology. Given the relative success of this study, student-generated analogies are a tool to consider when establishing effective instructional strategies in biological science courses. Analogies evoke rich instantaneous mental pictures; they can be tools

of discovery (Harrison & Treagust, 1993). They help to create meaning, and the comparison is memorable. And when created by students, analogies inspire high levels of critical thinking and are windows into the minds of students, allowing educators to identify misunderstandings (Duit, 1991; Lancor, 2012; Middleton, 1991; Spier-Dance et al., 2005; Wong, 1993). For these reasons, the creation of analogies continues to be an effective strategy in the educator's – and the nurses' -- toolbox.

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APPENDICES

APPENDIX A

STUDENT INFORMATION AND CONSENT FORM

CONSENT FORM

Participation in a study or project regarding research, innovation, or critical analysis in the context of a Masters degree in college teaching[1] *requires the consent of participants.*

In the context of my studies related to a Masters in College Teaching at Université de Sherbrooke, I am conducting research on a pedagogical innovation supervised by Carolyn Lewis Dellah (Ph.D.) who, at the end of this consent form, attests to all information provided.

1. PROJECT TITLE
   The use of student-generated analogies as a learning strategy in biology for nursing

2. LEAD RESEARCHER
   Isabelle Ménard
   Telephone: (819) 564-3666, EXT. 135
   Email: imenard@crc-lennox.qc.ca

3. INTRODUCTION
   This form presents the ethical considerations of this project. It is important to read it and to understand each point. As lead researcher, I am available to answer all of your questions.

4. PROJECT DESCRIPTION
   Nursing students are often found struggling in their biology courses, a fact that is supported by literature. A challenge that faces biology instructors is to make their course more relevant to nursing. The researcher is exploring the use of student-generated analogies as a potential bio-nursing strategy, giving the students the opportunity to improve learning in biology, but also to practice preparing analogies as a useful tool for patient education.
   The objective of the study is to compare how nursing students can understand and explain a difficult topic in biology without analogies, and then with analogies. The researcher will compare the results of using the two different

[1] Based on M. F. Fortin (2010). *Fondements et étapes du processus de recherche. Méthodes quantitatives et qualitatives.* Montréal: Chenelière Éducation.

types of teaching strategies, and will also collect data on student perceptions. A questionnaire will be given, followed perhaps by interviews or focus groups if more information is needed to complete the study.

5. PARTICIPATION

Students in the Anatomy and Physiology III course will be participating in this study. All students will be required to participate in the classroom activities of analogy construction, as it will be an inherent part of the course. However, in addition, students will be asked to fill out two questionnaires in two different instances (maximum 20 minutes each). They may be asked to be interviewed or be part of a focus group during the following semester. This would require a maximum of 30 minutes of their time. Completing the questionnaires and participating in interviews or focus groups will be by student consent only, and no pressure will be exerted on the students to participate.

6. ADVANTAGES OF PARTICIPATION

This study will help the researcher test out the effectiveness of student-generated analogies in the nursing biology classroom. Thus, benefits will be realized by future students of the nursing program.

The participants in the study will benefit from a greater understanding of difficult biology topics, and therefore have the advantage in future testing in that discipline. They will also develop an ability to create effective analogies, a tool that will be helpful to their nursing practice for the task of patient education.

7. BENEFITS, RISKS, AND DRAWBACKS

This study has the potential to increase awareness of the usefulness of using analogy construction in nursing education. It also has the potential to help nurses better communicate complex information to their patients, thereby ensuring better quality healthcare.

Participants in this study are not expected to suffer any negative effects from this study. It is considered to be under the threshold of minimal risk.

Minimal risk: When the probability of occurrence and the level of possible drawbacks or risk are comparable to those in the daily life of the participants. Individuals who agree to participate in this project are exposed to very little risk of suffering inconveniences (physical pain, discomfort, sense of failure, irrational fear, *or* threats to identity) (Fortin, 2010).

8. PRIVACY AND CONFIDENTIALITY
   All physical data will be kept under lock and key and electronic files will be stored on a password protected drive. The numbered consent forms collected by a college employee will remain in the office of this employee until the end of the semester, at which point it will be kept by the researcher. All other data will remain with the researcher. The raw data will be destroyed 2 years after the submission of the research study.

9. COMPENSATION AND EXPENDITURES
   There will be no monetary or other compensation for project participation.

10. VOLUNTARY PARTICIPATION AND WITHDRAWAL FROM THE STUDY
    Participation in the study (completing questionnaires and participating in interviews or focus groups) is on a voluntary basis, no student will be required or expected to participate. No negative consequences will be associated with a refusal to participate. Furthermore, participants are free to withdraw from the study at any time, without prejudice and without having to justify their decision, by informing the lead researcher. They will, however, have to participate in the construction of analogies, as that is an integral part of the course. Finally, once the study is complete, all data will be removed from the study and will be destroyed.

11. CONTACTS
    If you have questions about this project, you can contact the LEAD RESEARCHER. If you have questions about the program, contact the RESEARCH SUPERVISOR or the COORDINATOR OF THE MASTERS PROGRAM at performa@usherbrooke.ca

12. CONSENT OF THE PARTICIPANT
    I have read and understood the content of this form. I have had the opportunity to ask all my questions, and these have been answered to my satisfaction. I know that I am free to participate in the project (in terms of completing the questionnaires and participating in interviews or focus groups), or I may choose not to participate. Furthermore, I know that I remain free to withdraw at any time by verbal notice, without prejudice. I certify that I was given all the time I needed to make my decision. I have signed below, consenting to participate in this project.

Name of participant*: _____

Signature : _____
(*If a minor is involved, consent and signature of parental authority)

Date : _____

☐ By checking this box, I am expressing that I am willing to participate in a follow-up interview, allowing the researcher to contact me in the Winter 2016 semester if needed

13. COMMITMENT OF THE LEAD RESEARCHER
I certify a) that I have answered the questions of the signatories in regard to the terms of this consent form, and b), that I clearly informed them of their freedom to end their participation in the project at any time.

Name of the lead researcher: Isabelle Ménard

Signature: _____
Date: _____

Name of the college employee: Judith Beaudoin
Signature: _____
Date:_____

14. COMMITMENT OF THE SUPERVISOR
I attest that the information contained in this form have been provided in good faith by Isabelle Ménard.

Name of the Supervisor: Carolyn Lewis Dellah

Signature: Carolyn Lewis Dellah

Date: September 23, 2015

APPENDIX B

PRE-INTERVENTION QUESTIONNAIRE

PARTICIPANT NUMBER : _____

QUESTIONNAIRE

To continue providing a biology education that is best suited to your needs as future nursing professionals, we have created a research project that will allow us to explore the use of analogies as a tool for learning biology for nursing. By agreeing to participate in this project, you are contributing to research that will help nursing students in years to come. Thank you for taking the time to fill out this questionnaire!

The information provided in this questionnaire will remain confidential.

GENERAL INFORMATION

1. What is your sex?

☐ Male ☐ Female

2. What is your mother tongue?

☐ English ☐ French ☐ Other: _____

3. To which age group do you belong?

☐ 17-24 ☐ 25-34 ☐ 35-44 ☐ 45+

4. What level of education have you attained?

☐ High school diploma

☐ Professional education diploma (DEP or other)

☐ Cégep diploma

☐ University degree (Undergraduate or Graduate)

☐ Other: _____

5. Which of the following best describes your <u>principal</u> situation in the past year?

☐ Enrolled in high school

☐ Enrolled in professional program (DEP or other)

☐ Enrolled in higher education (cégep, college or University)

☐ Working

☐ Unemployed

☐ Other: _____

6. Which of the following best describes your previous healthcare experience (summer or other permanent work, NOT clinical stage)?

