NURSING STUDENTS' KNOWLEDGE OF GENETICS AND GENOMICS: AN ONLINE MODULE

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DEDICATION

To my parents, Frank and Cecelia Jordan,
who instilled a love of learning and
passion for excellence in their children.

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ABSTRACT

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The purpose of this study was to discover the knowledge of genetics and genomics held by Texas Woman's University College of Nursing students in their junior and senior years of the nursing curriculum. A quantitative study was conducted. The study consisted of an online introductory module in genetic and genomic nursing. The module was made available to 223 students in 2 classes. 114 students took the module. Pre and post tests of 10 questions each with the module were given to the experimental group. The control group received a pretest of the same 20 questions followed by the module. To answer the research question, which asked if there was an effect of viewing online modules on participants' scores at posttest, two types of analyses were conducted. The first type of analyses involved a series of cross tabulations with Pearson chi squares examining the relationships between group (control versus experimental) on participants' correct/incorrect responses for the test to assess student competence before exposure to the module questions and the Test to assess student competence after exposure to the module questions. The second was an item analyses of responses to each of the 20 questions. Two separate ANOVAs were conducted on the effect on participants' overall

scores. No overall statistical significance was found in the responses between the experimental and control groups. The statistical analyses revealed several individually significant or marginally significant findings, but none that influenced the overall statistical significance of the study. While the null hypothesis for the study is correct and needs to be accepted for this study, there are important findings from an educational perspective. From the perspective of this study, the junior and senior nursing students who took the introductory module showed a beginning knowledge of genetics and genomics as a biological science as well as the nursing implications of this knowledge. The educational implications of the study show the readiness of the TWU College of Nursing students for greater depth in genetics/genomics in each specific area of the nursing curriculum.

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CHAPTER I

INTRODUCTION: NURSING STUDENTS KNOWLEDGE OF GENETICS AND GENOMICS: AN ONLINE MODULE

The American Association of Colleges of Nursing, (AACN) has noted that the current level of instruction for nursing students on genetics and genomics has not kept pace with the status of the research in genetics and genomics. For this reason, it has been recommended by the AACN that genetics and genomics in nursing education needs to be upgraded. From the TWU Nursing faculty workshop held on January 14, 2009, the necessity of enhanced implementation of genetics and genomics in baccalaureate nursing curriculums was proposed. The presenters, Dr. Deborah Tapler, Dr. Janice Anderson and Donna Walls, MSN, learned of this newly mandated emphasis by the American Association of Colleges of Nursing (AACN) in the AACN Baccalaureate Conference in San Antonio, Texas, December 4-6, 2008. During this conference, Jean Jenkins, PhD, RN, FAAN, Senior Clinical Advisor from the National Human Genome Research Institute in Bethesda, Maryland, presented guidelines for teaching genetics and genomics in university schools of nursing.

On October 21, 2010 the Texas Board of Nursing approved the revised version of the Differentiated Essential Competencies (DECs) for both professional and vocational nurses in the state of Texas. Nursing programs in the state of Texas are required to reach

final implementation of these guidelines by Spring 2012. These guidelines for Professional Nursing programs include twenty-five core competencies under four main nursing roles. Implementation of genetics and genomics under these four main nursing roles are clearly stated in Role II Provider of Patient-Centered Care: Clinical Judgments and Behaviors A, 2-c; Knowledge Competency B, 4, Clinical Judgments and Behaviors 7; Knowledge Competency C, 3-b; Knowledge Competency F, 2; Clinical Judgments and Behaviors G.1-b.; Role IV Member of the Health Care Team, Knowledge Competency C, 6-b.

It is the purpose of this study to provide an introductory online module in genetics and genomics to nursing students of the Texas Woman's University undergraduate nursing program who will be enrolled in Nursing 4902 Section 40 EKG Interpretation and Nursing Implications (Nursing elective), taught in Summer 3 session (July 11-August 12, 2011) and in Nursing 3025 Section 30 Women's Health Family Competencies in Nursing, taught in theFall2011 semester (August 29 to December 15, 2011).

Statement of the Problem

Based on discussions with the baccalaureate nursing faculty on the TWU Houston J. and Florence A. Doswell College of Nursing campus, it was noted that the information on genetics and genomics that was presented in the 2010 academic year to baccalaureate nursing students was limited to information on single gene disorders during lectures in two courses. These courses introduce nursing students to couples beginning families in

obstetrics/women's health and in nursing of children as related to children with genetic differences. The material presented during the 2010 academic year is not in accordance with the AACN guidelines for nursing curricula. The faculty team coordinators in each of these courses are open to development of enhanced information for nursing students and are supportive of the development of course materials on genetics and genomics in the TWU baccalaureate curriculum. These coordinators suggest that an elective course be developed as a beginning point for bringing the enhanced curriculum to the TWU baccalaureate nursing program. A view of genetics and genomics from the broader perspective obviates the need for nursing students to gain increased knowledge in this rapidly developing area of biomedical technology. The implications for families with young children are profound from both the physical and the psychological points of view.

Definitions

For the purpose of this study genetics is defined as the study of individual genes and their impact on relatively rare single gene disorders. (Jenkins & Calzone, 2008).

Genomics is the study of all the genes in the human genome together, including their interaction with each other, the environment and the influence of other psychosocial and cultural factors. (Jenkins & Calzone, 2008).

Theoretical Model

The bioelectrochemical model of child development consists of a group of biophysical theories referred to by (Thomas, 2005). The bioelectrochemical model utilizes several theoretical frameworks of differing levels of structure. These levels range

from biological, physical body functioning as a unit to the levels of atomic and subatomic structure. These levels, six in all, are: the unitary child; the organic child; the cellular child; the molecular child; the elemental / atomic child and the subatomic child. Each level has its own theoretical base. Together they adequately provide the theoretical framework for such a study. The schema of this framework derives from the disciplines of human ecology, physiology, molecular biology, genetics, biochemistry, and atomic physics.

(Thomas, 2005) further states that the framework at some levels represents reality as known, but at others it is theory as to how things might be. He sees the difference between the levels to be the amount of convincing evidence compiled to support the postulated relationships between those levels. The levels proposed by (Thomas, 2005) resulting from this compilation of theories are the following:

- The first level, the unitary child is the growing child. This child is an integrated individual who interacts with the surrounding environment.
- The second level, the organic child is the growing child viewed from the perspective of systems of organs. Some examples of these organic systems are brain and nervous system, heart and circulatory system, lungs and respiratory system, kidneys and urinary system, skin and integumentary system, liver and gastrointestinal system.
- The third level, the cellular child is the growing child from the view of the individual types of cells that make up each of the body systems. Some

examples of these cells are: blood cells, nerve cells (neurons), skin cells, bone cells, and muscle cells.

- The fourth level, the molecular child is the growing child from the perspective of the proteins, enzymes, fats and differing body fluids which compose the cellular structure of the child.
- The fifth level, the elemental/atomic child is the growing child viewed from the level of the atoms making up each of the components of the body cells. These atoms are in turn made up of particles named protons, neutrons and electrons with their respective electrical charges.
- The sixth level, the subatomic child is the growing child from the perspective of the subatomic particles that make up atoms which in turn are made up of six types of substances that have been designated as quarks (Thomas, 2005).

According to Thomas's scheme compiling the above levels and their respective models, the science of genetics and genomics interacts at the third and fourth level; namely that of the cellular and molecular child. At the third level, the cellular level, (Thomas, 2005) describes the body cells as being both specialized and each in turn is made up of a cell body and the nucleus of the cell which acts as its command center. It is the nucleus that is comprised of the genetic material, the chromosomes which are made up of DNA which is the blue print of development for the child at the cellular level. The chromosomes, made up of genes, are inherited from the parents. Half of the genetic

material is from the father and half is from the mother. At the cellular level human development begins with conception when the male sperm unites with the female egg. This fertilized cell then divides and the new organism begins development. It is the DNA, as the developmental process continues, that provides the instructions for the specialization in the cell. Development continues from the cellular level to the organic level to the unitary level of each unique, growing child.

Moving from the cellular level to its components at the molecular level, proteins are the most important molecules that make up the developing embryo which becomes the growing child. The proteins are made up of twenty different amino acids linked in chains of varying lengths and arrangements in the human body. Proteins differ from each other by their amino acid arrangements. It is also noted that enzymes are special types of proteins that regulate the rate at which chemical reactions occur in the human body.

(Thomas, 2005) goes on to discuss DNA as the most critical type of protein molecules in the human body. He highlights the basic structure of DNA with its double helix formation and its four nucleotide bases. He mentions briefly the importance of genetic counseling, the use of which has become part of medicine and nursing in the 21st century. He discusses the use of genetic engineering and biotechnical prospects for the future. Genetic engineering is at work in the development of vaccines, such as the annual development of influenza vaccines which must change due to the mutation (DNA alteration) of the influenza virus as it spreads throughout the world. Biotechnical change occurs as medications are developed according to the genetic nature of individuals and

groups of persons whose DNA composition precludes or enhances the effects of pharmaceutical preparations.

Use of Theoretical Model

It is appropriate to use this model for the study at hand because genetics and genomics as defined through the Human Genome Project started in 1990 and completed in 2003 fits well into levels three, the cellular child and four, the molecular child of Thomas's model (Lashley, 2007). Development of a course not only involves genetics and genomics but focuses on presenting genetic and genomic material to nursing students as a necessity defined by the American Academy of Colleges of Nursing (AACN).

Learning Theory Implications

Consideration must be given to the realization that nursing students are adult learners. Instruction aimed at increasing their knowledge base must be done in light of the several points made by (Knowles, Holton& Swanson, 2005), in their text, *Adult Learner: The Definitive Classic in Adult Education and Human Resource Development.* (Knowles, Holton& Swanson, 2005) stated that adults are autonomous and self-directed; goal-oriented; relevancy-oriented; practical and need to be shown respect. The design of this project takes these characteristics of adult learners into consideration

The purpose of this project is to determine the effectiveness of an online Blackboard module presenting genetics and genomics to nursing students during an elective course in Summer 3 session 2011 and Nursing 3025 Section 30 Women's Health Family Competencies in Nursing, taught in the Fall 2011 semester . The placing of the

module concerning human genetics and the human genome project online as an introduction to the course is an appropriate way to initiate nursing students to this material. The information is being provided in a manner in which they can access it and meet the requirements according to their own schedules. The requirement is that they obtain the information in a timely manner to exhibit their learning in future courses. Provision of the information by this method shows respect for them as adults able to manage their own lives and learning.

(Anderson & Krathewohl, 2001), state that the knowledge level according to Bloom's Taxonomy of Educational Objectives is made up of four major types: factual knowledge, conceptual knowledge, procedural knowledge and metacognitive knowledge.

- Factual knowledge according to these authors involves the basic elements students must know to be acquainted with a discipline or to solve problems in it (Anderson & Krathewohl, 2001).
- Conceptual knowledge relates to the interrelationships among the basic elements within a larger structure that enable them to function together (Anderson & Krathewohl, 2001).

These two types of knowledge are expected of nursing students as they move into each of the various nursing specialties.

The online genetics/genomics module presented in this project will provide basic terminology and definitions of those terms which represent factual knowledge. The application of the factual knowledge in the roles of the practicing nurse related to these

basic elements represents the level of conceptual knowledge. Conceptual knowledge will be needed by the nursing students to answer the genetics and genomics questions in this research project.

- Procedural knowledge, the third type explained by (Anderson & Krathewohl 2001), will not be expected of the students from this learning module because they will not have acquired skills from the content at the time of the presentation.

A clinical course adapting genetic and genomic knowledge to the procedures and skills carried out by students in a clinical setting would be needed to provide procedural knowledge. (Anderson & Krathewohl 2001), define

- metacognition as knowledge about cognition in general and awareness of and knowledge about one's own cognition.

It would be possible to acquire metacognitive knowledge of genetics and genomics only after the first three knowledge levels have been attained. This level is beyond the scope of the current research. At the beginning of this research project it would be appropriate to ask the following as an initial research question.

Research Question

What factual and conceptual knowledge can be acquired by second semester junior and first semester senior nursing students from an introductory online module in genetics and genomics?

The above question leads to the following hypothesis:

There will be no statistically significant difference in the scores concerning knowledge of the implications of genetics for nurses by second semester junior and first and second semester senior nursing students after exposure to an online module on introductory information about human genetics and genomics than before exposure to the online module on introductory information about human genetics and genomics.

The independent variable is defined as exposure to the online module. The dependent variable is defined as the knowledge reflected by scores of students on a post test over the material covered in the module.

CHAPTER II

REVIEW OF LITERATURE: GENETICS IN NURSING

Theoretical Perspective of Genetics and Genomics

Rationale for this study has been gained from the multiple writings of the leaders in genetic nursing who repeatedly underscore the need for all nurses and especially those entering the nursing workforce in the 21st century to be well informed of the role of genetics and genomics in the broad spectrum of health care. While much is stated about the necessity and the topics to be covered, to date there is limited availability of statistically normed testing materials in the area.

Historical Perspective of Genetics in Nursing Education

(Lea, 2000) began the discussion in her article "A Clinician's Primer in Human Genetics: What Nurses Need to Know." with the indication that genetics has been a part of the study of human biology since Gregor Mendel in 1865 described the elements of inheritance that we now know as genes. In 2000, the Human Genome Project had not yet been completed. The knowledge of genetics and genomics was not utilized in everyday nursing care. For this reason, she took the concepts of genes, inheritance, chromosomes, DNA, RNA, amino acids, mitosis and meiosis; defined and reviewed the roles of these concepts for nurses' application in patient care. She discussed gene mutations as they affect human health and disease patterns in inherited conditions as well as in different forms of cancer. She used basic family history genograms to show how the traits are

passed from one generation to the next. Lea and other nursing leaders wisely saw that the gap in nursing knowledge cannot be filled without provision of the information for practicing nurses and simultaneously providing this knowledge to nursing students as they prepare to enter the health care field (Lea, 2000).

Assumptions in Genetics and Health Care

(Lashley, 2000) in "Genetics in Nursing Education" spoke to the necessity of nurses being in the front lines of genetic research with the impact that the Human Genome Project has brought to health care in the 21st century. Her view of the role of nursing is based on a set of assumptions regarding genetics and health care in the future. Her assumptions are the following:

1. Most, even all, disorders have a genetic basis.
2. Inherited genetic disorders are noted throughout the entire lifespan.
3. Any individual with an inherited condition must be given consideration by health care workers in light of that condition.
4. It is a fact that complex disorders such as cardiac conditions and cancer have a genetic component.
5. Culture and social factors create diversity among people, with genetic variation having an equal impact on the diversity.
6. Assessment of genetic risk and the need for counseling regarding these disorders will continue to increase.
7. Nurses in all areas of practice will be impacted by clients with genetic disorders.

8. Persons diagnosed with genetic disorders in infancy that formerly would have had an early demise, are now living into adulthood and even to the geriatric stage of life.
9. Genetics will change the ways of thinking both of health care professionals and the lay public about health promotion and disease prevention (Lashley, 2000).

