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Incorporating Problem-Based Learning in an Undergraduate Prerequisite Anatomy and Physiology Course for Allied Health and Pre-Nursing Students



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Introduction

Background:

- Anatomy and Physiology (A&P) courses are **gateway prerequisites** for many undergraduate students wishing to enter nursing and allied health fields
 - Required for entry of pre-nursing students into B.S. in nursing programs
 - Required for completion of various undergraduate allied health degrees (nutrition, etc.)
- At UNC, nursing and allied health students take two semesters of A&P coursework, listed in the catalog as BIO 245 (Introduction to Human Anatomy and Physiology) and BIO 246 (Advanced Human Anatomy and Physiology)

Problem:

- High DFW rate [1].
- Deficit of existing research establishing best pedagogical practices in A&P classrooms, especially undergraduate mixed-majors A&P classrooms with both pre-nursing and allied health students

Overall Purpose:

- To design and implement a learning theory-laden educational intervention, Problem-Based Learning (PBL), in the novel context of undergraduate anatomy and physiology classes at the University of Northern Colorado.

What is Problem-Based Learning (PBL)?

- Students are presented with an ill-structured problem and are tasked to collaborate with each other to find a solution
- This process builds metacognitive problem-solving skills and systems thinking skills that can be applicable outside of the classroom

What Does Our PBL Look Like?

- Extended (multi-week) case study investigating a hypothetical patient's illness
- Students must distill multiple pieces of clinical and environmental information, leverage their understanding of the human body, and research relevant resources to make conclusions and diagnoses about a hypothetical patient.

Research Questions

RQ1: How do student attitudes relate to learning outcomes?

RQ2: Is Problem-Based Learning an effective pedagogical tool to improve systemic thinking and learning outcomes for undergraduate nursing and allied health students in anatomy & physiology?

Methods

Participants: Participants were students in BIO 246 labs from the Spring 2019 (n = 30) and Fall 2019 (n = 105) semesters (comparison pedagogy semesters), and the Spring 2020 (n = 20) semester (first in which we implemented the PBL).

Data Collection: We chose quantitative measures for Learning Outcomes, Student Affect, and Systems Thinking. These were collected during lab meeting times via a pre-test survey at the beginning of the semester, a post-test survey on the last week of lab, and class assignments collected from instructors throughout the semester ("Measures" section of poster).

Design-Based Implementation: Design-based research is characterized by iterative revision and implementation of changes within learning environments.

- During the Spring 2019 semester we assigned weekly concept maps to be completed in-class. After reviewing student feedback, we created a Concept Mapping Workshop to train students how to make concept maps, and then used the maps as formal assignments starting in the Fall 2019 semester.
- We then implemented the PBL during the Spring 2020 semester. In lieu of other assessments from the comparison pedagogy semesters, three PBL Case Reports were assigned.

Analysis: Paid student research assistants are coding the complexity of the concept maps based on types of components. When data collection is complete, we will build regression models with all survey factors to predict course and learning outcomes, and we will compare learning gains and concept map complexity gains between the comparison and PBL intervention cohorts.

PBL Activity

Task: Students are tasked with investigating a "Case Report Scenario," where they must collaborate in a group of 3 to 4 students to help diagnose and treat a hypothetical patient. Each week they will participate in a synchronous group discussion (either virtually or on-campus, depending on course delivery method) where they will take on a specific Student Role (described below) within their group, interpret medical test results, research clinical and physiological concepts, and answer questions to aid with their investigation.

Timeframe: 6 weeks total; One 30-40-minute synchronous group discussion per week (either face-to-face in lab or via Microsoft Teams online, depending on course delivery method), accompanied by 30-40 minutes of asynchronous individual research.

Student Roles: The student Roles that you will assume during the weekly synchronous group discussions include Scribe (record keeper), Researcher (investigates questions), and Facilitator (manages time and flow of discussion).

- All Group Members:** All group members should contribute to discussion and answering questions. It is expected that: Each group member signs into Microsoft Teams during your decided group time; each member contributes to Guiding Question answers and at least one Research Question per week
- Facilitator (1 student):** The main role of the facilitator is to keep everyone on track during the group work time. This includes designating time at the beginning of the discussion to review everyone's at-home work from the previous week, confirming that all Guiding Questions and Research Questions that came up during discussion are assigned to group members to research at home for the following week, and keeping track of time to make sure the discussion moves along in a timely manner.
- Researchers (1-2 students):** As questions arise during discussion, these are the students largely responsible for using the computers to look up information and share it with the group. This includes resolving questions relating to Guiding Questions as they arise and presenting Research Question Responses.
- Scribe (1 student):** The scribe is responsible for writing the Weekly Progress Notes for the day and e-mails the notes to everyone in the group. You may use the Weekly Progress Notes Template, or format it on your own with all the components listed under Weekly Progress Notes in the rubric. Acting as the scribe includes writing down Guiding Question Responses, summarizing presented Research Question Responses, and keeping records of general notes and questions that arose during the discussion.