☐ I have no experience in healthcare

☐ I have worked in healthcare part time

☐ I have worked in healthcare full time

If you have worked in healthcare part time or full time, please provide your position and the number of years spent in that position:

_____

_____

7. Which of the following best describes your biological education before entering the nursing program at Champlain?

☐ I have had no biological education

☐ I have a high school biology education

☐ I have a cégep biology education

☐ I have a University biology education

☐ I have a biology education from another institution (Institution: _____)

BIOLOGY FOR NURSING

For the following, please choose the option that best suits your perception of the statements provided.

8. I believe that nursing practitioners should have a good knowledge of biological science.

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

9. Do you find biological science topics easy or difficult to understand?

Very easy ○ ○ ○ ○ ○ Very difficult

10. Do you find biological science terminology easy or difficult to acquire?

Very easy ○ ○ ○ ○ ○ Very difficult

11. Do you find that explaining biological science topics to others is easy or difficult?

Very easy ○ ○ ○ ○ ○ Very difficult

12. Do you think that it is important to understand biological science in order to communicate better with patients?

Very important ○ ○ ○ ○ ○ Not important

Following the video activity:

13. Did you find that understanding your topic was easy or difficult?

Very easy ○ ○ ○ ○ ○ Very difficult

14. Did you find it easy or difficult to explain complex concepts?

Very easy ○ ○ ○ ○ ○ Very difficult

15. Did you find it easy or difficult to simplify the concepts?

Very easy ○ ○ ○ ○ ○ Very difficult

16. Did you find it easy or difficult to find simpler vocabulary for complex scientific terminology?

Very easy ○ ○ ○ ○ ○ Very difficult

17. Do you think that a real patient would have found it easy or difficult to understand your explanation of the topic?

Very easy ○ ○ ○ ○ ○ Very difficult

18. Did you find the approach (the explanation and not the process of using video) used in this exercise to be an effective or ineffective tool for patient education?

Very effective ○ ○ ○ ○ ○ Very ineffective

APPENDIX C

POST-INTERVENTION QUESTIONNAIRE

PARTICIPANT NUMBER : _____

QUESTIONNAIRE

Before learning to use analogies to explain difficult topics in biology, we asked you to fill out a questionnaire about biology for nursing. Now that we have explored the use of analogies, we ask you to fill out a similar questionnaire to compare responses. Thank you for taking the time to fill out this questionnaire!

The information provided in this questionnaire will remain confidential.

Following the analogies activity:

1. Did you find that understanding your topic was easy or difficult?

   Very easy ○ ○ ○ ○ ○ Very difficult

2. Did you find it easy or difficult to explain complex concepts?

   Very easy ○ ○ ○ ○ ○ Very difficult

3. Did you find it easy or difficult to simplify the concepts?

   Very easy ○ ○ ○ ○ ○ Very difficult

4. Did you find it easy or difficult to find simpler vocabulary for complex scientific terminology?

   Very easy ○ ○ ○ ○ ○ Very difficult

5. Do you think that a real patient would have found it easy or difficult to understand your explanation of the topic?

Very easy ○ ○ ○ ○ ○ Very difficult

6. Did you find that preparing your own analogy was helpful in understanding this topic better?

Very helpful ○ ○ ○ ○ ○ Not helpful

7. Did you find it easy or difficult to choose and create an analogy for your topic?

Very easy ○ ○ ○ ○ ○ Very difficult

8. Did using the step by step "Teaching With Analogies model" help you in creating your analogy?

Very helpful ○ ○ ○ ○ ○ Not helpful

9. Did using an analogy make it easier or more difficult to explain your topic?

Very easy ○ ○ ○ ○ ○ Very difficult

10. Did you find it easier or more difficult to <u>understand</u> your topic after creating your analogy than after the initial video exercise?

Very easy ○ ○ ○ ○ ○ Very difficult

11. Did you find it easier or more difficult to communicate your analogy than communicating the topic directly in the initial video exercise?

Very easy ○ ○ ○ ○ ○ Very difficult

12. Did you find the analogies approach used in this exercise to be an effective or ineffective tool for patient education?

Very effective ○ ○ ○ ○ ○ Very ineffective

13. Based on your experience as a nursing student, do you think that the analogies approach used in this exercise would be welcome by patients?

Very interesting ○ ○ ○ ○ ○ Not interesting

14. Do analogies provided by teachers help you understand difficult topics? Why or why not?

15. How did the "Teaching With Analogies model" and training help you create and assess analogies?

16. How did the exercise with analogies help/hinder your understanding of the difficult topic?

17. Did you feel that your communication of the difficult topic improved with analogies? Why or why not?

18. Do you plan on using analogies for patient education? Why or why not?

APPENDIX D

INTERVIEW QUESTIONNAIRE

PARTICIPANT NAME : _____
PARTICIPANT NUMBER : _____

QUESTIONNAIRE

In order to answer these questions, I am asking you to step out of your student role into that of a future professional. Try to imagine how the activity done in class could be useful or not to your role as a nurse, especially as it pertains to patient education.

1. Do you feel that analogies used in biology education in the past have been helpful or not? Explain.

2. How did the creation of an analogy help/hinder your understanding of the topic?

3. How did creating an analogy change the way you think about or approach the topic?

4. Did creating the analogy highlight some areas of misunderstanding about the topic? Explain.

5. What was most difficult about creating the analogy?

6. Did you find the Teaching With Analogies model helpful in learning how to build a useful analogy?

7. How could the video assignment be more helpful in preparing for patient education?

8. Do you feel that the video assignment format was more or less helpful than an oral presentation in class? Explain.

9. How could analogies assignment be more helpful in preparing for patient education?

10. Which of the two activities (with or without analogy) would be most helpful in preparing for patient education?

11. Have you ever used or thought of using analogies in your clinical practice? If so, when and how?
12. Do you think that analogies would be useful in some situations (and with some patients) more than others? Explain.

13. Will this exercise change the way you approach patient education? Why or why not?

14. Do you feel prepared to step into the role of patient educator? Explain.

15. Can you think of another activity to prepare future nurses for patient education?

APPENDIX E

VIDEO ASSIGNMENT INSTRUCTIONS

VIDEO ACTIVITY 1 (5% of final grade) **Due Wednesday November 23rd**

This activity has been prepared in order to test both your understanding of a difficult biological subject and your capacity in explaining to a third party. Given that you will be required to explain difficult concepts (biological or otherwise) to future patients, gaining skill in this area is very important.