(Lashley, 2000) concurred with (Lea, 2000) regarding the knowledge that is required for those who graduate from a program in nursing. She further stated the following points for inclusion in nursing programs. Based on the nine assumptions stated above, she saw that these assumptions need to be reflected in nursing programs as competencies in the following ways:

1. Genetic disorders that occur more frequently in the specific populations with whom the nursing students come in contact must be taught in the programs impacted by those populations.
2. Nursing students need to be exposed to the social impact of genetics in the concepts of discrimination and eugenics.
3. The interaction of the environment with human genetics must be taught in relation to health and disease.
4. Nursing students must have an understanding of the current role played by genetics in the diagnosis and development of treatment for complex disorders. Their learning needs to include planning and implementation of care for those adults with genetic conditions at all stages in the life span.

5. Nursing students need to develop an adept manner of acquiring family genetic histories.
6. An awareness of the social, legal, and ethical issues related to genetics needs to be taught to nursing students as these affect individuals, groups and societies.
7. Application of traditional nursing skills such as patient education, confidentiality and counseling must be applied to genetic information.
8. Nursing students' education must include the acquisition of a non-judgmental attitude re: genetic information and its manifestation in particular clients.
9. A mindset must be developed in nursing students as they progress through the curriculum to continue the use of current research and knowledge as it develops in genetics (Lashley, 2000).

Implementation of Genetic and Genomic Content in Nursing Curricula

The above two articles provide the backdrop for the continuing campaign to include enhanced genetic and genomic education in nursing curricula. The following literature provides several published methods of implementation from various sectors of the United States.

(Jenkins, Prows, Dimond, Monson, & Williams, 2001), in their article "Recommendations for Educating Nurses in Genetics" echoed Lashley's statements. They emphasized the realization that genetic disorders affect all ages, social, economic, racial, ethnic, and religious classifications. They stated that nursing educators are faced with the challenge of preparing nursing students to go into the work force with

knowledge of genetics integrated into their practice. They also acknowledged that new graduates and practicing nurses who have not had the information and understanding from their nursing school days must be given the opportunity to acquire this new knowledge. This is an added challenge for nursing educators (Jenkins, Prows, Dimond, Monson, & Williams, 2001).

Emphasis in the article was placed on the need for nursing faculty to accept, prepare for and be ready for the challenge of educating both nursing students and practicing nurses in the era of genetic medicine and nursing. The authors discussed the mandate given by the American Association of Colleges of Nursing (AACN), in its 1998 position statement, *The Essentials of Baccalaureate Education for Professional Nursing Practice,* to include genetics as an important learning area for nurses. They further reported the support given by the American Nurses Association (ANA) in its House of Delegates convention in 1999 (Jenkins, Prows, Dimond, Monson, & Williams, 2001).

The above competencies for baccalaureate prepared nurses as indicated in (Lashley, 2000) cannot occur without genetics prepared faculty. (Jenkins, Prows, Dimond, Monson, & Williams, 2001) point out that an impetus for preparing faculty was proposed and funded by the Ethical, Legal and Social Implications Research Program of the National Human Genome Research Institute at NIH in1996. The two components of the Genetics Program for Nursing Faculty, (GPNF) were the Genetics Summer Institute, (GSI), and ongoing support mechanisms for the participants of the GSI (Jenkins, Prows, Dimond, Monson, & Williams, 2001).

The GSI was an ongoing effort through 2009. In summer 2010, the emphasis changed from nursing faculty to biology teachers. (Prows, Hetteberg, Johnson, Latta, Lovell, Saal, & Warren, 2003), used their publication "Outcomes of a Genetics Education Program for Nursing Faculty" to address the results of the first four years of the GSI. The aims of the GPNF were two-fold:

- To increase nursing faculty knowledge about genetics and its clinical application.
- To increase genetic content taught in entry-level nursing education programs.

(Prows, Hetteberg, Johnson, Latta, Lovell, Saal, &Warren, 2003) went on to follow the discussion of the GSI program presented in 1997 and 1998 with the statistics from the pre-and post-test given to the participants in the program. The statistics revealed a significant increase in the genetic information presented in the curriculum of the nursing programs in which the participants taught. Because of ongoing resistance from faculty members at their schools, some of the participants chose to implement the increased genetic material in their own courses first (Prows, Hetteberg, Johnson, Latta, Lovell, Saal, &Warren, 2003).

(Hettteberg & Prows, 2004) in "A Checklist to Assist in the Integration of Genetics into Nursing Curricula" provided a checklist to assist in integrating genetics into nursing curricula. They broke the checklist into four sections.

- The first section emphasized determining the existing genetics content.
- The second area discussed involved increasing the faculty's awareness about the need to include genetics in the curricula.
- The third item in the checklist involved increasing the faculty knowledge about genetics.
- The fourth area of the checklist consisted of multiple ways to integrate genetics content into individual courses.

Suggestions were given to assist fellow faculty members to add genetic objectives, content and testing materials in their courses. A major tenet of the article was to provide the basic genetic content in an initial nursing course and then reinforce the learning from that course in all clinical nursing courses (Hettteberg & Prows, 2004).

In 2004 four faculty leaders took the challenge of providing a theoretical framework for implementing genetic content into the nursing curriculum at the University of Texas at Austin (UT-Austin). These faculty leaders, Horner, Abel, Taylor and Sands concurred with (Lashley, 2000), (Jenkins, Prows, Dimond, Monson, & Williams, 2001) and (Prows, 2003, 2004) who describe the necessity of providing genetics in the nursing curriculum. These four leaders discuss the framework used and their implementation of it in the nursing curriculum at the University of Texas at Austin (Horner, Abel, Taylor, & Sands, 2004).

According to (Horner, Abel, Taylor, & Sands, 2004), Rogers' innovation-diffusion theory provided this framework for the curriculum at UT-Austin. Innovation-

diffusion theory gave five stages in the decision process individuals use to implement an innovation. The stages are as follows:

- The knowledge stage in which an individual learns of an innovative idea.
- The second or persuasive stage is where those marketing the product, who have already adopted the idea, provide feedback to the decision-maker.
- The third stage, the decision making stage, is where the idea is adopted or rejected.
- The fourth stage is the implementation stage if the idea is adopted.
- Stage five is the confirmation stage where the effectiveness of the innovation is evaluated.

This article stated the case that discoveries in the field of genetics created the need for nurses and nursing faculty to become knowledgeable about the therapies that were developing rapidly as a result of the completion of the Human Genome Sequence. The authors stated that through the support of the Dean of the College of Nursing, five faculty members became the core group with expertise in genetics. These faculty members provided the foundation for implementing changes to include genetics in the curriculum (Horner, Abel, Taylor, & Sands, 2004).

Genetics in Nursing Practice

(Jenkins, Grady, & Collins, 2005) spoke to the role and responsibility of nurses in the genomic revolution that is reframing health care. Their article provided an overview of a series to be presented over two years in subsequent issues of the *Journal of Nursing*

Scholarship. This issue started by providing examples in which nurses needed to use genetics in their everyday practice. This was followed by a glossary of genetics and genomics terms which would be required for the subsequent articles. The overview emphasized the ability of nurses to assimilate and integrate the mushrooming science of genetics and genomics along with interdisciplinary colleagues. Assimilation and integration of genetic and genomic knowledge was a mandate because patients and their families expect health care providers to have this knowledge. Because of the long standing tradition of nurses as frontline educators in health care, genetic and genomic knowledge is essential to remain current as health care professionals. The series of articles (seven in all) extended from 2005 through 2007. Each article spoke to the many concepts and areas of genetic and genomic knowledge that practicing baccalaureate-educated nurses are expected to utilize in their daily practice of their profession (Jenkins, Grady, & Collins, 2005).

Highlights will be discussed from the articles in the series to delineate the knowledge needed by nurses in their everyday professional practice. The articles were written by experts in the various areas of nursing practice to demonstrate the knowledge necessary for nurses working with patients in each type of practice. Nurses will be required to explain and support patients through their decisions regarding the effect of genetics on their lives.

Feetham, Thomson and Hinshaw (2005) in the article "Nursing Leadership in Genomics for Health and Society" carried on from the overview in "Nursing and the

Genomic Revolution". This installment started with the reminder that genes not only cause disease but affect disease susceptibility and resistance, prognosis and progression as well as response to illnesses and their treatments. Genetics is used to define the study of individual genes and their effects. Genomics is the study of the functions and interactions of all the genes in the genome. This involves the study of the whole human genome, its variations and internal intra-actions along with its interactions with the environment and other social and cultural factors. Application of genomics will of necessity include movement from intervention after disease or loss of function to more predictive models of intervention before the onset of disease or loss of function (Feetham, Thomson and Hinshaw, 2005).

Knowledge of genetic testing is essential for the practicing baccalaureate prepared nurse. Genetic testing, which began in the 1950s, is now utilized for over 1000 conditions. The uses of genetic testing have come to include preconception, prenatal and newborn screening; pre-dispositional and pre-symptomatic testing; diagnostic confirmation; prognostic information and choosing optimal therapeutic alternatives, through such means as pharmacogenomic testing. Some countries have developed bio-banks of DNA and other data to advance the understanding of genotype and phenotype relationships of patients requiring health care for genetic conditions (Feetham, Thomson, & Hinshaw, 2005).

The role of the family history is of paramount importance as part of the genetic testing. Nurses, whose role of patient assessment is recognized as being essential, must be

absolutely clear in their understanding of the importance of history taking in their assessment of every individual. This history of every patient includes the implications of genetic predisposition either covert or overt, with each health care encounter (Feetham, Thomson, & Hinshaw, 2005).

While only in initial stages at this time, pharmacogenetic testing will become more common. As stated above, by history taking an individual's responses to medications can often be found to be genetically determined. Previously unknown in the treatment of respiratory disorders with Albuterol (a first line drug of choice for the immediate relief of respiratory distress), is the relationship between genotype in the Beta2-adrenergic receptor gene and the therapeutic response to Albuterol. One study as an example found the response rate in children with 2 glycine amino acids (*GlyGly*) to be 10%, for children with one argenine and 1 glycine amino acid (*ArgGly*) to be 25%, for children with 2 argenine amino acids (*ArgArg*) 60%. A further study showed that those with the highest response rate also had the highest decrease in effectiveness with repeated use of the albuterol. This is only one example of the multiple ways genetic testing will become useful in pharmcogenetics in the future. This also provides an example of the need for practicing nurses to keep abreast of the changes in the results found through pharmacogenetic testing (Feetham, Thomson, & Hinshaw, 2005).

Of ethical significance is the term genetic exceptionalism. Genetic information is a unique identifier. Recognition must be given to the fact that genetic information should be given special consideration and be handled differently from other types of personal

and clinical information. Genetic information is heritable, shared through generations and relevant to family members, ancestors and descendents. While this information can be helpful to encourage people to change health habits to decrease risks, it could be used to stigmatize and discriminate against certain individuals, families or groups. If handled well through the genomic era, when such information becomes available for all persons, this concern may be only a transitory one (Feetham, Thomson, & Hinshaw, 2005).

Just as nurses have consistently been at the forefront of patient information protection, genetic testing is another area where nurses need to be aware of the pitfalls. A family genetic study, while providing useful information for research or clinical care may also disclose information that a family is not expecting and for which they are not prepared. An example of this may be misattributed paternity. The effect on the family relationships and family dynamics of such a finding could be extremely disruptive (Feetham, Thomson, & Hinshaw, 2005).

Individuals and families will be faced with the need to learn the interaction of genes with the environment and behavior. As given in the example of Huntington's disease, once thought to be a single gene disorder, the concept of penetrance and influence of other genes have changed the reality of the chances of occurrence in families where it was once thought to be an inevitable consequence. In the discussion of penetrance, the discovery of the BRCA1 and BRCA2 breast and ovarian cancer genes were at first thought to have a penetrance of 85% to 90%. With further studies since the original BRCA1and BRCA2 studies, penetrance has been shown to be more in the range

of 27% to 55%. It is crucial for nurses and health care providers to understand the meaning, interpretation and the limitations of genetic information. It is imperative for nurses and health care providers to continue to monitor and keep updated on the latest in genetic information. What may have seemed to be a significant risk for an individual or a family at the time of discovery may later through added studies, be found over time to be less of a risk. Nurses are in the position to help individuals and their families understand that a particular genetic finding before disease or loss occurrence is not deterministic of the disease or loss occurring (Feetham, Thomson, & Hinshaw, 2005).

Unexpected genetic findings resulting from genetic testing or from taking a genetic family history can have a profound effect on a family. This area may be easily overlooked or the impact for a family not realized by the nurse. Unexpected learning for a family when a study of their family genetic history is undertaken can have a significantly disruptive impact. Examples of such information can be unanticipated discovery of increased health risks not previously known. The disruptive consequences of such knowledge can be long enduring for a family. Nurses and all health care providers and researchers must be prepared to understand how this information changes relationships in a family. It is their responsibility to explain the situation to the individuals and families involved (Feetham, Thomson, & Hinshaw, 2005).

(Kenner, Gallo, & Bryant, 2005) provided the installment of the series entitled "Promoting Children's Health through Understanding of Genetics and Genomics". Their discussion related to the translation of genomic knowledge to practice as it influences

children and their families. The purpose of this article was to update pediatric nurses on the latest knowledge about newborn screening. Two case exemplars-Usher Syndrome and sickle cell disease were used to illustrate the knowledge required for pediatric nurses. An extensive list of childhood chronic conditions with a genetic base was also provided in the article. Statements about the relationship of genes to disorders and the current scientific research which is being done concluded the article. It was noted that the National Coalition for Health Professional Education in Genetics has developed core competencies for the education of health professionals (Kenner, Gallo, & Bryant, 2005).

The installment of the series "Non-Hodgkin's Lymphoma as an Exemplar of the Effects of Genetics and Genomics" was provided by (Calzone, Lea, & Masny, 2006). This installment stated that all cancers are based in genetics. Cancers result from multiple genetic mutations. These mutations cause erratic uncontrolled cell growth. The mutations in question can be inherited or acquired from interactions with the environment and other genes along the carcinogenic pathway. The genetic and genomic implications influence the care continuum of disorders, no matter in which setting the care occurs. The purpose of the paper was to show that genetic and genomic scientific advances affect nursing practice, whether that practice is in acute care or a primary care setting. It is not an inherited predisposition that causes most cancers, but rather the result of an accumulated series of mutations in a single somatic cell that divides, replicates and develops further mutations creating even more genetic instability. This instability causes irregularities in cell growth regulation until transformation into cancer is complete. All individuals are

subject to somatic cell mutations throughout their life span. These can occur during normal cell replication as well as from the impact of personal and environmental risk factors (Calzone, Lea, & Masny, 2006).

Cancer characteristics and resulting therapies can be understood better through genomics. It is genomics that makes it possible to identify individual metabolic mechanisms and the manner in which an individual will respond to drug therapy. The continuum of cancer or its stages determine the parallel continuum of care. As a result, the nurse who provides care at any stage of the continuum from primary prevention through diagnosis, treatment, rehabilitation or end of life care, must be aware of the genetics and genomics that impact the client, the treatment and the resulting care. (Calzone, Lea, & Masny, 2006) noted that all nurses need to integrate genetics and genomics into their practice because all other diseases exist on a genetic continuum as well.

