Exploring the Application of Genetic Concepts to the Process of Disease in a Pathophysiology Course for Undergraduate Nursing Students

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Introduction

Current research in genetics has led to discoveries of the genetic aspects of many diseases, drugs, and cancer therapies, as well as prenatal and genomic disease testing. Therefore, a rudimentary understanding of genetic concepts, especially within the context of disease processes is essential for twenty-first century nursing practice. For example, recognition of potential genetic disorders may improve patient intake skills as well as the ability of a nurse to provide accurate biological knowledge to educate patients and their families. This research project explores the genetic literacy of nursing students admitted to a Bachelor of Science nursing program taking a 300-level pathophysiology course taught with a genetics-focused curriculum. The goal of this project is to identify common misconceptions and to then create effective assessments in order to improve the nursing curriculum, as well as promote alignment of nursing education with Vision and Change guidelines. This poster presents the results of year two.

Background

This research project began as an attempt to incorporate genetics concepts related to human disease into required sciences courses in a bachelor's program for nursing students. During academic year one, it was assumed that students would enter BIOL 312 with a sufficient grasp of genetic concepts because it is one of the final science courses in their program. Therefore, a review assignment was created in the form of an expert skeleton concept map as a formative assessment tool for a reading assignment covering basic genetic concepts (mitosis, meiosis, Mendelian genetics, DNA replication, and epigenetics). The effectiveness of the assignment was determined by using a vetted pre- and post-test known as the Genetic Literacy Assessment Instrument (GLA), which is designed for non-major biology students.

However, the 2017-2018 pre/posttest comparisons, revealed that in most cases the scores stayed the same between to two attempts or were lower in the post test. Based on the poor performance, it was decided that the GLAI would be used as a needs assessment to determine the conceptual knowledge of students entering the course for the 2018-2019 academic groups. The results pf the GLAI pre-test would be used to emphasize genetic concepts related to that particular group's misconceptions during the course of the semester. Based on the work completed during year one, 3 overarching learning goals with corresponding learning outcomes were identified that would be incorporated and related to each body system unit for the 2018/2019 academic year cohorts.

Learning Goal 1: Understand the Role Cellular Structure & Function in Disease

- Provide an example of a damaging agent or disease that affects a specific organelle. Emphasis on the following organelles: Cell membrane (receptors, proteins, etc), mitochondria & mitochondrial DNA (mutations), and nuclear DNA (factors/processes leading to mutations à i.e. what is a mutation)
- Identify the common causes of cellular adaptations related to cell stress.
- Explain the role of DNA replication to mutations.
- Explain the role of transcription and translation to disease and targets for treatment.

Learning Goal 2: Be able to explain basic patterns of inheritance and the role of genetics in the onset of disease.

- Explain the process of epigenetics.
- Differentiate between inherited autosomal inheritance and sex-linked inheritance.
- Using a Punnet Square, be able to identify the risk for offspring for the various patterns.
- Explain the relationship of nondisjunction in meiosis to disease.
- Differentiate between diseases that arise from mutation, meiotic incident, or inherited allele.

Learning Goal 3: Understand and Explain the Relationship Between the Cell Cycle and Cancer

- Explain the role of the cell cycle to the development of cancer.
- Explain how cancer cells act differently than other cells.
- Provide examples of common carcinogens (relate to mutations).
- Explain role of oncogenes and tumor suppressor genes in carcinogenesis (relate to inherited mutations).
- Relate effect of common cancer treatments and their side effects to the cell cycle.

Methodology

Theoretical Framework: Grounded Theory & Constructivism

This process involved a continuous assessment of how students understood and applied genetic concepts throughout the course of the semester using group activities (formative) during class time followed by an application of that process via an individual assignment (formative), and a unit quiz or project (summative) for each body system/disease unit. In addition, the final exam included 2 applications of genetic concepts and revised post-test assessment (concept inventory) was used to determine basic understanding of the concepts (summative).

Data Collection:
Phase 1: Administer Genetic Literacy Assessment (GLA) during the first week of class & assign reading review & concept map.
Phase 2: Review results of Phase 1 to adjust curriculum to address student misconceptions while teaching the disease concepts of the pathophysiology course. This included a series of modules consisting of 3 components: a review mini-lecture, a formative assessment, and a summative application assessment for each body system unit.
Phase 3: Administer a cumulative course assessment using case studies to identify if students were able to apply the problem concepts to disease processes, as well as a short genetics review concept inventory.

Data Analysis:
Constant comparative analysis of student assessments to identify lingering misconceptions and adjust curriculum.