Choosing from one of the topics provided, prepare a 2 minute video presentation of yourself explaining this topic as you would to a patient. A few things to note:

- Remember this is a biology course and not a nursing course; make sure to address the topic from a biological perspective and not get into a nursing perspective
- The topic you choose will also be the same one you use in the second video activity, so make sure you are prepared to address it for both
- Do not use analogies or metaphors as a part of this activity
- Time is crucial, you may not always have much time in your shift to explain topics to patients, so using the time you have effectively is important
- Use appropriate biological vocabulary, but when you expect this vocabulary to be difficult to understand, explain it as you would to a potential patient
- Feel free to explore creativity! Perhaps Jennifer would allow you to pretend to teach the mannequins in the nursing labs…

I ask you to prepare this short video using your cell phone, tablet or laptop camera and upload it to private YouTube (send me the link). If you do not have the technology needed, please contact me and we will work out a solution. Don't spend too much time trying to perfect it on video quality or your acting, work on the skills being assessed: understanding of the topic and communication.

If you do not upload it on YouTube, send video to: imenard@crc-lennox.qc.ca

VIDEO ACTIVITY 2 (5% of final grade) **Due Monday November 30th**

This second video activity will be assigned after the presentation on Teaching with analogies. Do not prepare it before this presentation, as you will be lacking the knowledge required for this assignment.

You will keep the same concept chosen for the first video assignment, and prepare a 4 minute video presentation of yourself explaining this topic as you would to a patient. However, this concept will need to be explained using an appropriate analogy generated by yourself. A few things to note:

- Once again, time is crucial so keep within the timeframe required
- Choose an analogy that your patient can understand (take note of the concepts and clientele provided)
- Make sure you are using a good analogy which shares several characteristics with the concept (target) chosen, otherwise your analogy will not be useful for understanding and cause more confusion
- Make the link between the concept (target) and the analog, otherwise the patient will be unable to understand the initial concept
- Point out where the analogy breaks down to avoid creating a set of misconceptions in your patient
- Review your notes on analogy creation to help guide you
- Feel free to use your creativity once again!

I ask you to prepare this short video using your cell phone, tablet or laptop camera and upload it to YouTube. If you do not have the technology needed, please contact me and we will work out a solution. Don't spend too much time trying to perfect it on video quality or your acting, work on the skills being assessed: understanding of the topic, communication and analogy construction.

If you do not upload it on YouTube, send video to: imenard@crc-lennox.qc.ca

Choose one of the following topics; you will use the same one for both video activities.

1) A woman was just announced that her son suffers from Duchenne Muscular Dystrophy. She wants to know what an X-linked disorder is and why her future children (especially boys) are at risk of suffering from this same disorder.
2) An older patient was diagnosed with left-sided heart failure. He wants to understand what heart failure is and why left sided heart failure causes issues with his respiration.
3) A woman has been suffering from Myasthenia Gravis and is concerned because she has recently been suffering from muscle weakness (her left eye is starting to droop). She wants to understand why and how this autoimmune disorder is affecting her muscles (discuss pathophysiology at the neuromuscular junction).
4) A patient is questioning the use of triple therapy (antibiotics, stomach lining protector and proton pump inhibitor) in the treatment of his stomach ulcers, insisting that stomach acid is the only reason for his affliction. Explain to him why triple therapy is the recommended therapy for stomach ulcers.
5) A young patient has just been diagnosed with Type I diabetes, and his parents want to know if it might be linked to the fact that his mother suffered from gestational diabetes, Explain the reason why gestational diabetes cannot be transmitted to a developing fetus (discuss the placental barrier) and how both pathologies are isolated from one another.
6) An elderly patient is asking you for advice about his diet, which he was told to modify due to a recent cardiovascular diagnosis. He was told to stay away from foods high in cholesterol and saturated fats, and he was also given values of HDL and LDL cholesterol. He is quite confused about dietary cholesterol and fats and the link with blood cholesterol levels. Explain how dietary fats can contribute to blood cholesterol levels and the difference between LDL and HDL cholesterol.

APPENDIX F

RUBRICS FOR THE VIDEO ASSESSMENT

NAME : _____

RUBRICS VIDEO ASSIGNMENTS

1) Student understanding

This rubric will be used to assess student understanding of the topic within the context of the questions provided. The same rubric will be used for video assignment1 and video assignment 2.

CRITERIA	EXEMPLARY (4)	COMMENDABLE (3)	ACCEPTABLE (2)	REVISIT (1)
Subject Knowledge : did the student understand the topic?	The student showed excellent knowledge of the subject as indicated by appropriate vocabulary, pertinent information and remarkable explanations	The student showed a very good knowledge of the subject as indicated by generally appropriate vocabulary, pertinent information and adequate explanations	The student showed a fair knowledge of the subject as indicated by generally acceptable vocabulary, and reasonable information, but some concepts seem vague and misunderstood	The presentation showed clear gaps in student understanding; the vocabulary was misused and the information was vague and inappropriate for the question/situation
Relevance : did the student address the situation/question?	The presentation was clear and concise; it was complete and thorough without giving too much information beyond the scope of the question/situation	The presentation was clear and concise; it was complete but lacked some information or too much irrelevant information was provided	The presentation was somewhat clear; it was missing some information, or the information provided was not relevant	The presentation was unclear, and the information provided was irrelevant to the question/situation
Contextualization : did the student address the topic in the appropriate context?	The student presented the theory appropriate to the context provided	The student presented most of the theory appropriate to the context provided	The student presented some theory appropriate to the context provided but was missing some important information	The student did not present the theory required by the context provided
Organization : did the student present the information in a logical manner?	The student's reasoning was clearly expressed; the listener was easily able to follow the arrangement of the information	The student's reasoning was adequate and generally clear; the listener was able to follow the arrangement of the information	The student's reasoning was vague and somewhat unclear; the listener struggled to follow the arrangement of the information	The student's reasoning was vague and unclear; the listener was unable to follow the arrangement of the information
Transitions: is the student capable of flowing from one subject to another and drawing conclusions from the whole?	The student is capable of expressing information from the different systems/concepts in a flowing manner; conclusions are remarkable	The student is capable of expressing information from the different systems/concepts though in a somewhat stilted manner; conclusions are suitable	The student struggles to express information from the different systems/concepts; conclusions are doubtful	The student is unaware of the role of different systems/concepts and approaches the problem from a one-dimensional approach; conclusions are erroneous or absent

Grade: /20

Comments: _____

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2) Communication

This rubric will be used to assess student communication of the topic as they would to a patient. The same rubric will be used for video assignment1 and video assignment 2.

CRITERIA	EXEMPLARY (4)	COMMENDABLE (3)	ACCEPTABLE (2)	REVISIT (1)
Elocution: is the student clear and easy to understand?	The student is clear and easy to understand	The student is generally clear and easy to understand; some sections are unclear	The student is often unclear and difficult to understand	It is very difficult to understand the student
Body language: is the student using his body to communicate effectively?	The student maintains eye contact and a good posture, is poised and confident	The student makes infrequent eye contact and has a slightly slouched body posture, demonstrate some poise and confidence	The student struggles with having any eye contact, has a slouched posture and shows some nervousness	The student avoids all eye contact, has a slouched posture and is very nervous
Awareness of the listener: is the student aware of the listener and his/her limitations?	The student is aware of the listener's limited understanding of the subject matter and succeeds to make the topic understandable	The student is aware of the listener's limited understanding of the subject matter and tries to make the topic understandable	The student is unaware of the listener's limited understanding of the subject matter and struggles to make the topic understandable	The student does not try to make the topic understandable to the listener
Preparedness: is the student well prepared and respectful of time constraints	The student is well prepared and respects the time constraints	The student is somewhat prepared and has no more than 1 minute over the time constraints	The student is lacking preparation and has no more than 2 minutes over or 1 minute under the time constraints	The student is clearly unprepared and does not respect the time constraints
Professionalism: is the student capable of communicating in a professional manner?	The student communicates in a professional and respectful manner; is engaged and enthusiastic	The student communicates in a professional and respectful manner; is engaged and mildly enthusiastic	The student communicates in a respectful manner though slightly unprofessional; lacks enthusiasm and engagement	The student is uninterested and unengaged; lacks enthusiasm and shows lack of respectful for the exercise

Grade: /20

Comments: _____

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3) Analogy building

This rubric will be used to assess the student's capacity to build an effective analogy. This rubric will be used for video assignment 2 only.