Treatment and prognosis at present is guided by genetic and genomic information. This refers both to the genetics of the individual and of the cancer. Determination of the active and the inactive genes in the cancer can give information on the best targets for pharmaceutical interventions. This can on an individual basis, identify those individuals who would receive benefit from more aggressive therapy and those who can be spared rigorous therapy because they have an excellent prognosis without more intensive therapy (Calzone, Lea, & Masny, 2006).

When the disease progresses in spite of the treatment given, it is the genetic features of the original tumor as well as additional genetic changes creating genetic instability that cause progression of the disease. The nurse providing care needs to be aware of the molecular rationale for this progression and be able to provide holistic care for the patient. This includes meeting clinical, psychosocial and spiritual needs in relation to the advancing stages of the disease. From this progression to management of the terminal stages of any cancerous condition, the nurse needs to understand the genetic basis for the patient's response to palliative treatment (care at the terminal stage of life which is focused on pain free comfort and human dignity), so that he/she can effectively monitor and evaluate the responses of the patient to care. At this stage the goal is to provide the best possible quality of life for the patient as long as possible. The individual's genomic make-up is integral to his/her response to even palliative pharmaceutical care (Calzone, Lea, & Masny, 2006).

(Dolan, Biermann, & Damus, 2007) presented "Genomics for Health in Preconception and Prenatal periods". The article presents the movement among nurses who are practicing with prenatal patients, nurse educators and nurses in research by which the latest in genomic information is applied to nursing decision-making and clinical care during the preconception and prenatal stages in clients' lives. The genomic concerns are those which consider the paternal, maternal and fetal genomes.

Genetic screening and genetic testing have come to be the norm for almost every pregnant woman to have the option for testing to understand the genetic risks for her

fetus. Family history is one of the most important genomic tools available to all nurses. Nurses use this tool first to assess for genomic risk and then to interpret that risk to the pregnant woman. This is essential in assisting the client to implement risk reduction strategies. The Centers for Disease Control and Prevention in 2006 published recommendations for preconception care. These guidelines included a reproductive health plan with ongoing risk assessment and risk factor modification through the continuum of the reproductive years of both women and men (Dolan, Biermann, & Damus, 2007).

The use of assisted reproductive technology (ART) now provides additional options for families that are affected with known serious genetic disorders. Nurses have the responsibility to educate couples on the meaning and options in ART, provide anticipatory guidance and assist with decision-making. In line with this new technology, there are new risks with using donor gametes. What was previously maternal, paternal and fetal genomes, now becomes maternal, paternal, fetal and donor genomes to consider. While single gene disorders and chromosomal aneuploidy (ex. trisomies), can be predicted on the risk of the donor gamete, there is a whole new epigenetic arena to consider with the woman carrying the pregnancy. These considerations include nutrition, weight, weight gain, stress and other environmental influences. These need to be considered for the person carrying the pregnancy, be it the woman in the couple relationship or a carrier mother (Dolan, Biermann, & Damus, 2007).

Another area of risk to consider is that of residual risk. Preconception genetic testing is carrier screening and not diagnostic testing. The article gave the example that a

woman with a rare disease-causing mutation and no family history of the disease could still conceive and bear a child with the disorder. This brings again into focus the nurse's role in the paramount importance of education of women, their partners and their families regarding genetic/genomic risk. The requirement is not just for education, but for enhanced communication strategies to create success in the education. It is again the clues in the family history that the nurse must recognize interpret and use to educate in a way the family understands. The article ended by stressing the need for advanced knowledge of genetics/genomics for all nurses in order to improve the lives of newborns and their families (Dolan, Biermann, & Damus, 2007).

(Jenkins & Calzone, 2007), take the series of what nurses need to know about genetics and genomics to practice in the 21st century, to the source of providing nurses with the necessary education for practice with the article "Establishing the Essential Nursing Competencies for Genetics and Genomics". This article began with the dismal fact that on surveys in 2005, despite initiatives and recommendations world-wide; only 30% of academic nursing programs contained a curriculum thread in genetics and genomics. These two authors acknowledged that many factors contribute to the limited progress in nursing knowledge and utilization of genetic information.

Factors that were noted in this situation are: Lack of appreciation of the relevance of genetics and genomics to nursing practice; current lists of competencies in nursing were long and not realistically achievable; not enough faculty were prepared to teach genetic content; accrediting bodies did not consider genetics and genomics when

evaluating nurses for advanced practice; and state nursing boards did not require competency in genetics and genomics for either licensure or re-licensure at the time the article was written (Jenkins & Calzone, 2007).

These two authors noted the successful utilization of Rogers' diffusion-innovation framework previously spoken to, (Horner, Able, Taylor, & Sands, 2004), for integrating genetics and genomics into nursing curricula. While this was seen as an example of success, the vastness of the need for genetics and genomics knowledge for nurses in the workforce in the U.S. far outstripped the then current understanding present in the general nursing workforce. The authors spoke to the relationship of the average age of nurses in the U.S. to the application of genetics and genomics in nursing practice. By 2004, only 26.6% of nurses in the U.S. were under the age of 40 years. As a result, the majority of the nursing workforce (2.9 million nurses), were less likely to have any genetics and genomics content in their educational programs. The same situation exists currently. (Jenkins & Calzone, 2007).

In spite of the seemingly daunting lack of nursing knowledge of genetics, the success that has been produced in the United Kingdom where the average age of nurses is 42 years is shown as having possible practicality for use in educating nurses in the U.S. The strategy used in the U.K. was one of simplicity. The Royal College of Nursing used a process of consensus to arrive at seven measurable, simple and achievable essential competencies applicable to the entire U.K. nursing profession. From development of the competencies as a beginning, the U.K. National Health Service, (NHS) established a

NHS National Genetics Education and Development Centre. This center supports genetics education initiatives, provides educational resources for educators and serves as a clearinghouse for genetic resources and materials for all disciplines. The National Genetics Education and Development Centre identified gaps in educational initiatives or materials and worked to develop the resources (Jenkins & Calzone, 2007).

The U.K. program served as a springboard for the current efforts in the U.S. These efforts have been carried out as follows. In 2004, both the National Human Genome Research Institute (NHGRI) and the National Cancer Institute (NCI) of the National Institutes of Health (NIH) together planned a broad genetic and genomic training initiative for the U.S. nursing workforce. A steering committee was established that was made up of nursing leaders in research, clinicians, and representatives from academic settings, other NIH institutes and U.S. DHHS agencies. This committee reviewed competencies as recommended in published, peer-reviewed nursing literature. In January 2005, the committee drafted a proposal of competencies which was presented to the National Coalition for Health Professional Education in Genetics. In 2006, this draft was posted by the American Nurses Association for public comment. A final draft was revised by the steering committee based on the comments received. This revision was also established by consensus. The document was titled *Essentials of Genetic and Genomic Nursing: Competencies, and Curricular Guidelines. (2006),* edited by Jean Jenkins and Kathleen Calzone. *Outcome Indicators* was added to the second edition in

2008, also edited by Jenkins and Calzone. This document has provided the impetus and guidelines for the work of this researcher. (Jenkins & Calzone, 2007).

Despite the somewhat discouraging beginning of the above article, (Conley& Tinkle, 2007) discussed "The Future of Genomic Nursing Research". The article began by stating that one of the major goals of genomic-based research was to benefit society by improving the health of individuals, families and communities. An equally major goal was to assure that genomic research is utilized to change health care. Nursing research which is well established in the bio-behavioral realm can provide a unique perspective to the enormous number of findings which come almost daily from the genomics studies that are following completion of the Human Genome Project. Nursing use of genomic research must be carefully done to assure that it is based on scientific evidence. Likewise the nursing perspective of health must clearly be incorporated into genomic research. The authors make a strong point for nurses at all levels to be involved in genomic research. Nurses at the doctoral level need to be conducting genetic and genomic studies in the institutions where nursing care is provided and in the community where genetics and genomics are instrumental in determining the quality of life individuals are able to attain and maintain. Just as the doctoral level nurses will be conducting nursing genetic and genomic research, baccalaureate and masters level nurses will be members of the teams managing the care of the patients/clients and families involved in the research. The baccalaureate educated nurses will be the nurses with first line contact with these individuals and their families. They will be the nurses who first hear the questions and

concerns voiced by the individuals and families. In all areas of nursing, including genetic nursing, nurses are taught to be client advocates and educators. For this reason, it is imperative for nursing students throughout their initial educational program to become as versed in the genetic implications for patients/clients and their families in every area of nursing as it is to become knowledgeable of all other aspects of nursing care. As mentioned previously in this series of articles, one global barrier to nursing research in the area of genomics is lack of nursing education in genomics. Not only do nursing researchers lack education in genomics but they also need to be educated in the fundamental skills of research in the area of conducting genomic research (Conley & Tinkle, 2007).

As indicated above through the Genomics to Health Series there is much still to be done to integrate genetics and genomics into nursing at all levels across the nation to meet the needs of the population.

The two genetic nursing leaders, Kathleen Calzone from the National Cancer Institute and Jean Jenkins from NIH (who edited the document) took *Essentials of Genetic and Genomic Nursing: Competencies, Curricular Guidelines, and Outcome Indicators 2nd Edition* (2008) and built an online framework from it. They made it accessible to nurses and nursing educators. The framework was launched in February 2010 as the *Genetics/ Genomics Competency Center for Education (G2C2)* at http://www.g-2c-2.com. The website to date, has as its purpose to make available to nurses and nursing educators, educational materials through maps that show the

relationships between competencies, professional abilities, learning activities and assessments.

When entering the website, the first page is set up for nurses, physician assistants and genetic counselors. Each category of providers has a curriculum map, an area to search for learning activities and in the case of nursing and physician assistants, an area that discusses the essential competencies for practice. When clicking on the curriculum map for each of the three professions, an interactive table appears from which it is possible to search among the professional competencies and core knowledge for any specific competency. By clicking on the adjacent area it is possible to find performance indicators related to each competency. The third category horizontally provides learning activities and resources to assist in developing the needed performances. The fourth horizontal category provides assessments to test the knowledge of the performance indicators.

According to Kathleen Calzone, in a presentation of the website at the October 2010 International Society of Nurses in Genetics (ISONG) Annual Conference held in Dallas, Texas, this website is currently undergoing revisions for clarity and visibility. Exploration of this website currently reveals the competencies that form the background for the text by (Lashley, 2007), the initial text recommended in *Essentials of Genetic and Genomic Nursing: Competencies, Curricular Guidelines and Outcome Indicators* (2nd ed.) (2008).

Connected to this website another website called Project Aim is being developed. This website is currently unavailable with a tentative release date of Spring 2011. This is an educational program for use by nursing faculty to use with nursing students. The attendees at the ISONG conference were treated to a preview of the website. It is called G3C Staff Lounge. It is an interactive series of unfolding case studies with a faculty support page which is called the Faculty Portal. The Student Portal also begins with G3C Staff Lounge for students. In this activity the student begins by reviewing the patient records for a Case. Students then begin the case, and progress through it self-guided. The student interacts with the patient, (played by an actor), from whom the student collects information, views and adds to the record, views the collected material and accesses supplemental learning activities. Varied patient scenarios are planned. The project is currently undergoing updates in design and navigational ease. Funding has been received from the Department of Defense to develop four additional cases for the website in 2010-2011. The website will be tested in winter 2010 with plans to launch it in Spring to Summer of 2011. (Calzone, 2010, October).

Current Educational Developments

Since the above ISONG conference in October 2010, Lea., Skirton, Read, & Williams, (2011), presented "Implications for Educating the Next Generation of Nurses on Genetics and Genomics in the 21st Century. Their purpose was to provide nurse educators with an overview of genetic and genomic advances within nursing under a holistic perspective. The article speaks to the value of the family history which has been

used by nurses and other health care professionals for many years to now being an imperative tool for use in genetics by the nurse in whatever setting she works. The authors speak to the advantages, necessities and to the pitfalls found in acquiring a family history from the genetic perspective. From family histories the discussion moves to genetic and genomic research and nursing education. The urgency of nurses and nursing students to be well grounded in genetic and genomic research is reiterated. The authors take the case for the expanded use of genetic testing as it is now evolving to the everyday clinical setting where nurses must be knowledgeable about these tests to function in a safe and effective manner. Direct to consumer genetic testing requires that the practicing nurse be knowledgeable not only about what this means, but also the complications and limitations of the use of these tests. The consumer who responds to advertisements for these tests may not be aware of what these tests do not tell them. It is up to the nurse to be able to explain the meaning. Gene based treatments and interventions which include pharmacogenetics, genetic-genomic guided therapies and gene therapy are all in the realm that the practicing nurse must be able to know and assist the patient with. The authors speak to the required and soon to be required nursing competencies, reliable professional genetic and genomic resources and information services. With all of the needs and implications for the practicing nurse in the 21st century of this genetic/genomic evolution in health care, it is easy to see why the authors targeted the nurse educators who have the responsibility to provide this new information as it evolves to the nursing students who will be the nurses providing this care in the 21st century. The message from

these authors is not new, but the urgency of the message for informed, safe and effective nursing in this rapidly changing area of health care needs to be listened to by those responsible for educating these nurses. (Lea, Skirton, Read, & Williams, 2011)

An attempt to understand what nursing students have gained through genetic knowledge recently placed in the nursing curriculum was undertaken by Hsiao, C., Van Riper, M. Lee, S., Chen, S., & Lin, S. (2011). As stated in their presentation, "Taiwanese Nursing Students' Perceived Knowledge and Clinical Comfort with Genetics". They noted that at the time of their study, about one-third of the nursing programs in the United States have integrated genetics and genomics into their curriculums, graduate and/or undergraduate. These researchers chose to model their study on a similar study by (Dodson and Llewellan, 2010) done in the United States a year earlier not yet published at the time of their survey. The authors administered a self=report survey to 501 nursing students in a Taiwanese school of nursing. 434 students returned the questionnaires. This survey was designed to assess the perceived knowledge of the students and their comfort with use of the information in the clinical setting. The researchers included questions regarding the integration of genetics into the curriculum. Data analysis was done by means of descriptive statistics and a one-way analysis of variance. The school of nursing, a 4 year baccalaureate program provided content in nursing during all four years of the program. Of all the students the 3rd year (junior) students statistically showed the most perceived knowledge and clinical comfort with genetics. This was followed in order by Seniors, Sophomores and Freshmen. The authors alluded to the difference in findings

from this study compared to the one done by Dodson and Llewallen (2010). In that study Seniors showed more perceived knowledge and comfort with genetic information in the curriculum. A possible explanation from the authors was that many of the Juniors had taken an elective genetics counseling course that had not been available to the Seniors. From the survey the indication by the students was that there was a critical need for genetics information to be included in the curriculum. From both current study and that by (Dodson and Llewallen, 2010), students felt uncomfortable obtaining genetic information from patients and discussing genetic implications of a diagnosis with a family. They did feel comfortable accessing genetic information from the internet and in drawing a pedigree from a family history.

From this study the authors saw the implications for the future to include recommendations for integrating genetics and genomics as a central science into nursing curricula in Taiwan. While these recommendations can only be made in relation to the current study under discussion, the same recommendations should be considered in all nursing curricula. The considerations regarding student performance should include:

1. Student ability to identify essential genetic and genomic competencies as evidenced by demonstrating the ability to draw a patient's pedigree and to be able to speak to a patient about family history.
2. Student ability to incorporate genetic and genomic content into the care plans for patients in all nursing areas.