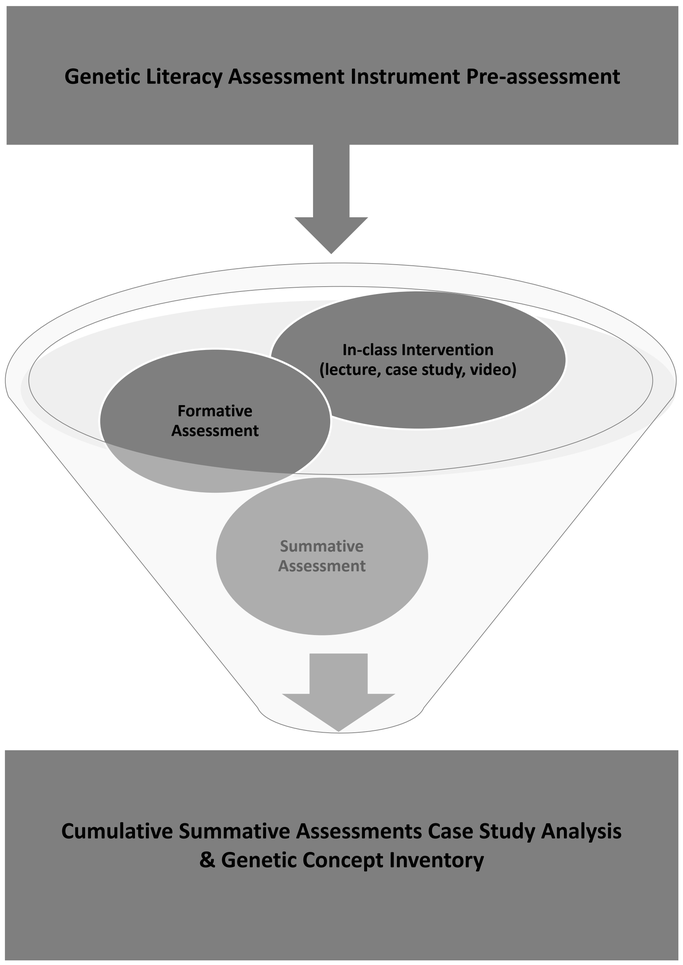

Figure 1. Process of assessments and constant comparative analysis throughout the semester.

Results

Pre-assessment Results (n=31)
Concepts most commonly misunderstood as identified on GLAI:

- Genetic determinism
- Central Dogma principles/gene expression`
- Role of meiosis
- Genetic mutations (DNA replication)
- Genetic variation in humans & between other organisms
- Evolutionary principles of genetics
- Inheritance & predicting probabilities
- Role of cell cycle/mitosis

Mean Score: 18/31 (58%)
Median Score: 18/31 (58%)
Mode: 23/31 (74%)

Post-assessment Results (n=29)
True/False Concept Inventory

Mean Score: 13.10/15 (87.36%)
Median Score: 13/15 (86.67%)
Mode: 12/15 (80%)

Cumulative Case Study Application Final Assessment

Case study 1: Sickle Cell Anemia	% With Misconceptions (n=29)
Misunderstanding of recessive trait expression	37.93%
Pedigree construction	20.69%
Describing dominant vs. recessive allele	20.69%
Understanding of gene expression	13.79%
definition of allele	10.34%
Case Study 2: Cancer	
Cell cycle & cancer relationship (mutation)	27.59%
Characteristics of cancer cells	20.69%
Relationship of cancer treatment to cell cycle	27.59%
Relationship of continued mutation with drug resistance	61.29%

Discussion

The preliminary analysis of the pre-and post-assessments illustrate that there was a slight improvement in student understanding of the major genetic concepts incorporated into the curriculum of this course. Students were able to correctly identify basic definitions on the post-assessment concept inventory. Further, most students were able to apply these concepts to the case study application portion of the final assessment. Results indicate that students struggled the most with explaining how a recessive allele is expressed in sickle cell anemia (37.93%), explain the relationship of the cell cycle with cancer (27.59%), and the more advanced concept of how continued mutations in cancer cells lead to chemotherapeutic drug resistance (61.29%). This indicates that students may need more emphasis on these concepts in their respective formative assessments throughout the semester. In addition, this is a preliminary analysis of just the pre- and post-assessments. Cursory analysis of the unit formative and summative assessments was conducted as part of the constant comparative analysis to inform curriculum development; however, a more in-depth analysis of the misconceptions in these assessments is required. In addition, I would like to collect additional demographic information regarding the student's background before entering the course, especially with regard to transfer students and the length of time since they took the pre-requisites for this course. Finally, a focus group of students will most likely be added to the next round of data collection for this curriculum development project.

Acknowledgements

I acknowledge the overwhelming support and participation of my 2017/2018 and 2018/2019 pathophysiology students with this project.

Davenport University IRB Protocol #18121918..

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