CRITERIA[2] [3]	EXEMPLARY (4)	COMMENDABLE (3)	ACCEPTABLE (2)	REVISIT (1)
Introduction: does the student introduce the target concept?	The student introduced the target concept clearly and concisely	The student introduced the target concept clearly but at length	The student barely introduced the target concept	The student did not introduce the target concept
Choice and explanation of the analog: does the student choose an appropriate analog and do they review this analog?	The student reviewed knowledge about the analog; analog was appropriate for the specific patient	The student briefly reviewed knowledge about the analog; analog was somewhat appropriate for the specific patient	The student barely reviewed knowledge about the analog; analog was not the best choice for the specific patient	The student did not review knowledge about the analog; analog was inappropriate for the specific patient
Connection of the target concept and the analog: does the student examine the association between the target and the analog?	The student addresses all the appropriate connections between the target and the analog	The student addresses most of the appropriate connections between the target and the analog	The student briefly addresses the connections between the target and the analog; some connections are incorrect	The student very briefly addresses the connections between the target and the analog; most of the connections are incorrect
Examination of the analog's limitations: does the student identify where the link between the target and the analog break down?	The student clearly identifies the areas where the target and the analog diverge	The student identifies some areas where the target and the analog diverge	The student briefly and incorrectly identifies areas where the target and the analog diverge	The student cannot identify where the target and the analog diverge
Conclusion: does the student draw appropriate conclusions about the target concept?	The student is able to close the loop by drawing appropriate conclusions about the target concept with the help of the analog	The student is able to close the loop by drawing mostly correct conclusions about the target concept with the help of the analog	The student struggles to draw appropriate conclusions about the target concept and has difficulty reviewing the connection with the analog	The student is incapable to drawing appropriate conclusions about the target concept and its connection with the analog

Grade: /20

Comments: _____

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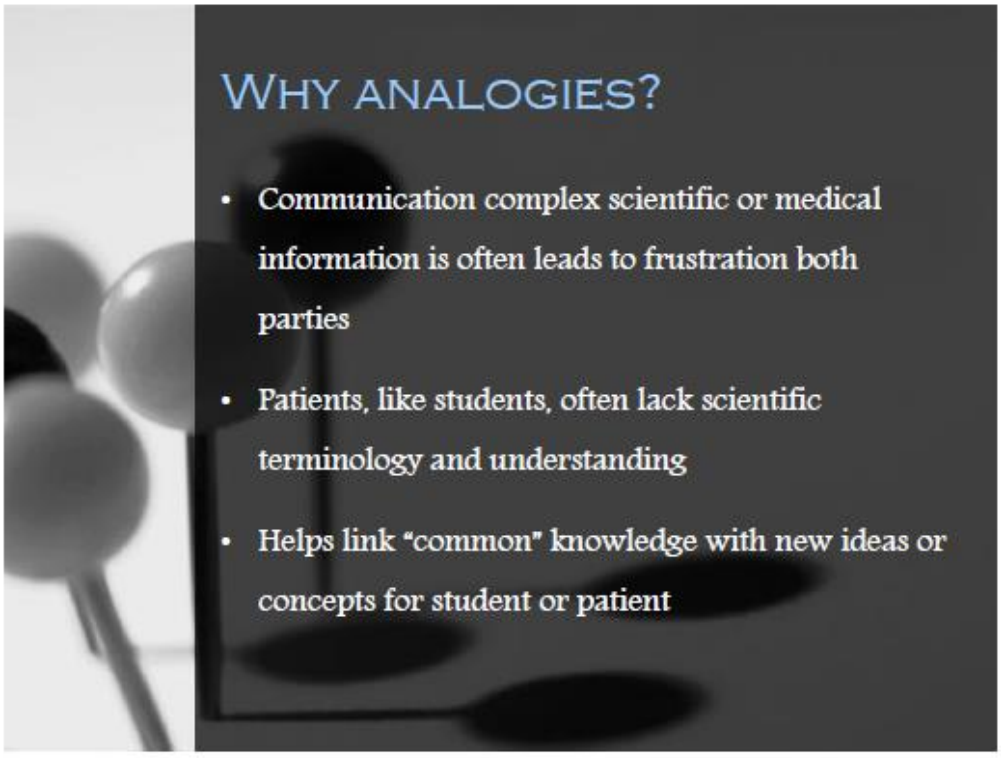
[2] Coll, R. K. (2009). A better way to teach with analogies [Electronic version]. *Chemistry Education in New Zealand*, 2-6.

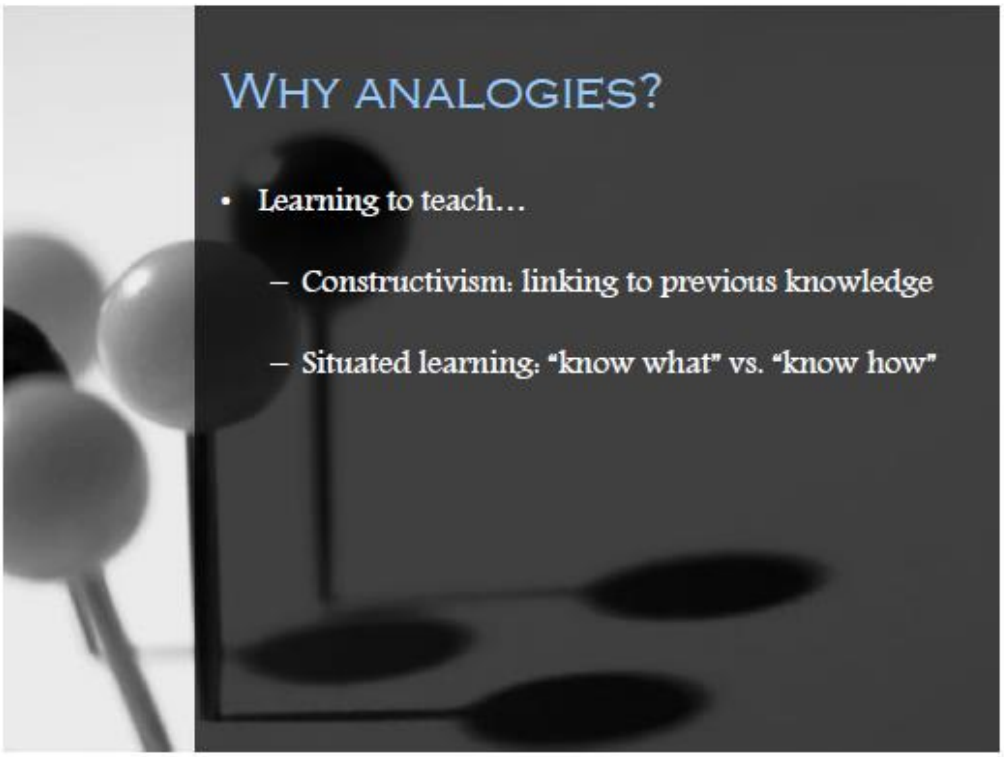
[3] Glynn, S. M. (2008). 5.1 Making science concepts meaningful to students: teaching with analogies [Electronic version]. *Four decades of research in science education: From curriculum development to quality improvement*, 113.