3. Student ability to implement the ethical, legal and social considerations of genetic and genomic information in their care plans and case studies in all nursing areas.
4. Student ability to access available genetic and genomic primary resources, for example; genetic educational resources such as the online case studies developed by the Genetics Education Program for Nurses at Cincinnati Children's Hospital Medical Center.

These implications for student performance challenge the faculty of nursing programs to develop effective delivery of genetic and genomic materials in their lectures and to use simulation in conjunction with the classroom content. Scenarios should be developed and used that are closely grounded in the reality of the clinical setting (Hsiao, Van Riper, Lee, Chen, & Lin, 2011).

The latest article of the current genetics and genomics series by (Daack-Hirsch, Dieter & Quinn Griffin, 2011), "Integrating Genomics into Undergraduate Nursing Education" not only reiterates the need for genetics and genomics in all nursing curricula, but also provides several methods for integrating genomics into the undergraduate curricula.

The first method discussed is called Integration: Faculty initiated change. A faculty workgroup is suggested that will consist of a group of genetic experts, or a group of faculty interested in implementing genetics into the curriculum guided by the curriculum chair of the faculty. The workgroup would first glean input and support from

a broad spectrum of the nursing faculty and then develop a plan with faculty from each content area for implementation of the genetic materials into their area. As a first step these authors advise a faculty self-assessment of their genetic knowledge. They recommend use of the Genetic Literacy Assessment Instrument (GLAI). This instrument was originally developed to evaluate the entry level biology literacy level of high school graduates.

From the point of faculty self assessment the plan of the workgroup should create a genetics/genomics curriculum thread to be implemented throughout all levels of the curriculum. This would be followed by deciding with the faculty of each content area what genetic/genomic content to incorporate and where in their courses would genetic content best be incorporated. While a standalone course is discussed, the authors favor use of the curricular genetics/genomics thread implemented at all levels, in each course in the curriculum. An area of utmost importance is the implementation of the genetic/genomic content into the clinical practicum with simulation being a highly recommended point of entry to provide the students opportunity to become comfortable with discussing the genetic material with patients. Suggestions are given for use of print and online materials as well as posters to spark and keep the interest of students. Other teaching tools such as bulletin boards, use of clickers in the classroom, internet media such as web quests, wikis, blogs and the virtual three dimensional world called Second Life are discussed (Daack-Hirsch, Dieter & Quinn Griffin, 2011),.

The urgency recognized to place genetic and genomic content into nursing curricula in schools of nursing in United States prompted Williams, Prows, Conley, Eggert, Kirk, & Nichols, (2011), to present "Strategies to Prepare Faculty to Integrate Genomics into Nursing Education Programs". The authors acknowledge that the necessity of a foundation in genetics and genomics for nursing was an understood necessity as early as 1980. At that time federally funded workshops for nurses were already being implemented. This article takes a world view. It discusses the progress since 1980 in the countries providing major support for application of genetic and genomic content in nursing programs.

The first task was to develop nursing competencies in genetics and genomics. As previously discussed above the first 2 countries to do that were the United Kingdom in 2006 and the United States in 2008.

The next step, development of guidelines for genomic course content was done in the United Kingdom by the Nursing and Midwifery Council. In the United States the Essentials of Baccalaureate Education for Professional Nursing Practice are guidelines used by the American Association of Colleges of Nursing (AACN). This group endorsed the *Essentials of Genetic and Genomic Nursing: Competencies, Curricula Guidelines and Outcome Indicators (2008)* by Jenkins and Calzone. While these guidelines exist and are promulgated to all nursing programs in the United States, there are still barriers to their implementation. A major barrier is having enough genetically prepared faculty in most nursing programs. To counter this limitation as viewed in both the United States and the

United Kingdom, both countries developed summer and compact continuing education programs to prepare nursing faculty to assist programs to implement genetic/genomic content in their curricula. These programs have had varying levels of success in each of the two countries.

The current movement has been to identify a Genomic Nursing Championship Network in each country. In the United States this has taken the form of a federally funded program through the National Human Genome Research Institute (NHGRI), Health Resource Services Administration, Bureau of Health Professions, Division of Nursing, and National Cancer Institute. The U.S. Faculty Champion Initiative was designed to assist educators within their own school. After attending an introductory program, invited participants returned to their own institutions and developed innovative approaches to the genomic educational needs of the faculties of home institutions. These faculty champions established "task forces", created faculty websites, developed and provided monthly newsletters and identified key stakeholders in the institutions who could support the time and financial resources for the genomic "infrastructure" in each program. The faculty "champions" are available via a list with contact information at: http://www.genome.gov/27535175.

Beyond the faculty champions network, the authors discuss current doctoral and post doctoral educational opportunities for faculty in the U.S.to enhance their education in genomics In continuing education offerings, the previous on-site Genetics summer Institute was replaced with an 18 week teacher facilitated, web-based genomics institute.

This program continues to be offered twice a year to provide foundational knowledge in genomics. Faculty are the main recipients of this program. Another web-based continuing education offering is a 5 week program, Applying Genomics in Nursing Practice that is targeted to nurse clinicians. To date73% of the 26 nurses who have completed the program are nursing faculty. This program is sponsored by the (Cincinnati Children's Genetics Education Program for Nurses, 2010).

From the several types of programs that have been available to faculty, particularly the National Institute of Nursing Research Summer Genetics Institute, there were three common experiences that have occurred for all faculty prepared in genetics. The first is that students vary immensely in the level of preparation they have in genetics before coming to either an undergraduate or a graduate program in nursing. The second common experience is that the nursing educators have need for a network of resources to provide ongoing genomic preparation because of the ever expanding knowledge base in genetics and genomics. A third common experience of the programs implementing genomics in their curricula is that students need practica in which to apply their genomic knowledge in clinical decision making (Williams, Prows, Conley, Eggert, Kirk, & Nichols, 2011).

Summary

Starting with the articles in 2000 by Lea and by Lashley the call is for education of all practicing nurses and those entering the nursing profession in genetics and genomics. Those who are entering the profession currently will be the nursing leaders in

the 21st century. (Lashley, 2000) developed 9 assumptions about genetics and genomics that all nurses practicing will be required to know. These assumptions are the basis for the genetic nursing competencies developed into the *Essentials of Genetic and Genomic Nursing: Competencies, Curricula Guidelines and Outcome Indicators (2008)* by Jenkins and Calzone. This document of competencies was in turn published by the American Nurses Association, (ANA) and adopted by the American Association of Colleges of Nursing, (ACCN) to be integrated into undergraduate nursing curricula.

Three current published programs developed to implement these competencies were reviewed. A series of articles from genetic nursing leaders was reviewed which presented multiple examples of what nurses in current practice need to know to provide genetically adequate, competent and safe care for patients in all settings. The necessity for nurses from all levels of nursing education to be involved in genetic nursing research was discussed as well.

From the above literature and the latest developments by Jenkins and Calzone of the *Genetics/ Genomics Competency Center for Education (G2C2)* at http://www.g-2c-2.com., sponsored by NIH and National Human Genome Research Institute, this researcher has determined the need to develop a source of additional knowledge of genetics and genomics for the baccalaureate nursing students in the Texas Woman's University Houston J. and Florence A. Doswell College of Nursing. The following study to accomplish this was undertaken.

CHAPTER III

METHODOLOGY OF STUDY

This study used an online presentation of an *Introduction to Genetics and Genomics for Nursing Students* lecture with a test to assess student competence before and after exposure to the module responses, to determine the knowledge of genetics and genomics of baccalaureate nursing students at Texas Woman's University Houston J. and Florence A. Doswell College of Nursing. From the answers to ten test questions to assess student competence before exposure to the module questions, modifications to the introductory module are proposed. From answers to the ten test to assess student competence after exposure to the module questions following an online introductory module on genetics and genomics, a proposal for the development of a complete course in genetics for nursing students is made. This will be followed by work with the entire undergraduate nursing faculty to integrate the latest genetic developments in each area of nursing into their courses. The text by Lashley, 2007, *Essentials of Clinical Genetics in Nursing Practice,* used to develop the proposed module, effectively speaks to all nine of the genetic nursing competencies presented in (Jenkins & Calzone,2008) *Essentials of Genetic and Genomic Nursing: Competencies, Curricular Guidelines, and Outcome Indicators* (2nd ed).

In discussion with the Nursing 3025 Women's Health Family Competencies faculty regarding the need for enhanced genetics and genomics information in the

undergraduate nursing curriculum, an online lecture in introductory genetics and genomics with tests to assess student competence before and after exposure to the module were developed. The module was presented to baccalaureate nursing students in an elective course, N4902 Section 40 EKG Interpretation and Nursing Implications, during Summer 3 session July 11-August 12, 2011 and in Nursing 3025 Women's Health Family Competencies, Fall semester 2011. The tests to assess student competence before and after exposure to the module were developed by the researcher based on the materials chosen to present the information to the students. The test questions for the pre- and post-tests are in multiple choice format with only one correct answer for each question. This is the testing format most familiar to the students at this level of nursing studies.

Sample

The sample for this study was 114 nursing students in the Texas Woman's University Houston J. and Florence A. Doswell College of Nursing program enrolled in N4902 Section 40 EKG Interpretation and Nursing Implications and 108 nursing students enrolled in Nursing 3025 Section 30 Women's Health Family Competencies in Nursing, taught in the Fall 2011 semester. The only requirement to participate in the study is that the student be enrolled in Nursing 4902 Section 40 EKG Interpretation and Nursing Implications or in Nursing 3025 Section 30 Women's Health Family Competencies in Nursing.

Instrument

The instrument used for this study is an online module consisting of a test to assess student competence before exposure to the module, Power Point slides of content followed by a test to assess student competence after exposure to the module for one of two randomly selected groups of students in the Nursing 4902 Section 40 EKG Interpretation and Nursing Implications and Nursing 3025 Section 30 Women's Health Family Competencies in Nursing.

Lashley, 2007, *Essentials of Clinical Genetics in Nursing Practice.* was chosen as the text for this module and is tentatively being explored as the text for a course to follow from this research for several reasons. This text comes recommended as a genetics and nursing text in (Jenkins & Calzone, 2008). *Essentials of Genetic and Genomic Nursing: Competencies, Curricula Guidelines and Outcome Indicators. (2nd ed.).* The first section of the text provides the essential genetic/genomic information for the practicing nurse who is unfamiliar with genetics. It is also a review with application to nursing in general for the nursing student who has recently had an undergraduate exposure to genetics in the required core sciences before starting the professional nursing courses. The test to assess student competence before and after exposure to the module questions were taken from information covered in the first five chapters. The second section provides greater depth in discussion of genetics as it applies to various areas of nursing in which the student will be gaining knowledge and skills for professional practice. The reliability of the students' answers to the questions was assessed by use of the same chapter content in the questions

on the test to assess student competence before and after exposure to the module. Content validity of the questions used was provided by linking the questions directly to rationale obtained from specific pages in the text used, (Lashley, 2007), *Essentials of Clinical Genetics in Nursing Practice* and from the slides presented in the online module.

Methodology

The methodology used for this study is as follows:

Preparation for utilization of the module included solicitation of feedback from three faculty members in the TWU College of Nursing who teach the subjects of the study in concurrent courses regarding the appropriateness of the questions and the module for the students in the course and the validity of the questions in relation to the content of the module. The faculty members were given a copy of the questions, answers and the power point outline with the request for feedback within a 2 week period of time. Two of the three packets of the module were returned by the faculty as one faculty member did not return the packet. Neither faculty member questioned the validity of the content presented. Alternative wording of some of the test questions were suggested.

Additional preparation was done by soliciting the assistance of a clinical group of second semester senior nursing students, (nine students) to read the questions for clarity and readability only. The students were provided only the questions and space on the paper with the questions to give comments. They were given a structured one hour period of time in a room with a proctor to assure security of the test questions. The pages with the questions and the students' comments were collected as each student left the room

similar to test security for all exams. For their willingness to assist the researcher, the students were credited with one clinical hour for their work. All 9 students reviewed all 20 questions. For the most part the comments the students gave did not reflect the readability of the questions, but were related to attempting to ascertain which answers were more correct.

With the agreement of the faculty member teaching Nursing 4902 Section 40 EKG Interpretation and Nursing Implications and the faculty member teaching Nursing 3025 Section 30 Women's Health Family Competencies in Nursing, the online module was set up on the Black Board site for each course prior to the presentation to the students. The heading, Genetics Module was placed on the left hand side of the site for the students to access the module. As the module was set up, the students enrolled in the course were randomly assigned by the Black board program into two groups. Depending upon which group the Black Board randomization program placed the student into, when a student entered the module he/she would be directed to either the experimental or control group. The groups were designated as group 1 and group 2 by the randomization program. No indication was given to the students on entering the program as to whether it was the experimental or control group.

In a designated lecture prior to presentation of the online module, the faculty member teaching Nursing 4902 Section 40 EKG Interpretation and Nursing Implications and the faculty member teaching Nursing 3025 Section 30 Women's Health Family Competencies in Nursing, explained the availability of the module for students' use. It was

explained that the genetics and genomics module is part of the dissertational research of a nursing faculty member.

1. The students were informed that in addition to the online genetics module on Blackboard, there were supplemental materials available on reserve in the Houston J. and Florence A. Doswell College of Nursing Library.
2. This module was available on the Blackboard site for Nursing 4902 and Nursing 3025 after the lecture in which the dissertational research project was explained. It was expected that it would take the students approximately 1 hour to complete the module. They were allowed to sign out and return to the module while reviewing the power point presentation. They were not allowed to sign out and return during either the test to assess student competence before exposure to the module or after exposure to the module.
3. The students were given the information that for the purpose of the study they were randomly assigned to one of two anonymous groups. They were assured that both groups received the content of the entire module. One group was the experimental group and the other the control group.
4. The module was available starting on the selected date and two weeks were provided as the time limit to complete the module, ending on a specific date, at a designated time.

5. On entering the Nursing 4902 and the Nursing 3025 Blackboard site, a course announcement about the module was available and linked directly to the module.
6. With launching the module on Blackboard all students in each of the courses were randomly assigned to one of 2 groups for the purpose of the study.

8. On signing into the module each student was directed to the module according to his/her randomly assigned group.
9. One group received 10 randomly selected questions as a test to assess student competence before exposure to the module. Once the test to assess student competence before exposure to the module was completed, the student was not able to go back to the test to assess student competence before exposure to the module. The student's score on the test to assess student competence before exposure to the module was immediately visible.
10. At the close of the test to assess student competence before exposure to the module the power point slides of genetics/genomics content were immediately available.
11. The student had as long as needed to study the power point material. The slides were able copied for study.

12. Following the Power Point content, the student was directed to the test to assess student competence after exposure to the module of 10 additional randomly selected questions over the same content.
13. If the student signed out of the module at this point to study, on reentering the module the student was directed to the test to assess student competence after exposure to the module.
14. On completing the test to assess student competence after exposure to the module the student was given immediate feedback on his/her score. The correct answers were not immediately available to the students on either the test to assess student competence before or after exposure to the module due to the requirement for test security. Time of discussion of the correct answers was determined with the faculty teaching Nursing4902 and Nursing 3025.