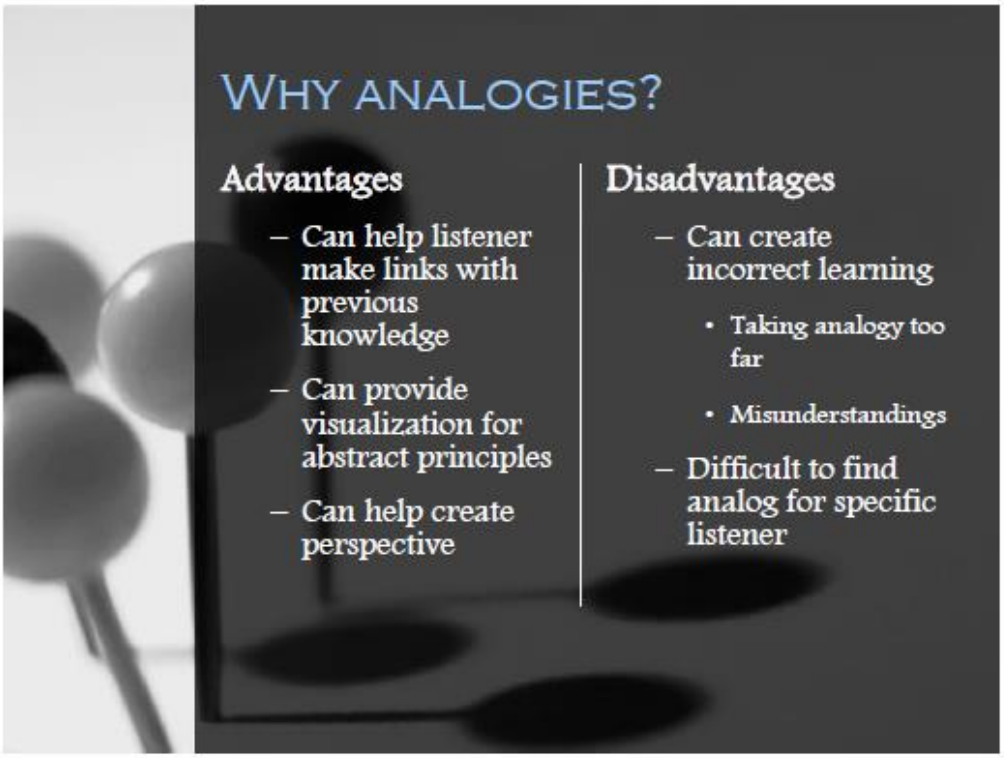
APPENDIX G

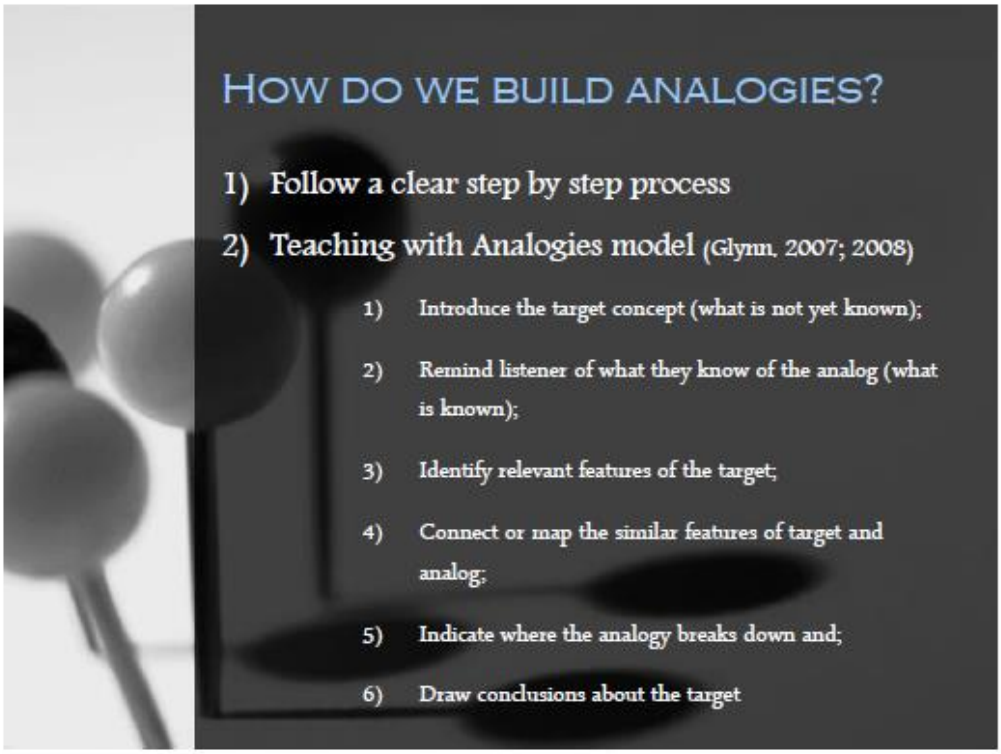
PRESENTATION OF ANALOGIES IN BIOLOGY

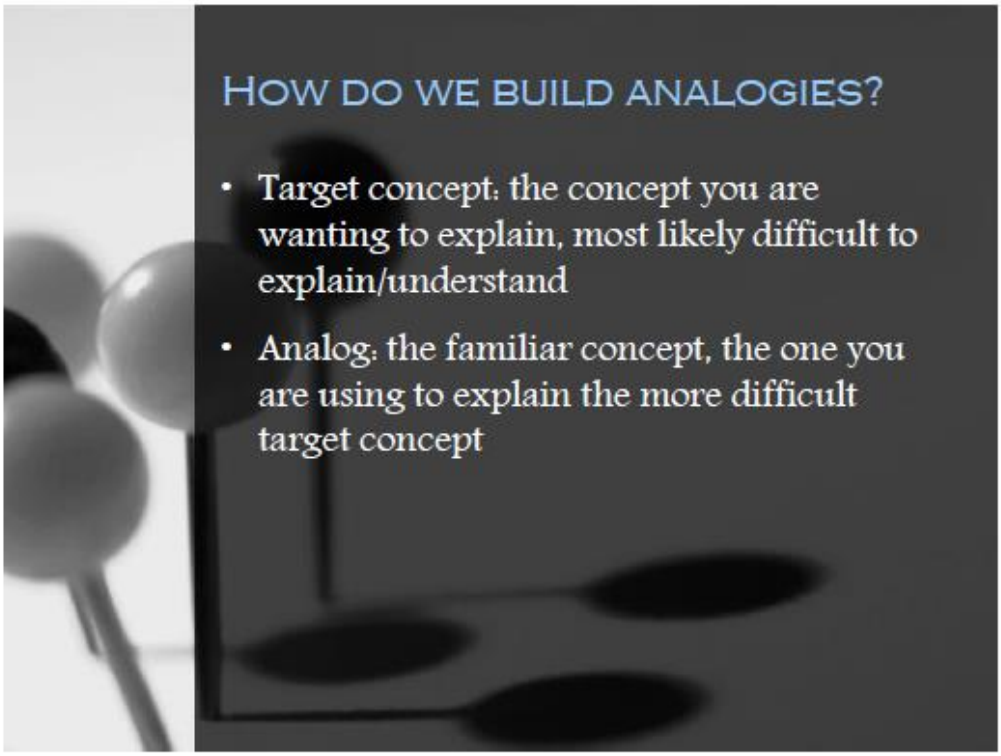

ANALOGIES IN BIOLOGY
"Without boredom, our imagination can't play"
-Ethan Hawke


WHY ANALOGIES?
• Communication complex scientific or medical information is often leads to frustration both parties
• Patients, like students, often lack scientific terminology and understanding
• Helps link "common" knowledge with new ideas or concepts for student or patient

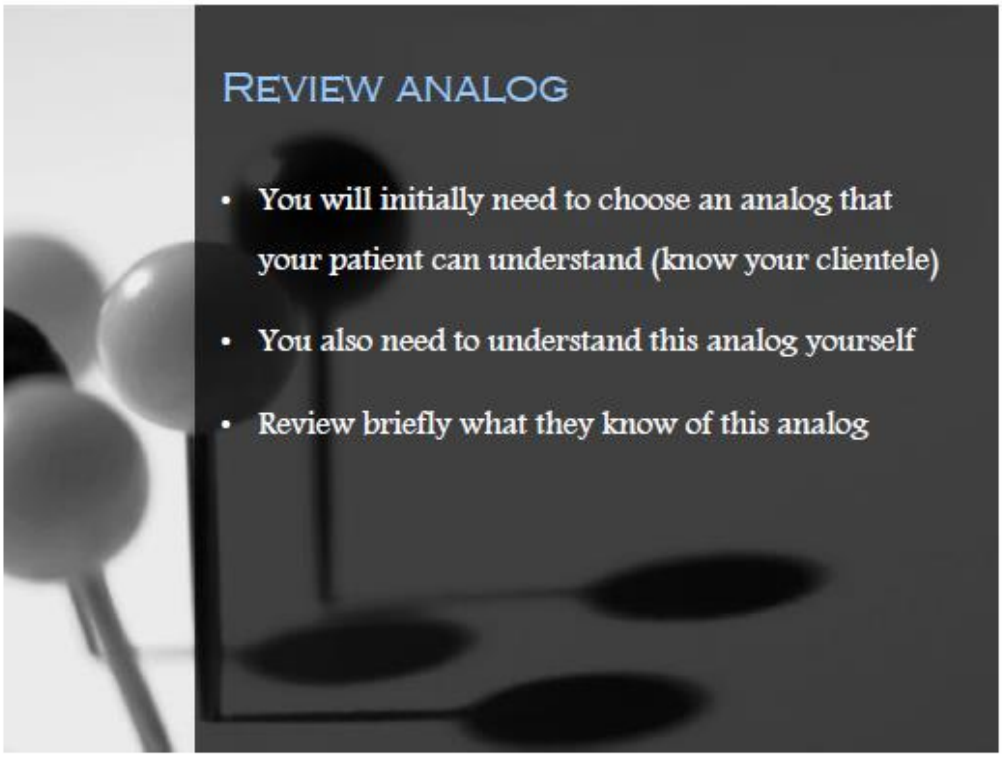

WHY ANALOGIES?
• Learning to teach…
– Constructivism: linking to previous knowledge
– Situated learning: "know what" vs. "know how"

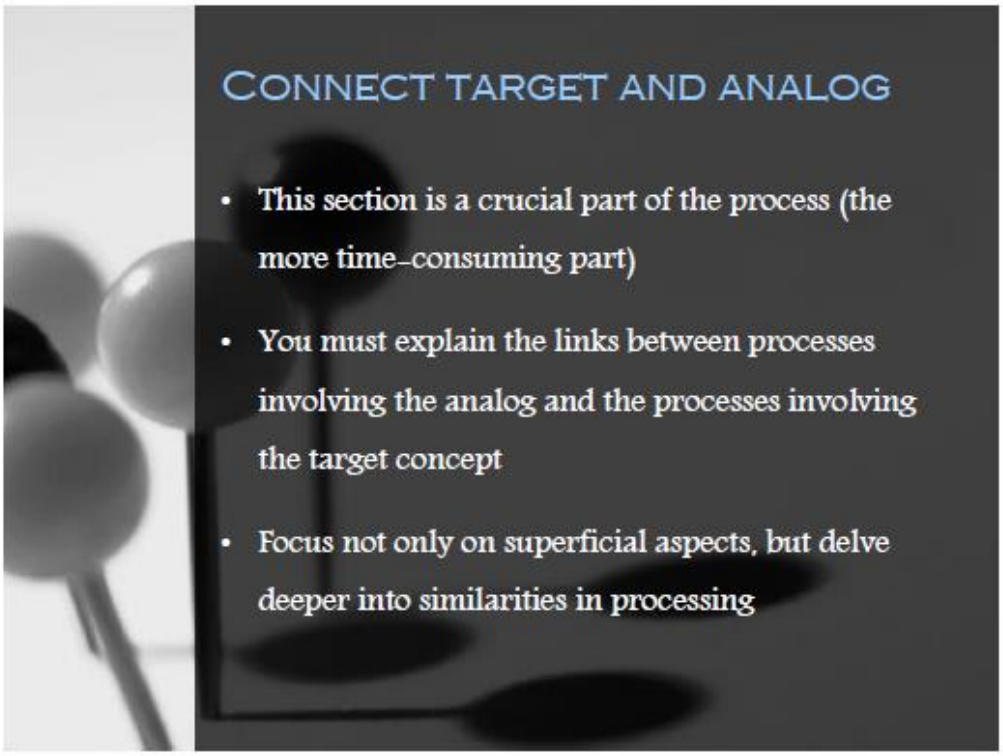

WHY ANALOGIES?
Advantages
– Can help listener make links with previous knowledge
– Can provide visualization for abstract principles
– Can help create perspective
Disadvantages
– Can create incorrect learning
• Taking analogy too far
• Misunderstandings
– Difficult to find analog for specific listener