The procedure for the second randomly selected group of students differed in the following ways.

1. The second group received the same 20 questions as in the test to assess student competence before and after exposure to the module above as a test to assess student competence before exposure to the module. Once the test to assess student competence before exposure to the module was completed, the student was not able to go back to the test to assess student competence before exposure to the module. The student's score on the test

to assess student competence before exposure to the module was immediately visible.

2. At the close of the test to assess student competence before exposure to the module the power point slides of genetics/genomics content were immediately available. The student had as long as needed to study the power point material. The slides were able to be copied for study. This randomly assigned group of students received no test to assess student competence after exposure to the module as this group was the designated control group who received no test to assess student competence after exposure to the module.

The protection of the human subjects of this study was considered of great importance. The students were informed of the way the information was collected when they were given the information about accessing the online module. They were told in the lecture prior to the availability of the online module and the information was reinforced with the module that this was part of a doctoral study by the researcher. There was no coercion or direct incentive given for participation. The students were informed that only the statistical data from the answers to the test to assess student competence before and after exposure to the module questions were used for the purpose of this doctoral study. Their performance on the test to assess student competence before and after exposure to the module was not reflected in their course grade in any way. They were informed that their participation was anonymous. They were told that they were free to not participate

in the study or to opt out of any portion of the module. The students were informed that there was no penalty to them individually or as a student group, for not using the module for learning. Any student in Nursing 4902 Section 40 EKG Interpretation and Nursing Implications or Nursing 3025 Women's Health Family Competencies in Nursing, choosing not to use the module still had access to the materials on reserve in the Houston J. and Florence A. Doswell College of Nursing library in order to enhance their understanding of genetics and genomics to benefit them in each of the courses. They were then provided with an Agreement to Participate in Research Contract to sign according to the guidelines of the Texas Woman's University Institutional Review Board. They were given the explanation that signing the document and participation in the research was completely voluntary. They were given 2 copies of the contract. One copy they signed and returned to be placed with the Undergraduate Nursing Secretary for filing with the Institutional Review Board at the end of the study. The second copy was the student's copy to keep.

Only the statistical data was utilized for the purpose of this study. The researcher was not part of the lecturing or clinical faculty of Nursing 4902 Section 40 EKG Interpretation and Nursing Implications or Nursing 3025 Section 30 Women's Health Family Competencies in Nursing, so the students participating in the course were not known personally by the researcher. As stated in the description of the methodology, the questions on the tests to assess student competence before and after exposure to the module were of the format the students are used to from previous classes. Feedback was given at the submission of the answers to the questions, so that the number missed was

immediately known by the student in order to minimize the stress of the exam and provide the student with the opportunity to review the material not understood. The potential benefit of the module was explained as assisting the students in understanding other materials presented in their coming nursing courses. Using the module could also benefit the students in their future nursing careers.

The researcher collected the statistical data online from the tests to assess student competence before and after exposure to the module only. There was no attempt to connect the online answers to the subjects who had no personal contact with the researcher. It was understood by the researcher that the present study had to meet the requirements of the TWU Institutional Review Board (IRB).

Both of the tests to assess student competence before and after exposure to the module developed by the researcher were from material presented in genetics and genomics information found in the material referenced in the power point presentation to the module. The consistency of responses by the students in correlation to the content of the module was assessed. Need for clarification of material to enhance the students' learning will be determined from the responses. By analyzing the responses given by the students, the knowledge of the corresponding competencies can be determined.

Analysis of Data

Participants' responses were coded for answering correctly or incorrectly (0 = incorrect; 1 = correct) for each question. These scores were summed to create a test to assess student competence before exposure to the module score for Questions 1 through

10 and a test to assess student competence after exposure to the module score for Questions 11 through 20. The questions were categorized in this manner because the experimental group received Questions 1 through 10 prior to exposure to the online module (The tests to assess student competence before and after exposure to the module questions are found in the Appendix). (The test bank with rationale for each question from which the questions were taken and randomized for use with each group is also found in the Appendix).After viewing the online module, the experimental group viewed Questions 11 through 20. (The online module can be found in the Appendix).Although the control group answered all 20 questions before viewing the online module and the questions were presented in a different order than for the experimental group, their questions were matched directly with the test to assess student competence before and after exposure to the module questions. Furthermore, participants' responses as to which option/answer they selected were entered into the data file. For example, responses for choice A, choice B, choice C, and choice D were entered for each participant.

Descriptive analyses, specifically, frequencies and percentages, were conducted to describe group (i.e., control or experimental). Descriptive analyses were conducted as the frequencies and percentages of the number of correct versus incorrect responses for each of the 20 questions. Frequencies and percentages were also conducted to describe participants' choices for each question.

To answer the research question, which asked if there was an effect of viewing online modules on participants' scores at test to assess student competence after exposure

to the module, two types of analyses were conducted. The first type of analyses involved conducting a series of cross tabulations with Pearson chi squares which examined the relationships between group (control versus experimental) on participants' correct/incorrect responses for the test to assess student competence before exposure to the module questions and the test to assess student competence after exposure to the module questions. The second type of analyses was an item analyses in which responses to each of the 20 questions were analyzed with a cross tabulation with Pearson chi square analyses to determine if there was a significant relationship between group and item responses. Finally, two separate ANOVAs were conducted to determine if there was an effect on participants' overall test to assess student competence before and after exposure to the module scores.

CHAPTER IV

RESULTS OF STUDY

The current study examined how viewing a learning module that reviews information on genetics and genomics affected junior and senior level nursing students' scores in a test to assess student competence before and after exposure to the module repeated measure design. Students in the experimental condition answered ten test to assess student competence before exposure to the module questions, after which they could spend unlimited reviewing learning modules. After reviewing these modules, they answered ten similar test to assess student competence after exposure to the module questions. Participants in the control condition answered the same 20 questions in a test to assess student competence before exposure to the module scenario, after which they could view the learning modules. Analyses compared participants' responses correct or incorrect, as well as looking at the individual responses by condition.

Descriptive Analyses

A total of 114 nursing students participated in the study. Two students were removed due to missing data for a total of 112 nursing students. As seen in Table 1, the number of students in the control (49.1%) and experimental groups (50.9%) were fairly equally distributed.

Table 1

Frequencies and Percentages of Participants' Group Assignment

	Frequency	%
Group		
Control	55	49.1
Experimental	57	50.9

Note. Frequencies not equaling 112 reflect missing data.

Test to Assess Student Competence Before Exposure to the Module Questions-Correct

Table 2 designates the correct answers for each question administered. For question 1 87.5% of the students answered the question correctly. Question 2 was answered correctly by 53.6% of the students. 81.3% of the students answered Question 3 correctly. For Question 4, 65.2 % of the students answered the question correctly. Question 5 was answered correctly by 61.6% of the students. 34.8 % of the students answered Question 6 correctly. For Question 7 the correct answer was given by 21.4 % of the students. For question 8, 41.1% of the students answered the question correctly. Question 9 was answered correctly by 91.1% of the students. 92 % of the students answered Question 10 correctly.

Test to Assess Student Competence After Exposure to the Module Questions-Correct

For Question11, 89.5% of the students answered the question correctly. As shown in Table 2, Question 12 was answered correctly by 95.8% of the students. 49.5% of the students answered Question13 correctly. For Question 14 the correct answer was given by 76.8 % of the students. For Question15, 44.2 % of the students answered the question correctly. Question 16 was answered correctly by 57.9% of the students. 98.9% of the students answered Question17 correctly. For Question 18 the correct answer was given by 58.9% of the students. Question 19 was answered correctly by 27.4% of the students. Finally, 27.4% of the students answered Question 20 correctly.

Table 2

Frequencies and Percentages of Participants' Correct Responses to Questions

	Incorrect		Correct			Incorrect		Correct	
	f	%	*f*	%		*f*	%	*f*	%
Q1.	14	12.5	98	87.5	Q11.	10	10.5	85	89.5
Q2.	52	46.4	60	53.6	Q12.	4	4.2	91	95.8
Q3.	21	18.8	91	81.3	Q13.	48	50.5	47	49.5
Q4.	39	34.8	73	65.2	Q14.	22	23.2	73	76.8
Q5.	43	38.4	69	61.6	Q15.	53	55.8	42	44.2
Q6.	73	65.2	39	34.8	Q16.	40	42.1	55	57.9
Q7.	88	78.6	24	21.4	Q17.	1	1.1	94	98.9
Q8.	66	58.9	46	41.1	Q18.	39	41.1	56	58.9

Table 2 continued

Q9.	10	8.9	102	91.1	Q19.	69	72.6	26	27.4
Q10.	9	8.0	103	92.0	Q20.	69	72.6	26	27.4

Note. Frequencies not equaling 112 reflect missing data. It should be noted that 17 participants did not complete Questions 11 through 20.

Test to Assess Student Competence Before Exposure to the Module Questions- Item Analysis

The item analysis is shown in Table 3. As seen from Question 1, the greatest frequency of responses were given in answer B with 87.5%. From Question 2, the greatest frequency of responses were given in answer A with 53.6%. Question 3 shows the greatest frequency of response from answer C with 81.3%. As seen from Question 4, the greatest frequency of responses were given in answer C with 65.2%. From Question 5, the greatest frequency of responses were given in answer C with 61.6%. Question 6 shows the greatest frequency of response from answer B with 34.8%, followed by 33.9% of response for answer C. As seen from Question 7, the greatest frequency of responses were given in answer D with 37.8%. From Question 8, the greatest frequency of responses were given in answer D with 41.1%. Question 9 shows the greatest frequency of response from answer D with 91.1%. As seen from Question 10, the greatest frequency of responses were given in answer C with 92.0%.

Test to Assess Student Competence After Exposure to the Module Questions- Item Analysis

From Question11, the greatest frequency of responses were given in answer A with 89.5%. Question 12 shows the greatest frequency of response from answer D with 95.8%. As seen from Question13, the greatest frequency of responses were given in answer A with 49.5%, followed by 36.8% of students choosing answer B. From Question14, the greatest frequency of responses were given in answer D with 76.8%. Question 15 shows the greatest frequency of response from answer A with 44.2%. As seen from Question16, the greatest frequency of responses were given in answer C with 57.9%. From Question17, the greatest frequency of responses were given in answer C with 98.9%. Question 18 shows the greatest frequency of response from answer A with 58.9%. Question 19 shows the greatest frequency of response from answer B with 34.7%. As seen from Question 20, the greatest frequency of responses were given in answer A with 31.6%.

Table 3

Frequencies and Percentages of Participants' Item Responses to Questions

	Answer A		Answer B		Answer C		Answer D	
	f	%	*f*	%	*f*	%	*f*	%
Q1.	--	--	98	87.5	6	5.4	8	7.1
Q2.	60	53.6	20	17.9	24	21.4	8	7.1
Q3.	4	3.6	5	4.5	91	81.3	12	10.7

Table 4 Continued

Q4.	6	5.4	27	24.1	73	65.2	6	5.4
Q5.	15	13.4	8	7.1	69	61.6	20	17.9
Q6.	17	15.2	39	34.8	38	33.9	18	16.1
Q7.	16	14.4	24	21.6	29	26.1	42	37.8
Q8.	15	13.4	38	33.9	13	11.6	46	41.1
Q9.	6	5.4	2	1.8	2	1.8	102	91.1
Q10.	4	3.6	2	1.8	103	92.0	3	2.7
Q11.	85	89.5	2	2.1	7	7.4	1	1.1
Q12.	2	2.1	1	1.1	1	1.1	91	95.8
Q13.	47	49.5	35	36.8	6	6.3	7	7.4
Q14.	3	3.2	13	13.7	6	6.3	73	76.8
Q15.	42	44.2	21	22.1	23	24.2	9	9.5
Q16.	12	12.6	4	4.2	55	57.9	24	25.3
Q17.	1	1.1	--	--	94	98.9	--	--
Q18.	56	58.9	9	9.5	28	29.5	2	2.1
Q19.	26	27.4	33	34.7	6	6.3	30	31.6
Q20.	30	31.6	26	27.4	23	24.2	16	16.8

Note. Frequencies not equaling 112 reflect missing data. It should be noted that 17 participants did not complete Questions 11 through 20.

Total Scores

Table 4 gives the descriptive statistics for the Test to Assess Student Competence before Exposure to the Module (Questions 1-10) and Test to Assess Student Competence after Exposure to the Module scores (11through 20). Test to Assess Student Competence before Exposure to the module scores range from 2 to 10. With an average score of 6.29 (*SD* =1.58). Test to Assess Student Competence after Exposure to the Module scores range from 3 to 9 with an average score of 6.26 (*SD*=1.47).

Table 4

Means and Standard Deviations of Test to Assess Student Competence Before and After Exposure to the Module Questions

	N	Mean	*SD*	Min	Max
Test to Assess Student Competence before Exposure to the Module Scores	112	6.29	1.58	2	10
Test to Assess Student Competence after Exposure to the Module Scores	95	6.26	1.47	3	9

Primary Analyses

A series of cross tabulations were conducted to examine the relationships between correct test to assess student competence before exposure to the module responses and

group. As seen in Table 5, the relationship between group and Question 10 student correct responses was marginally significant, $\chi^2(1) = 2.83, p = .092$, Cramer's $V = .159$. A marginally greater proportion of participants in the control group answered Question 10 correctly (96.4%) compared to the experimental group (87.7%). There were no other significant relationships between post test questions which were correctly answered and group, all *ps ns*. Questions 1through 10 involve the following content.

1. Cause of common adult onset health conditions.
2. Role of nurses in caring for persons with genetic disorders
3. Composition of DNA and RNA.
4. Process of mitosis vs. meiosis.
5. Most common polymorphism.
6. Characteristics of polymorphisms.
7. Persons affected in autosomal recessive condition.
8. Inheritance of Huntington's disease
9. First step in establishing genetic history
10. Optimal family history

Because the students in both experimental and control groups came the same class and to the date of using the module were exposed to the same course content, the difference in responses by group to question 10 is unclear.

Table 5 *Frequencies and Percentages of Correct Responses to Test to Assess Student Competence Before Exposure to the Module Questions by Group*

	Control		Experimental			
	f	%	*f*	%	χ^2	*p*
Q1 Response					.41	.520
Incorrect	8	14.5	6	10.5		
Correct	47	85.5	51	89.5		
Q2 Response					1.72	.189
Incorrect	29	52.7	23	40.4		
Correct	26	47.3	34	59.6		
Q3 Response					.67	.414
Incorrect	12	21.8	9	15.8		
Correct	43	78.2	48	84.2		
Q4 Response					1.56	.211
Incorrect	16	29.1	23	40.4		
Correct	39	70.9	34	59.6		
Q5 Response					.19	.664
Incorrect	20	36.4	23	40.4		
Correct	35	63.6	34	59.6		
Q6 Response					.00	.952
Incorrect	36	65.5	37	64.9		
Correct	19	34.5	20	35.1		

Table Cont'd

	Control		Experimental			
	f	%	*f*	%	χ^2	*p*
Q7 Response					.01	.921
Incorrect	43	78.2	45	78.9		
Correct	12	21.8	12	21.1		
Q8 Response					.05	.821
Incorrect	33	60.0	33	57.9		
Correct	22	40.0	24	42.1		
Q9 Response					.36	.546
Incorrect	4	7.3	6	10.5		
Correct	51	92.7	51	89.5		
Q10 Response					2.83	.092
Incorrect	2	3.6	7	12.3		
Correct	53	96.4	50	87.7		

As seen in Table 6, the relationship between group and Question 14 student correct responses was significant, χ^2 (1) =4.41, p = .036, Cramer's V = .215. A greater proportion of participants in the experimental group answered Question 14 correctly (87.5%) compared to the control group (69.1%). There were no other significant relationships between test to assess student competence after exposure to the module questions which were correctly answered and group, all *ps ns.*

Questions 11through 20 involve the following content.

10. Use of genetic knowledge for treatment

11. Cause of most health conditions

12. Mutation occurring in germ-line

13. Meiosis vs. mitosis

14. Forensic application of genetics to parenthood

15. Location of .1% of DNA variation

16. Characteristic of Down's Syndrome

17. Characteristics of X-linked recessive disorders

18. Newborn screen as type of testing

19. First step in initial prenatal nursing visit

Since the experimental group was exposed to the power point module before answering question #14 it is most likely the exposure to the information on mitosis and meiosis on slide 5 of the power points that would have provided a review of these processes for the students in the experimental group giving them the opportunity to remember this material for the exam.

Table 6

Frequencies and Percentages of Correct Responses to Test to Assess Student Competence After Exposure to the Module Questions by Group

	Control		Experimental			
	f	%	*f*	%	χ^2	*p*
Q11 Response					1.47	.226
Incorrect	4	7.3	6	15.0		
Correct	51	92.7	34	85.0		
Q12 Response					.11	.744
Incorrect	2	3.6	2	5.0		
Correct	53	96.4	38	95.0		
Q13 Response					.01	.930
Incorrect	28	50.9	20	50.0		
Correct	27	49.1	20	50.0		
Q14 Response					4.41	.036
Incorrect	17	30.9	5	12.5		
Correct	38	69.1	35	87.5		
Q15 Response					2.38	.123
Incorrect	27	49.1	26	65.0		
Correct	28	50.9	14	35.0		
Q16 Response					.13	.723
Incorrect	24	43.6	16	40.0		
Correct	31	56.4	24	60.0		
Q17 Response					.74	.391
Incorrect	1	1.8	0	.0		
Correct	54	98.2	40	100.0		

Table 6, continued

	Control		Experimental			
	f	%	*f*	%	χ^2	*p*
Q18 Response					.06	.807
Incorrect	22	40.0	17	42.5		
Correct	33	60.0	23	57.5		
Q19 Response					.20	.659
Incorrect	39	70.9	30	75.0		
Correct	16	29.1	10	25.0		
Q20 Response					.92	.339
Incorrect	42	76.4	27	67.5		
Correct	13	23.6	13	32.5		

As seen in Table 7 the relationship between Question 2 item response and group was significant, $\chi^2(1) = 8.83$, $p = .032$, Cramer's $V = .281$. A greater proportion of participants in the experimental group (59.6%) selected "a" as the answer to Question 2 than in the control group (47.3%). A greater proportion of participants in the experimental group (22.8%) selected "b" as the answer to Question 2 than in the control group (12.7%). A greater proportion of participants in the control group (27.3%) selected "c" as the answer to Question 2 than in the experimental group (15.8%). Finally a greater proportion of participants in the control group (12.7%) selected "d" as the answer to Question 2 than in the experimental group (1.8%). For question #2, answer (a) was the correct answer. Answer (b) was the distracter that the students would have been most familiar with. The control group received this question as #15 of the set of questions they were given to answer. There is no evidence from this information as to the reason that the

experimental and control groups would have consistently chosen the different answers possible.

A marginally significant relationship was seen between Question 10 item response and the group, χ^2 (1) =6.39, p = .094, Cramer's V = .239. A greater proportion of participants in the experimental group (7.0%) selected "a" as the answer to Question10 than in the control group (.0%). A greater proportion of participants in the control group (96.4%) selected "c" as the answer to Question 10 than in the experimental group (87.7%). This result should be viewed with caution as there were insufficient participants in each cell. Additionally, there were no other significant relationships between pretest questions item response and group, all *ps* *ns*.

Both the experimental group and the control group received this question as # 10 in the question randomization. Both experimental and control groups would have received this information in an initial nursing course that included content on taking family histories. The correct answer to the question is (c), the family history should span at least 3 generations, as opposed to the answer (a) given most frequently by the experimental group, namely to be limited to those family members that are living. There is no readily apparent reason for this choice to be different between the two groups.

Table 7

Frequencies and Percentages of Item Responses to Test to Assess Student Competence Before Exposure to the Module Questions by Group

	Control		Experimental			
	f	%	*f*	%	χ^2	*p*
Q1 Item					.63	.731
Answer B	47	85.5	51	89.5		
Answer C	3	5.5	3	5.3		
Answer D	5	9.1	3	5.3		
Q2 Item					8.83	.032
Answer A	26	47.3	34	59.6		
Answer B	7	12.7	13	22.8		
Answer C	15	27.3	9	15.8		
Answer D	7	12.7	1	1.8		
Q3 Item					1.44	.696
Answer A	3	5.5	1	1.8		
Answer B	3	5.5	2	3.5		
Answer C	43	78.2	48	84.2		
Answer D	6	10.9	6	10.5		
Q4 Item					3.31	.347
Answer A	3	5.5	3	5.3		
Answer B	12	21.8	15	26.3		
Answer C	39	70.9	34	59.6		
Answer D	1	1.8	5	8.8		
Q5 Item					1.88	.598
Answer A	9	16.4	6	10.5		
Answer B	3	5.5	5	8.8		
Answer C	35	63.6	34	59.6		
Answer D	8	14.5	12	21.1		

Table Cont'd

Q6 Item					.38	.945
Answer A	8	14.5	9	15.8		
Answer B	19	34.5	20	35.1		
Answer C	20	36.4	18	31.6		
Answer D	8	14.5	10	17.5		
Q7 Item					.58	.902
Answer A	7	13.0	9	15.8		
Answer B	12	22.2	12	21.1		
Answer C	13	24.1	16	28.1		
Answer D	22	40.7	20	35.1		
Q8 Item					.20	.978
Answer A	8	14.5	7	12.3		
Answer B	19	34.5	19	33.3		
Answer C	6	10.9	7	12.3		
Answer D	22	40.0	24	42.1		
Q9 Item					4.63	.201
Answer A	1	1.8	5	8.8		
Answer B	2	3.6	0	.0		
Answer C	1	1.8	1	1.8		
Answer D	51	92.7	51	89.5		
Q10 Item					6.39	.094
Answer A	0	.0	4	7.0		
Answer B	0	.0	2	3.5		
Answer C	53	96.4	50	87.7		
Answer D	2	3.6	1	1.8		

As seen in Table 8, the relationship between Question 20 item response and group was significant, χ^2 (1) =8.76, p = .033, Cramer's V = .304. A greater proportion of participants in the control group (40.0%) selected "a" as the answer to Question 20 than

in the experimental group (20.0%). A greater proportion of participants in the experimental group (32.5%) selected "b" as the answer to Question 20 than in the control group (23.6%). A greater proportion of participants in the control group (27.3%) selected "c" as the answer to Question 20 than in the experimental group (20.0%). Finally a greater proportion of participants in the experimental group (27.5%) selected "d" as the answer to Question 20 than in the control group (9.1%). There were no other significant relationships between post test questions item response and group, all *ps ns.*

Question #20 for the experimental group was question #13 for the control group. This question involved the first step in providing care to a prenatal (or any patient). Both the experimental and control groups would have received this information in previous courses, both regarding assessment of patients and care of patients. The correct answer is (b) observation. It is unclear as to the reason the students selected the different distracters as the correct answer.

Table 8

Frequencies and Percentages of Item Responses to Test to Assess Student Competence After Exposure to the Module Questions by Group

	Control		Experimental			
	f	%	*f*	%	χ^2	*p*
Q11 Item					4.28	.233
Answer A	51	92.7	34	85.0		
Answer B	0	.0	2	5.0		
Answer C	4	7.3	3	7.5		
Answer D	0	.0	1	2.5		
Q12 Item					4.21	.240
Answer A	2	3.6	0	.0		
Answer B	0	.0	1	2.5		
Answer C	0	.0	1	2.5		
Answer D	53	96.4	38	95.0		
Q13 Item					2.08	.556
Answer A	27	49.1	20	50.0		
Answer B	21	38.2	14	35.0		
Answer C	2	3.6	4	10.0		
Answer D	5	9.1	2	5.0		
Q14 Item					4.64	.200
Answer A	2	3.6	1	2.5		
Answer B	10	18.2	3	7.5		
Answer C	5	9.1	1	2.5		
Answer D	38	69.1	35	87.5		
Q15 Item					3.87	.276
Answer A	28	50.9	14	35.0		
Answer B	12	21.8	9	22.5		
Answer C	12	21.8	11	27.5		
Answer D	3	5.5	6	15.0		
Q16 Item					2.59	.460
Answer A	9	16.4	3	7.5		

Table Cont'd

Answer B	3	5.5	1	2.5		
Answer C	31	56.4	24	60.0		
Answer D	12	21.8	12	30.0		
Q17 Item					.74	.391
Answer A	1	1.8	0	.0		
Answer C	54	98.2	40	100.0		
Q18 Item					.84	.841
Answer A	33	60.0	23	57.5		
Answer B	4	7.3	5	12.5		
Answer C	17	30.9	11	27.5		
Answer D	1	1.8	1	2.5		
Q19 Item					1.89	.595
Answer A	16	29.1	10	25.0		
Answer B	16	29.1	17	42.5		
Answer C	4	7.3	2	5.0		
Answer D	19	34.5	11	27.5		
Q20 Item					8.76	.033
Answer A	22	40.0	8	20.0		
Answer B	13	23.6	13	32.5		
Answer C	15	27.3	8	20.0		
Answer D	5	9.1	11	27.5		

Finally, analyses of variance (ANOVAs) were conducted to examine the effect of group on both tests to assess student competence before and after exposure to the module scores. As seen in Table 9, group did not have a significant effect on Test to assess student competence before exposure to the module, $F(1, 110) = .01$, $p = .925$, $\eta^2 < .001$. Group also did not have a significant effect on Test to assess student competence after exposure to the module scores, $F(1, 110) = .00$, $p = .947$, $\eta^2 < .001$.

Table 9

Means and Standard Deviations of Test to Assess Student Competence Before Exposure to the Module Scores and Test to Assess Student Competence After Exposure to the Module Scores by Group

	f	Mean	*SD*	*F*	*p*
Pre Test Scores				.01	.925
Control	55	6.31	1.44		
Experimental	57	6.28	1.72		
Post Test Scores				.00	.947
Control	55	6.25	1.44		
Experimental	40	6.28	1.54		

CHAPTER V

DISCUSSION OF RESULTS

Introduction

The purpose of this study was to ascertain the current level of knowledge regarding genetics and genomics of nursing students already in the professional nursing curriculum. An online introductory overview of genetic and genomic information was given along with a test to assess student competence before and after exposure to the module of the information. As these students exit the nursing program after four semesters of nursing studies they are required to have a working knowledge of the effects of genetics and genomics on nursing care of patients. A synopsis of the findings from Chapter Four with the conclusions that can be drawn, the implications of those conclusions and the recommendations that can be made from this study will be provided.

The sample for this study consisted of 114 students who responded to the online test to assess student competence before exposure to the module with a power point module following the test to assess student competence before exposure to the module from two courses. Two students were excluded due to incomplete data, thus leaving a final sample of 112 students. The study sample from Nursing 4902 Interpretation of EKGs and Nursing Implications included second semester junior nursing students, as well as first and second semester senior nursing students. The students from the course Nursing 3025 Women's Health Family Competencies were exclusively second semester junior nursing

students. The students in each course were randomly assigned to an experimental group and a control group .The results of their responses were compared both by group (ie., experimental and control) A series of cross tabulations with Pearson chi square analyses were done which examined the correct and incorrect responses as well as an item response analysis for each group (i.e., experimental and control).

Discussion of Findings

The statistical analysis of the data showed that in the test to assess student competence before exposure to the module findings by group (experimental and control) there was no significant relationship between correct response and group for questions 1 through 9. For question 10, however, there was a marginally significant relationship between correct response and group. A marginally greater proportion of participants in the control group correctly answered question 10 than those in the experimental group. Question10 involved taking a family history. In one of the first nursing courses regarding assessment of patients in the first junior year semester, the nursing students are required to learn taking family histories. The experimental group and the control group both were exposed to this learning. A reason for the difference in the response may be the location in the panel of questions for the experimental group compared to the control group. For the experimental group, the question was in the test to assess student competence before exposure to the module namely in the first ten questions. For the control group this question was also question number10. When they came to that question, they had already become familiar with answering genetic questions. Without use of the power point slides,

what they remembered from past course work may have been triggered by this question or they may have become acclimated to answering genetic questions by this time. In the test to assess student competence after exposure to the module there was no significant relationship between questions 11-13 and questions 15 through 20. There was, however, a significant relationship between question 14 and the correct response in that a greater proportion of participants in the experimental group answered question 14 correctly. This may be attributed to reviewing the on line module because slide number 5 provides the definition of meiosis and mitosis.

In the item analysis of the test to assess student competence before exposure to the module by group (experimental and control) there was no significant relationship between questions 1 and 3 through 9. There was, however, a significant relationship between question 2 item response and group. A greater proportion of participants in the experimental group selected "a" as the answer for question 2 than those in the control group, whereas a greater proportion of participants in the experimental group selected "b" as the answer for question 2 than those in the control group. Additionally, a greater proportion of those in the control group selected "c" for the answer to question 2 than those in the experimental group. Finally, a greater proportion of those in the control group selected "d" for the answer to question 2 than those in the experimental group. There was a marginally significant relationship between question 10 item response and group. This result should be viewed with caution as there were insufficient participants in each cell.

In the statistical analysis of the item responses on the test to assess student competence after exposure to the module by group there was no significant relationship between questions 11 through 19 and group. There was a significant relationship between question 20 item response and group. A greater proportion of participants in the control group selected "a" for the answer to question 20 compared to participants in the experimental group. A greater proportion of participants in the experimental group selected "b" as the answer for question 20 compared to participants in the control group. A greater proportion of participants in the control group selected "c" for the answer to question 20 than participants in the experimental group. A greater proportion of participants in the experimental group selected "d" as the answer for question 20 compared to participants in the control group. Question #20 for the experimental group was question #13 for the control group. This question involved the first step in providing care to a prenatal (or any patient). Both the experimental and control groups would have received this information in previous courses, both regarding assessment of patients and care of patients. The correct answer is (b) observation. It is unclear as to the reason the students selected the different distracters as the correct answer.

For the current study, the null hypothesis was that there will be no statistically significant difference in the scores concerning knowledge of the implications of genetics for nurses by second semester junior and first and second semester senior nursing students after exposure to an online module on introductory information about human

genetics and genomics than before exposure to the online module on introductory information about human genetics and genomics.