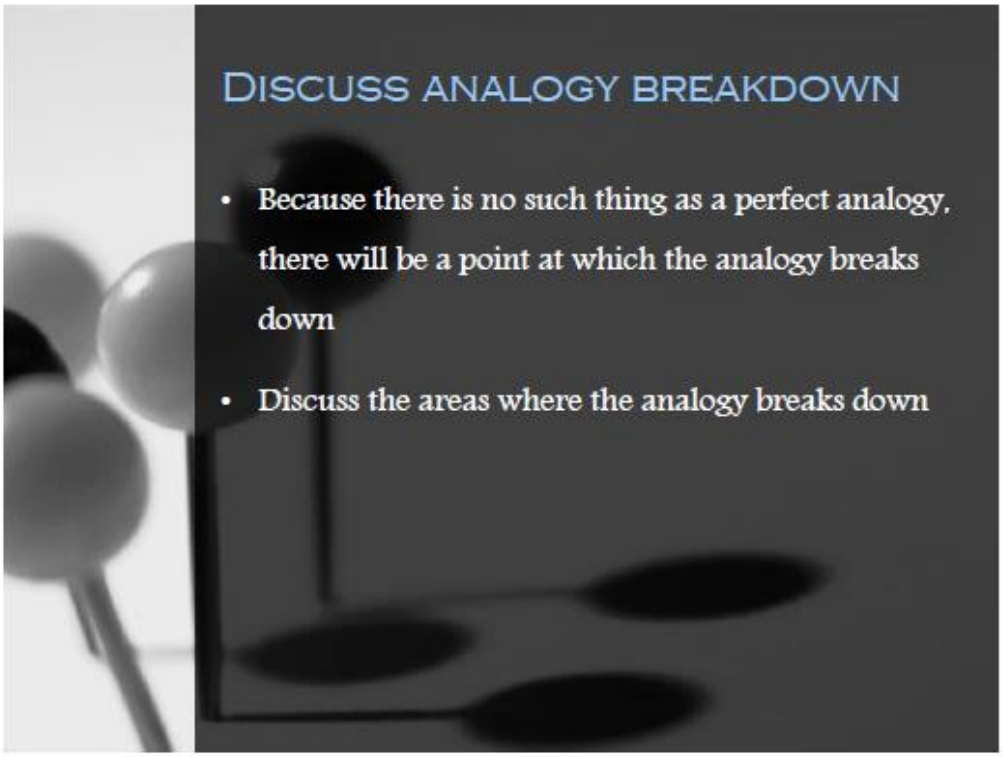

HOW DO WE BUILD ANALOGIES?
1) Follow a clear step by step process
2) Teaching with Analogies model (Glynn, 2007; 2008)
1) Introduce the target concept (what is not yet known);
2) Remind listener of what they know of the analog (what is known);
3) Identify relevant features of the target;
4) Connect or map the similar features of target and analog;
5) Indicate where the analogy breaks down and;
6) Draw conclusions about the target

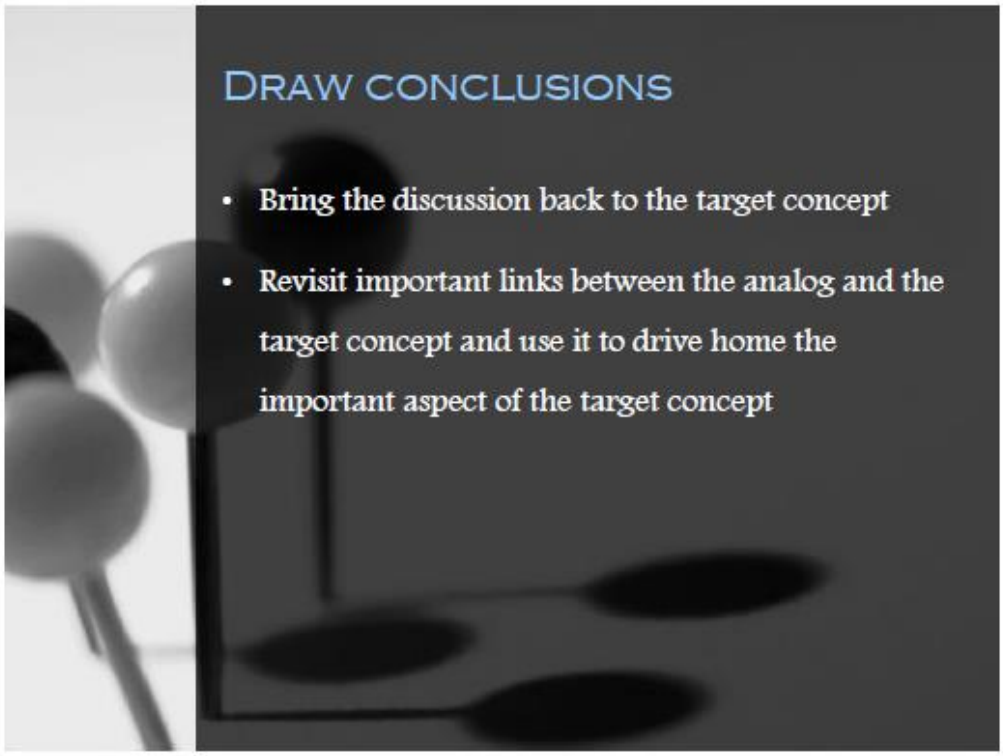

HOW DO WE BUILD ANALOGIES?
• Target concept: the concept you are wanting to explain, most likely difficult to explain/understand
• Analog: the familiar concept, the one you are using to explain the more difficult target concept

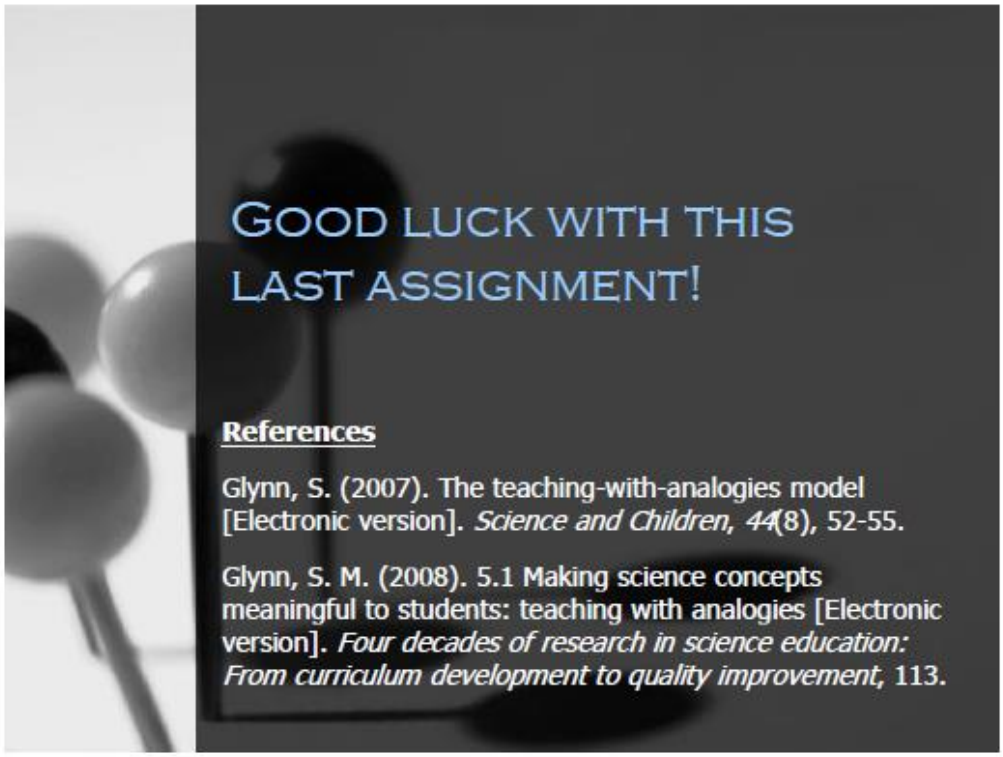

INTRODUCE TARGET CONCEPT
• Give a brief explanation of the target concept and some clear and easy nuggets of information
• Be clear about what the concept is before you enter into the next step


REVIEW ANALOG
• You will initially need to choose an analog that your patient can understand (know your clientele)
• You also need to understand this analog yourself
• Review briefly what they know of this analog


CONNECT TARGET AND ANALOG
• This section is a crucial part of the process (the more time-consuming part)
• You must explain the links between processes involving the analog and the processes involving the target concept
• Focus not only on superficial aspects, but delve deeper into similarities in processing


DISCUSS ANALOGY BREAKDOWN
• Because there is no such thing as a perfect analogy, there will be a point at which the analogy breaks down
• Discuss the areas where the analogy breaks down


DRAW CONCLUSIONS
• Bring the discussion back to the target concept
• Revisit important links between the analog and the target concept and use it to drive home the important aspect of the target concept


GOOD LUCK WITH THIS LAST ASSIGNMENT!
References
Glynn, S. (2007). The teaching-with-analogies model [Electronic version]. Science and Children, 44(8), 52-55.
Glynn, S. M. (2008). 5.1 Making science concepts meaningful to students: teaching with analogies [Electronic version]. Four decades of research in science education: From curriculum development to quality improvement, 113.

APPENDIX H

STATISTICAL ANALYSES (SPSS OUTPUT)

DESCRIPTIVE STATISTICS – FREQUENCIES

Age group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	17-24	18	78.3	78.3	78.3
	25-34	3	13.0	13.0	91.3
	35-44	1	4.3	4.3	95.7
	45+	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	4	17.4	17.4	17.4
	Female	19	82.6	82.6	100.0
	Total	23	100.0	100.0	

Mother tongue

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	English	6	26.1	26.1	26.1
	French	16	69.6	69.6	95.7
	Other	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

Previous healthcare experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No previous experience in healthcare	13	56.5	56.5	56.5
	Part time healthcare experience	7	30.4	30.4	87.0
	Full time healthcare experience	3	13.0	13.0	100.0
	Total	23	100.0	100.0	

Previous biological science education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No biology education	2	8.7	8.7	8.7
	High school biology education	16	69.6	69.6	78.3
	Cégep biology education	4	17.4	17.4	95.7
	Biology education from other institution	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

Student perception of their understanding of biological science

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very easy	4	17.4	17.4	17.4
	-1	3	13.0	13.0	30.4
	0	9	39.1	39.1	69.6
	1	3	13.0	13.0	82.6
	Very difficult	4	17.4	17.4	100.0
	Total	23	100.0	100.0	

Student perception of communication of biological science to others

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very easy	2	8.7	8.7	8.7
	-1	3	13.0	13.0	21.7
	0	11	47.8	47.8	69.6
	1	6	26.1	26.1	95.7
	Very difficult	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

Student perception of understanding in video assignment 1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very easy	8	34.8	34.8	34.8
	-1	8	34.8	34.8	69.6
	0	5	21.7	21.7	91.3
	1	2	8.7	8.7	100.0
	Total	23	100.0	100.0	

Student perception of understanding in video assignment 2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very easy	6	26.1	26.1	26.1
	-1	12	52.2	52.2	78.3
	0	4	17.4	17.4	95.7
	1	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

Student perception of communication in video assignment 1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very easy	5	21.7	21.7	21.7
	-1	7	30.4	30.4	52.2
	0	6	26.1	26.1	78.3
	1	5	21.7	21.7	100.0
	Total	23	100.0	100.0	

Student perception of communication in video assignment 2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very easy	5	21.7	21.7	21.7
	-1	8	34.8	34.8	56.5
	0	5	21.7	21.7	78.3
	1	5	21.7	21.7	100.0
	Total	23	100.0	100.0	

Teaching With Analogies model is helpful in creating analogy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very helpful	5	21.7	21.7	21.7
	-1	5	21.7	21.7	43.5
	0	6	26.1	26.1	69.6
	1	3	13.0	13.0	82.6
	Not helpful	4	17.4	17.4	100.0
	Total	23	100.0	100.0	

DESCRIPTIVE STATISTICS – MEANS

Mean grades for each rubric (Video assignments 1 and 2)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Grade for subject knowledge section of video assignment 1	23	25.0	100.0	70.000	17.1888
Grade for communication section of video assignment 1	23	60.0	100.0	88.261	12.3038
Grade for subject knowledge section of video assignment 2	23	45.0	100.0	77.174	16.2247
Grade for communication section of video assignment 2	23	65.0	100.0	89.130	11.4467
Grade for analogy section of video assignment 2	23	40.0	100.0	73.261	15.5657
Valid N (listwise)	23				

DEPENDENT T-TESTS

Student understanding (Video assignments 1 &2)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Grade for student understanding section of video assignment 2	77.174	23	16.2247	3.3831
	Grade for subject knowledge section of video assignment 1	70.000	23	17.1888	3.5841

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Grade for student understanding section of video assignment 2 & Grade for student understanding section of video assignment 1	23	.619	.002

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Grade for student understanding section of video assignment 2 - Grade for student understanding section of video assignment 1	7.1739	14.6028	3.0449	.8592	13.4886	2.356	22	.028

Student communication (Video assignments 1 &2)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Grade for communication section of video assignment 2	89.130	23	11.4467	2.3868
	Grade for communication section of video assignment 1	88.261	23	12.3038	2.5655

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Grade for communication section of video assignment 2 & Grade for communication section of video assignment 1	23	.788	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Grade for communication section of video assignment 2 - Grade for communication section of video assignment 1	.8696	7.7829	1.6228	-2.4960	4.2351	.536	22	.597

CHI SQUARE ANALYSES

Mother tongue Language and Video Assignment 1 grades

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	36.337[a]	26	.086
Likelihood Ratio	23.598	26	.599
Linear-by-Linear Association	.096	1	.757
N of Valid Cases	23		

a. 42 cells (100.0%) have expected count less than 5. The minimum expected count is .04.

Mother tongue Language and Video Assignment 2 grades

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.988[a]	26	.743
Likelihood Ratio	18.961	26	.838
Linear-by-Linear Association	.774	1	.379
N of Valid Cases	23		

a. 42 cells (100.0%) have expected count less than 5. The minimum expected count is .04.

Previous healthcare experience and Video Assignment 1 grades

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	27.241[a]	26	.397
Likelihood Ratio	29.480	26	.290
Linear-by-Linear Association	.343	1	.558
N of Valid Cases	23		

a. 42 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

Previous healthcare experience and Video Assignment 2 grades

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	29.951[a]	26	.270
Likelihood Ratio	28.662	26	.327
Linear-by-Linear Association	1.252	1	.263
N of Valid Cases	23		

a. 42 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

Previous biological science education and Video Assignment 1 grades

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	53.188[a]	39	.064
Likelihood Ratio	32.283	39	.768
Linear-by-Linear Association	5.402	1	.020
N of Valid Cases	23		

a. 56 cells (100.0%) have expected count less than 5. The minimum expected count is .04.

Previous biological science education and Video Assignment 2 grades

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	42.406[a]	39	.326
Likelihood Ratio	30.557	39	.831
Linear-by-Linear Association	1.685	1	.194
N of Valid Cases	23		

a. 56 cells (100.0%) have expected count less than 5. The minimum expected count is .04.

Previous biology education and perception of understanding biological sciences

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.762[a]	12	.040
Likelihood Ratio	17.686	12	.126
Linear-by-Linear Association	3.371	1	.066
N of Valid Cases	23		

a. 19 cells (95.0%) have expected count less than 5. The minimum expected count is .13.