From the above findings the null hypothesis is correct and needs to be accepted for this study. As will be discussed later, this is a positive finding. From the study as developed, the experimental group and control group in each course were equally matched. The participants in each group were picked by random selection through a program available through Blackboard as they were enrolled in the study. The expectation prior to the initiation of the study was the possibility of major gaps in the basic knowledge the junior and senior nursing students had of genetics and genomics as related to nursing. If that were the case, plans would need to be made in putting more genetic/genomic content into the nursing curriculum to provide major remediation in the basic biogenetic science knowledge of the students before applying it to nursing. The results of the current study, however, showed that statistically this is not the case.

The findings of this study are significantly different than 2 previous studies conducted regarding the level of genetic knowledge of nursing students. The study by Dodson & Lewallen (2010), examined the perceptions of knowledge of genetic terminology by 275 nursing students in a university in an eastern state of the United States. The students were from four years of nursing study at the university. This study examined the student's perceived knowledge of medical genetic terminology. This study was replicated with 501 Taiwanese nursing students by Hsiao, Van Riper, Lee, Chen, & Lin, (2011). In the study by Dodson & Lewallen (2010), senior nursing students showed a

greater perception of the medical genetic terms given in the survey than any of the other three classes (I.e., freshmen, sophomores and juniors). In the similar survey presented to Taiwanese students by Hsiao, Van Riper, Lee, Chen, & Lin, (2011)., the junior level nursing students scored higher on their perceived knowledge of medical genetic terminology than freshmen, sophomores and seniors. These two studies, while helpful in ascertaining what nursing students perceive they have acquired in medical genetic terminology, did not attempt to discover their actual knowledge. In both studies the researchers acknowledged the limitation that the results could not be generalized beyond their specific nursing student population.

This researcher while taking note of the above studies chose to examine by pre and post test questions with an online power point module, the direct knowledge of junior and senior nursing students of introductory genetic and genomic information as it relates to nursing. No attempt was made to ascertain students' clinical comfort with use of this knowledge as was assessed by Dodson & Lewallen (2010) as well as Hsiao, Van Riper, Lee, Chen, & Lin, (2011). The advantage seen by this researcher of studying the direct knowledge regarding genetics and genomics of the nursing students is the opportunity to use that direct knowledge to plan implementation of genetic and genomic concepts within the nursing curriculum. There was no statistically significant difference between the answers given to the pretest questions and the posttest questions by the students in the experimental group. This would seem to indicate that they had a beginning knowledge of genetics and genomics before entering the study. In the same manner, the researchers in

each of the above two studies, especially that of Hsiao, Van Riper, Lee, Chen, & Lin, (2011), acknowledged that the source of the differences in knowledge between the levels of students in their studies could not be traced directly to what the students had received in the nursing curriculum.

From the overall lack of statistical significance between the experimental and control groups, while seemingly a non-finding for statistical purposes is a positive finding from the point of curricular significance. This finding points to the fact that the students have a basic working knowledge of genetics and genomics. To the faculty this is good news because in planning for curricular implementation of genetic and genomic concepts in greater depth as mandated by the Texas Board of Nursing Differentiated Essential Competencies (DECs) discussed in Chapter I, it is possible to move directly to implementing concepts specific to each area of nursing with only a minimal biogenetic/genomic review. This could be facilitated in an online module in a beginning nursing course. From there the faculty of each nursing area would be able to implement in depth the genetic/genomic concepts appropriate to their area of study.

Limitations

There were several limitations of the study. The study required voluntary participation on the part of the students. As a result, out of 2 classes with a total of 223 students, only a total of 114 students participated. At the time of the study, the modular information is not identified with any course in the nursing curriculum, so beyond what was provided through the power point slides there is no way to know the source of the

knowledge for the students. The study was conducted with only the junior and senior nursing students of Texas Woman's University on the campus in Dallas so the findings can only be attributed to this group of students. They cannot be generalized to any other group of nursing students.

Recommendations for Future Study

It would be appropriate to repeat this type of study with several changes. To ascertain more fully the effect of the online module between the tests to assess student competence before and after exposure to the module, a repeat of the study with the experimental group taking the module with a specific time limitation to study the module would be advantageous. The control group could receive the same tests to assess student competence before and after exposure to the module without the module and an exact same time period intervening between the tests to assess student competence before and after exposure to the module. Another study that could be helpful would be to give the tests to assess student competence before and after exposure to the module with an introductory module to students as they enter the nursing program just prior to taking any nursing courses. The results could then be analyzed based on whether they had their first two years of core curriculum in a four-year university setting, a two-year community college program or whether they were post baccalaureate students on entry into the nursing curriculum.

Summary

To date the amount of genetic and genomic information that the TWU nursing students have received prior to their current nursing studies has not been determined. From this study it is evident that they scored well on the tests to assess student competence before and after exposure to the module connected to a Power point introductory module. For a research statistical point of view the minimal differences found between experimental groups and control groups could be disappointing. From a nursing curriculum and educational point of view the findings are positive .This finding provides the information that the nursing students are ready with only a brief review of genetic and genomic basics, to participate in a greater depth of study of the specific utilization of genetic and genomic concepts in each specific area of nursing care. Two examples of attempts to survey nursing student knowledge of genetics and genomics were reported in (Hsiao, Van Riper, Lee, Chen, & Lin, 2011).Their study replicated the survey done by (Dodson & Lewallen,2010). Both studies were surveys of nursing students' perceived knowledge and clinical comfort with utilization of genetic/genomic concepts. To date no research is available that attempts to directly examine nursing student knowledge of genetic/genomic concepts which correlate directly with knowledge that can be gained from nursing courses.

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APPENDIX A

Test to Assess Student Competence before Exposure to the Module

Appendix A
Test to Assess Student Competence before Exposure to the Module

Total Questions 10
Total Points 100

#1 Common adult-onset health conditions, such as arthritis, diabetes and cancer, are thought to be the result of:

a) Gene mutations alone.
b) Multiple gene mutations and environmental influences.
c) Strong environmental factors alone.
d) High genetic susceptibility and an inherent fear factor. (#3 in Test Bank)

#2 Nurses play many roles in caring for persons and families affected by genetically influenced disorders. These roles include:

a) **Recognizing the possibility of a genetic component in a disorder and taking appropriate referral action.**
b) Referring patients' questions to the diagnosing physician because explanations are beyond the scope of the nurse's function.
c) Calling the genetics counselor to communicate with families under stress from a genetic disorder of a family member.
d) Referring families with genetic risks because the genetics counselor will obtain the history and draw and interpret pedigrees as needed. (#4 in Test Bank)

#3 DNA and RNA are:

a) Both double stranded nucleic acids with similar components.
b) Both double stranded nucleic acids with different components.
c) **DNA is a double stranded nucleic acid; RNA is single stranded.**
d) The purine bases in DNA and RNA are different. (#5 in Test Bank)

#4 Mitosis is the process of somatic cell division. Mitosis differs from meiosis in that:

a) It happens in testes and ovaries to form gametes.
b) It has 2 cell divisions and results in 4 haploid daughter cells.
c) It has one cell division and results in 2 haploid daughter cells.
d) The daughter cells are genetically not the same. (#7 in Test Bank)

#5 Most genes are shared by all members of the human species. A genetic variation is called a polymorphism. An example of the most common polymorphism is:

a) Tay Sachs disease.
b) Phenyketunuria.
c) **The ABO and Rh blood groups.**
d) Cystic Fibrosis. (#9 in Test Bank)

#6 Polymorphisms are genetic variations that occur within a population when 2 or more alleles are present with a frequency of at least 1%.

a) Polymorphisms produce the same result in all individuals.
b) **The newer polymorphisms being studied are SNPs.**
c) Most polymorphisms cause disease. (#11in Test Bank)
d) With the mapping of the Human Genome the significance of all SNPs is known.

#7 In an autosomal recessive inherited condition:

a) Female family members are affected more frequently than males.
b) **Male and female family members are equally affected.**
c) Male family members are affected more frequently than females.
d) There is no correlation with gender. (#14 in Test Bank)

#8 Huntington disease is an example of an inherited gene mutation that is:

a) X-linked recessive so only females are affected.
b) Autosomal recessive so which sibling will be affected cannot be determined.
c) Y-linked dominant so only males are affected.
d) **Autosomal dominant so male and female family members are equally affected.** (#15 in Test Bank)

#9 The first step in establishing the genetic history of your patient should be to:

a) Observe the individual over time.
b) Conduct psychological testing.
c) Complete an extensive exclusionary process.
d) **Obtain a complete family health history.** (#17 in Test Bank)

#10 An optimal family history should:

a) Be limited to those living.
b) Focus primarily on the maternal history.
c) Span at least three generations. (#18 in Test Bank)
d) Emphasize paternal pedigree.

APPENDIX B

An Online Module:

Genetics and Genomics: An Introduction for TWU Nursing Students

Appendix B

Genetics and Genomics: An Introduction for TWU Nursing Students

By

Rosemarie C. Jordan Jaekel, B.A., M.S.N.

History of Genetics and Genomics

- 1865-Attributed beginning of Genetics to Gregor Mendel who started observations and analyses of the characteristics of garden peas noting that characteristics were passed from the parent generation to the next generation.
- Genetics as a science continued to grow for the next 135 years affecting all areas of biologic science and medicine in particular.
- 1990-In October the beginning of the Human Genome Project- an international initiative through the National Institutes of Health to map the human genome was begun.
- 2003-Completion of the Human Genome Project, 2 years ahead of schedule.
- Current genetic science has taken the Human Genome Project as a springboard for research in all areas of health and health care.

Basic Genetic Definitions

Chromosome- One of the thread-like "packages" of genes and other DNA in the nucleus of a cell.

Gene-The functional and physical unit of heredity passed from parent to offspring. Genes are pieces of DNA, and most genes carry the information for making a specific protein.

Genetic-Inherited. Having to do with information that is passed from parents to offspring through genes in sperm and egg cells.
Genome-All the DNA contained in an organism, which includes both the chromosomes within the nucleus and the DNA in mitochondria.
Genomics- The study of the functions and interactions of all the genes in the genome.
Epigenetic- Non-mutational phenomena that may modify the expression of a gene.
Meiosis-Reduction division of diploid germ cells resulting in haploid gametes (egg/sperm).

Mitosis- Somatic cell division that normally results in no change from the usual diploid number of chromosomes.

DNA-Deoxyribonucleic acid, the chemical inside the nucleus of a cell that carries the genetic instructions for making living organisms. Double stranded.

RNA-A nucleic acid with a similar composition to DNA. It is single stranded; has a base of Uracil in place of Thymine. It comes in 3 major types.

Genotype- The genetic identity of an individual that does not show as outward characteristics.

Phenotype- The observable traits or characteristics of an organism. Ex. hair or eye color.
Penetrance/manifestation- The likelihood that a person carrying a particular mutant gene will have an altered phenotype.
Dominance- occurs when a trait is expressed with the presence of one copy of the gene determining it.
Recessiveness- occurs when two copies of a gene are required to manifest a trait phenotypically.
Allele- One of the variant forms of a gene at a particular locus, or location on a chromosome.
Carrier- An individual who possesses one copy of a mutant allele that causes disease only when 2 copies are present.

Areas of Genetic Research

Genetics is primarily involved with single gene disorders.
Examples include:
Down's syndrome
Phenyketonuria
Huntington Disease
Other disorders once thought to have single gene manifestations.
Sickle Cell Anemia

Muscular Dystrophy
Cystic Fibrosis

Areas of Genomic Research

Multi factorial genetic disorders have multiple genes involved in their presentation.
Examples are:

Cardiovascular Disease
Hypertension
Diabetes
Alzheimer's disease
Breast Cancer
Colorectal Cancer
Asthma and related Respiratory disorders
Autism, PDD, Asperser's Syndrome, ADD/ADHD
Behavioral Disorders- Bi-Polar Disorder, Depression, Schizophrenia
Genetics of disease causing organisms
Environmental influence on genetic manifestations
Pharmacogenetics

Nursing in Genetics and Genomics

Nurses must use a "genetic eye". In all of the nursing functions listed below we as nurses need to think in terms of genetics and genomics.
Based on current genetics research, all illness and disease findings have a genetic or genomic base.
Some authors include accidental injuries in these categories because the patient's response to injury is based on genetic predisposition.

Nursing functions in all areas of nursing include:

Observation-At the beginning of a patient encounter, what are the genetic characteristics noted by the nurse?
History taking-a 3 generation family genogram is essential.
Assessment- is based on the genogram and observational findings.
Care planning- based on the assessment findings.
Nursing skills are carried out from the care plan.
Education of the patient is tailored to the patient's unique genetic, phenotypic manifestations.

Nursing Roles in Genetics

Planning, implementing, administering, evaluating, screening and testing programs.

Monitoring and evaluating clients with genetic disorders similarly to other disorders.

Working with families under stress caused by problems related to genetic conditions.

Coordinating care/services for individuals /families affected by genetic conditions.

Managing home care/therapy for persons with genetic conditions.

Following up on positive newborn screening tests.

Interviewing clients with possible genetically related conditions.

Assessing needs and interactions in clients and families affected by genetic disease.

Taking comprehensive and relevant family histories.

Assessing the client/family's cultural /ethnic health beliefs/practices related to genetics.

Assessing the client/family's strengths, weaknesses and family functioning.

Providing health education related to genetics.

Serving as advocate for clients/families affected by a genetic disorder.

Participating in public education about genetics.

Developing individualized care plans with anticipatory guidance for persons with genetic disorders.

Explaining the purpose, meaning, implications of genetic tests and results.

Reinforcing and interpreting genetic counseling and testing information.

Supporting families when undergoing counseling and in genetic decision making.

Recognizing genetic components in disorders and making appropriate referrals.

Appreciating and ameliorating social impacts of genetic problems on patients, families, communities.

Resources for Study (on library reserve)

Nurses and the Genomic Revolution
What Nurses Need to Know about Genetics

Essentials of Clinical Genetics in Nursing Practice Chapter 1(3-8).
A Clinician's Primer in Human Genetics, (583-614).

These articles may be copied for your study but the originals may not be taken out of the library.

References

Jenkins, J. F., Grady, P.A., & Collins, F. S. (2005). Nurses and the genomic revolution. *Journal of Nursing Scholarship, 37*, (2), 98-101.

Lashley, F. R. (2007). *Essentials of clinical genetics in nursing practice.* New York: Springer Publishing Company.

Lea, D. H. (2002). What nurses need to know about genetics. *Dimensions of Critical Care Nursing, 21* (3), *Essentials of Genetic and Genomic Nursing: Competencies, Curricular Guidelines, and Outcome Indicators 2nd Edition* (2008) *50*-61.

Lea, D. H. (2000). A clinician's primer in human genetics: What nurses need to know. *Nursing Clinics of North America, 35* (3), 583-614.

APPENDIX C

Test to Assess Student Competence after Exposure to the Module

Appendix C

Test to Assess Student Competence after Exposure to the Module

Total Questions 10
Total Points 100

#11 Nurses must be knowledgeable about basic human genetic principles because in the future a person's specific genetic makeup will be used to:

a) **Tailor medical treatment.**
b) Alter physical appearance.
c) Restructure environmental influence on illness.
d) Discourage specific types of health care. (#1 in Test Bank)

#12 Most health conditions are believed to:

a) Be unrelated to human genetics.
b) Have no underlying cause of disease.
c) Be caused by one recessive gene only.
d) **Have genetic and environmental influences.** (#2 in Test Bank)

#13 A mutation may be defined as a change in genetic material.

a) **If a mutation occurs in the germ line, it will affect both somatic and germ cells.**
b) If a mutation occurs in the germ line, it will affect germ cells only.
c) If a mutation occurs in the germ line, it will affect somatic cells only.
d) A mutation is always inherited. (#6 in Test Bank)

#14 Meiosis is the process of germ cell division. It differs from mitosis in that.

a) It functions for growth and repair.
b) The daughter cells are normally genetically identical. (#8 in Test Bank)
c) It happens in most somatic cells.
d) **The daughter cell chromosome number is half of the parent cell.**

#15 Forensic application and determination of genetic parenthood are some of the most common uses of DNA technology. DNA testing may use blood or buccal cell samples.

a) DNA is tested from the child, the mother and the potential fathers.
b) DNA is tested from the child, the potential mothers and fathers.
c) DNA is tested from the child and the potential fathers. (#10 in Test Bank)
d) DNA is tested from the child, the mother, siblings and the potential fathers.

#16 Humans resemble each other in 99.9% of their DNA. The .1% of variation in DNA occurs:

a) Only among individuals.
b) Only among populations. (#12 in Test Bank)
c) **At both the chromosome and gene levels.**
d) Only at the gene level.

#17 Which is characteristic of Down's syndrome?

a) Individuals who have 46 paired chromosomes.
b) Males who have only 23 chromosomes. (# 13 in Test Bank)
c) Individuals who have an extra chromosome #21.
d) Females who have two X chromosomes.

#18 Characteristics of X-linked recessive disorders include:

a) **The mutant gene is on the X chromosome.**
b) 2 copies are needed for phenotypic affect in males.
c) Females are more frequently affected than males. (# 16 in Test Bank)
d) There is male to male transmission.

#19 Newborn screening is a form of prevention of serious effects of genetic disease. Current newborn screening for PKU, Sickle cell, and Congenital Hypothyroidism involves:

a) **Post-natal testing.**
b) Complete blood testing.
c) Metabolic testing. (#19 in Test Bank)
d) Pre-natal testing.

#20 A first step the nurse takes in the initial prenatal nursing visit of the pregnant patient is:

a) Assessment.
b) **Observation**.
c) Health history. (#20 in Test Bank)
d) Family genetic history.

APPENDIX D

Test Bank for Test to Assess Student Competence Before and After Exposure to the Module Questions

Appendix D

Test Bank for Test to Assess Student Competence Before and After Exposure to the Module Questions

Chapter 1

#1 Nurses must be knowledgeable about basic human genetic principles because in the future a person's specific genetic makeup will be used to:

a) **Tailor medical treatment.**
b) Alter physical appearance.
c) Restructure environmental influence on illness.
d) Discourage specific types of health care.

Rationale:

Slide 11, Text: Chapter 1, page 4: **"Many disorders will be treated using knowledge from genetics both directly and indirectly, and the use of gene therapy will become more widespread". Nursing genetic competencies #1, #2, #3, #9.**

#2 Most health conditions are believed to:

a) Be unrelated to human genetics.
b) Have no underlying cause of disease.
c) Be caused by one recessive gene only.
d) **Have genetic and environmental influences.**

Rationale:

Slide 11, Text: Chapter 1, page 8: **"Genes never act in isolation: they interact with other genes against the individual's genetic background and internal milieu and with agents and factors in the external environment". Nursing genetic competencies # 2, #3, #4, #9.**

#3 Common adult-onset health conditions, such as arthritis, diabetes and cancer, are thought to be the result of:

a) Gene mutations alone.
b) **Multiple gene mutations and environmental influences.**
c) Strong environmental factors alone.
d) High genetic susceptibility and an inherent fear factor.

Rationale:

Slide 9, 11, Text: Chapter 1, page 3: **"The so-called common or complex diseases such as cancer, chronic obstructive pulmonary disease, diabetes mellitus, and heart disease have varying genetic components that are evident in etiology, diagnosis,**

treatment, management or preventive approaches". Nursing genetic competencies #1, #2, #3, #4, #9.

#4 Nurses play many roles in caring for persons and families affected by genetically influenced disorders. These roles include:

a) **Recognizing the possibility of a genetic component in a disorder and taking appropriate referral action.**
b) Referring patients' questions to the diagnosing physician because explanations are beyond the scope of the nurse's function.
c) Calling the genetics counselor to communicate with families under stress from a genetic disorder of a family member.
d) Referring families with genetic risks because the genetics counselor will obtain the history and draw and interpret pedigrees as needed.

Rationale:

Slides 13-16, Text: Chapter 1, page 7: **"Nurses maybe providing any of the following in relation to genetic disorders and variations, many of which are extensions of usual nursing practice: Working with families under stress engendered by problems related to a genetic disorder. Taking comprehensive and relevant family histories. Drawing and interpreting pedigrees. Providing health teaching and education related to genetics and genetic testing". Nursing genetic competencies #1, #2, #3, #4, #9.**

Chapter 2

#5 DNA and RNA are:

a) Both double stranded nucleic acids with similar components.
b) Both double stranded nucleic acids with different components.
c) DNA is a double stranded nucleic acid; RNA is single stranded.
d) The purine bases in DNA and RNA are different.

Rationale:

Slide 5, Text: Chapter 2, page 11: **"DNA and RNA are both nucleic acids with similar components. In DNA and RNA the purine bases are adenine (A) and guanine (G). In DNA the pyrimidine bases are cytosine (C) and thymine (T), and in RNA they are (C) and uracil (U) instead of (T). DNA is double stranded. RNA is single stranded". Nursing genetic competencies #2, #9.**

#6 A mutation may be defined as a change in genetic material.

a) **If a mutation occurs in the germ line, it will affect both somatic and germ cells.**
b) If a mutation occurs in the germ line, it will affect germ cells only.

c) If a mutation occurs in the germ line, it will affect somatic cells only.
d) A mutation is always inherited.

Rationale:

Slides 3, 5, 7, Text: Chapter 2, page 15: **"If a mutation occurs in the germ line, the mutation will be transmitted to all the cells of the offspring, both germ and somatic cells. Mutations can arise de novo (spontaneously), or they can be inherited". Nursing genetic competencies #2, #9.**

#7 Mitosis is the process of somatic cell division. Mitosis differs from meiosis in that:

a) It happens in testes and ovaries to form gametes.
b) It has 2 cell divisions and results in 4 haploid daughter cells.
c) It has one cell division and results in 2 haploid daughter cells.
d) The daughter cells are genetically not the same.

Rationale:

Slide 5, Text: Chapter 2, page 17: **"Table 2.1 a, b and d are listed as characteristics of meiosis". Only answer c is a characteristic of mitosis. Nursing genetic competencies #2, #9.**

#8 Meiosis is the process of germ cell division. It differs from mitosis in that.

a) It functions for growth and repair.
b) The daughter cells are normally genetically identical.
c) It happens in most somatic cells.
d) The daughter cell chromosome number is half of the parent cell.

Rationale:

Slide 5, Text: Chapter 2, page17: **"Table 2.1 a, b and c are listed as characteristics of mitosis". Only answer d is a characteristic of meiosis. Nursing genetic competencies #2, #9.**

Chapter 3

#9 Most genes are shared by all members of the human species. A genetic variation is called a polymorphism. An example of the most common polymorphism is:

a) Tay Sachs disease.
b) Phenyketunuria.
c) The ABO and Rh blood groups.
d) Cystic Fibrosis.

Rationale:

Slide 7, 8, Text: Chapter 3, page 37: **"ABO blood types are one of the most widespread polymorphisms". The rest of the above conditions are more common in people of specific cultural groups. Nursing genetic competencies #2, #4, #7, #8, #9.**

#10 Forensic application and determination of genetic parenthood are some of the most common uses of DNA technology. DNA testing may use blood or buccal cell samples.

a) **DNA is tested from the child, the mother and the potential fathers.**
b) DNA is tested from the child, the potential mothers and fathers.
c) DNA is tested from the child and the potential fathers.
d) DNA is tested from the child, the mother, siblings and the potential fathers.

Rationale:

Slides 4-6, Text: Chapter 3, page 35: **"Specific DNA regions are used from the mother, the child and the potential fathers". Nursing genetic competencies #1, #2, #3, #4, #5, #6, #7, #8, #9.**

#11Polymorphisms are genetic variations that occur within a population when 2 or more alleles are present with a frequency of at least 1%.

a) Polymorphisms produce the same result in all individuals.
b) **The newer polymorphisms being studied are SNPs.**
c) Most polymorphisms cause disease.
d) With the mapping of the Human Genome the significance of all SNPs is known.

Rationale:

Slide7, 8, Text: Chapter 3, pages 25-26: **Only b is correct. Polymorphisms cause variation is part of the definition. "Most polymorphisms appear neutral or cause benign variations. The reasons for such a high degree (3 million places in the Human Genome) of variation are not known". Nursing genetic competencies #2, #7, #9.**

#12 Humans resemble each other in 99.9% of their DNA. The .1% of variation in DNA occurs:

a) Only among individuals.
b) Only among populations.
c) **At both the chromosome and gene levels.**
d) Only at the gene level.

Rationale:

Slide 3, Text: Chapter 3, page 26: **"Deoxyribonucleic acid (DNA) varies among individuals and populations. Variation may be seen at the gene and the chromosome levels". Nursing genetic competencies #2, #7, #8, #9.**

Chapter 4

#13 Which is characteristic of Down's syndrome?

a) Individuals who have 46 paired chromosomes.
b) Males who have only 23 chromosomes.
c) **Individuals who have an extra chromosome #21.**
d) Females who have two X chromosomes.

Rationale:

Slides 3, 5, 7, 8, Text: Chapter 4, page 39: **"Table 4.1 Trisomy 1 extra chromosome present. Trisomy 21(Down's syndrome). Cells contain 47 chromosomes". Nursing genetic competencies #2, #4, #5, #7, #9.**

#14 In an autosomal recessive inherited condition:

a) Female family members are affected more frequently than males.
b) **Male and female family members are equally affected**.
c) Male family members are affected more frequently than females.
d) There is no correlation with gender.

Rationale:

Slides 3, 5, 6, 7, 8, Text: Chapter 4, page 50: "**In AR inheritance, the mutant gene is on an autosome rather than on a sex chromosome. Therefore males and females are affected in equal proportions". Nursing genetic competencies #2, #4, #5, #7, #9.**

#15 Huntington disease is an example of an inherited gene mutation that is:

a) X-linked recessive so only females are affected.
b) Autosomal recessive so which sibling will be affected cannot be determined.
c) Y-linked dominant so only males are affected.
d) **Autosomal dominant so male and female family members are equally affected**.

Rationale:

Slides 3, 5, 6, 7, 8, Text: Chapter 4, page 53: **" In Autosomal dominant inheritance, as in Autosomal recessive inheritance, the mutant gene is on an autosome, so males and females are equally affected". Nursing genetic competencies #1, #2, #3, #4, #5, #6, #7, #8, #9.**

#16 Characteristics of X-linked recessive disorders include:

a) **The mutant gene is on the X chromosome.**
b) 2 copies are needed for phenotypic affect in males.
c) Females are more frequently affected than males.
d) There is male to male transmission.

Rationale:

Slides 3, 5, 7, Text: Chapter 4, page 60: Table 4.9 **"Mutant gene is on the X chromosome. One copy of the mutant gene is needed for phenotypic effect in males (hemizygous). Males are more frequently affected than females. There is no male to male transmission". Nursing genetic competencies #1, #2, #3, #4, #5, #6, #7, #9.**

#17 The first step in establishing the genetic history of your patient should be to:

a) Observe the individual over time.
b) Conduct psychological testing.
c) Complete an extensive exclusionary process.
d) **Obtain a complete family health history.**

Rationale:

Slides 12, 14, Text: Chapter 5, page 73: **"Methods of prevention begin with education of the public and health care professionals and identification of those at risk as listed below:**
Family history over three generations and preparation of pedigree as part of risk assessment". While the nurse without specific preparation in genetic counseling is not expected to assume that role, in order to appropriately refer the client for genetic counseling, the nurse is expected to be able to take a three generational family history and diagram the significant conditions and relationships on a pedigree in order to provide an adequate referral for genetic counseling and appropriate genetic testing. Nursing genetic competencies #1, #2, #4, #5, #7, #9.

#18 An optimal family history should:

a) Be limited to those living.
b) Focus primarily on the maternal history.
c) **Span at least three generations.**
d) Emphasize paternal pedigree.

Rationale:

Slide 12, Text: Chapter 5, page 73: **"Methods of prevention begin with education of the public and health care professionals and identification of those at risk as listed below:**
Family history over three generations and preparation of pedigree as part of risk assessment". While the nurse without specific preparation in genetic counseling is not expected to assume that role, in order to appropriately refer the client for genetic counseling, the nurse is expected to be able to take a three generational family history and diagram the significant conditions and relationships on a pedigree in order to provide an adequate referral for genetic counseling and appropriate genetic testing. Nursing genetic competencies #1, #2, #4, #5, #7, #9.

#19 Newborn screening is a form of prevention of serious effects of genetic disease. Current newborn screening for PKU, Sickle cell, and Congenital Hypothyroidism involves:

a) **Post-natal testing.**
b) Complete blood testing.

c) Metabolic testing.
d) Pre-natal testing.

Rationale:

Slides 8, 14, 16, Text: Chapter 5, page 73 and 94. **"The institution of preventive measures or therapy that can treat or ameliorate the severity or influence the natural history of the disease in question". Additionally: Newborn refers to the infant after birth. Nursing genetic competencies #1, #2, #3, #4, #5, #6, #7, #8, #9.**

#20 A first step the nurse takes in the initial prenatal nursing visit of the pregnant patient is:

a) Assessment.
b) Observation.
c) Health history.
d) Family genetic history.

Rationale:

Slide 12, Text: Chapter 5, page 73 and Chapter 7, page 121: **"The initial recognition of the need for genetic evaluation may arise when an alert practitioner suspects a genetic problem because of family history, physical findings, observation, discussion with the family or knowledge of a related problem in a known relative". Nursing genetic competencies #1, #2, #4, #5, #7, #9.**

APPENDIX E

IRB Approval Letter

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378 FAX 940-898-4416
e-mail: IRB@twu.edu

May 13, 2011

Ms. Rosemarie Jaekel
P.O. Box 496056
Garland, TX 75049

Dear Ms. Jaekel:

Re: Nursing Students' Knowledge of Genetics and Genomics (Protocol #: 16620)

The above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and appears to meet our requirements for the protection of individuals' rights.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. A copy of the annual/final report is enclosed. A final report must be filed with the Institutional Review Board at the completion of the study. Because you do not utilize a signed consent form for your study, the filing of signatures of subjects with the IRB is not required.

This approval is valid one year from May 13, 2011. Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

Sincerely,

Kathy DeOrnellas, PhD

Dr. Kathy DeOrnellas, Chair
Institutional Review Board - Denton

enc.

cc. Dr. Larry LeFlore, Department of Family Sciences
Dr. Ronald Fannin, Department of Family Sciences
Graduate School