Example Weekly Work-Flow: For each weekly synchronous group discussion, groups may choose to structure the time/work-flow based on the specific needs of the group. However, an example breakdown of time may look like this:

Time	Activity
~10 minutes	Wrap-up from previous week by reviewing previous week's progress, Research Questions answered at home, and any unanswered Guiding Questions from previous week. During the first week, this time will be used to complete the Group Work Agreement and to study the patient's history and medical charts given in the Case Scenario.
~10 minutes	Begin current week's Guiding Questions.
~8 minutes	Discuss potential diagnoses/directions of inquiry/gaps in knowledge and identify further Research Questions.
~2 minutes	Assign Research Questions and any unanswered Guiding Questions to different group members to be answered asynchronously at home.

Measures

Learning Outcomes: Used to assess undergraduate students' conceptual understanding of physiology

- Final course grades
- Laboratory entrance quiz grades
 - 12 quizzes total out of 15 points each
- Homeostasis Concept Inventory (HCI) [2]
 - 20 questions: 10 Applied question and 10 Abstract questions

Student Affect:

- Biology Motivation Questionnaire (BMQ-II) [3].
 - 25 item Likert scale
 - Used to surveyed students about their sources of motivation
- Motivated Strategies for Learning Questionnaire (MSLQ) [4]
 - 61 item Likert scale
 - Used to assess students' self-regulation and learning strategies

Systems Thinking: Systems thinking refers to the ability to think about the interactions among the parts and whole of a network, including hierarchical and time-bound relationships, such as those present in physiological systems

- Lawson Classroom Test of Scientific Reasoning (CTSR) [5]
 - Used to examine the level of systems thinking students had coming into the course.
- Concept Maps:
 - 5 collected per student
 - While these received a grade from the Graduate Teaching Assistant, we are currently coding the maps from to further assess components of their complexity and validity

Student Demographics:

- We collected self-reported data on students' gender identity, racial/ethnic heritage, first generation student status, pre-requisite course completed, and major.

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Assessment: The multi-week investigation will culminate in the write-up of a Case Report, which will have 4 components. A brief description of each Case Report component is as follows:

- Guiding Question Responses:** A new list of **Guiding Questions** are posted each week for your group to answer. Your Case Report will include the answers for **all** of the Guiding Questions.
- Research Question Reports:** Students generate **Research Questions** on topics they would like to understand better in order to better interpret the symptoms or laboratory results of their hypothetical patient. While some research questions are simpler than others, the Research Question Reports that student choose to turn in should (1) include a written explanation, (2) include an original diagram of the entire system, (3) focus on a physiological mechanism, and (4) cite the sources used to create the Report.
- Weekly Progress Notes:** Include they **Scribe's Notes** from each week of the PBL.
- Patient Communication:** Contains student conclusions and rationale about the diagnosis, prognosis, and treatment plan for the given case. Instruct students to imagine they are the practitioner delivering their conclusions to the patient.

Findings

Finding 1: BIO 246 students are highly motivated.

- The majority of reported scores were at the upper anchor of the metric across all motivation subscales (Grade, Career, Self-efficacy, Self-determination, and Intrinsic Motivation).
- Students who report higher levels of self-efficacy and self-determination at the beginning of the semester tend to receive higher final grades (respectively, $r = 0.18, p = .026$; $r = 0.18, p = .023$).

Finding 2: Students with structured learning strategies fare better in BIO 246.

- Across all cohorts, students who tended to receive a higher final course grade in BIO 246 also reported that they...
 - ...Stay engaged despite distractions (Effort Regulation; $r = 0.39, p < .0001$)
 - ...Manage their studying time and space (Time and Study Environment; $r = 0.33, p < .0001$)
 - ...Monitor their learning progress (Metacognition; $r = 0.19, p = .022$)
 - ...Organize the information they need to learn (Organization; $r = 0.17, p = 0.034$)
 - ...Use rehearsal study strategies (Rehearsal; $r = 0.17, p = .042$)
- Students who report low levels of test anxiety also tend to have an overall higher final grade ($r = -0.29, p = .0003$).

Finding 3: The HCI may not be sensitive enough to capture learning over one semester.

- In the comparison cohorts, students did not score differently on the HCI at the end of the semester compared to their pre-test scores (paired t-test: $p = .223$).

Finding 4: PBLs may support the learning of physiology for undergraduate students.

- Our initial results indicate that these students, unlike those in the comparison cohorts, did significantly improve on the HCI (paired t-test: $p = .019$).
- The S20 cohort on average had a larger gain in HCI score between the pre- and post-test compared to the comparison cohorts ($M = 1.3$ and $M = 0.2$, respectively), though this difference was not statistically significant (unpaired t-test: $p = .064$).

Next steps...

- Analyze the concept maps more deeply to investigate changes in systems thinking across all cohorts.
- Add peer review and individual contributions elements to the Case Report assessment
- Dissemination:** PBL activities and are in preparation and under review for publication in *Course Source*, which is an online collection of peer-reviewed undergraduate biology curricula. Additionally, we are preparing a manuscript about these findings that will be submitted to the peer-reviewed journal *Advances in Physiology Education* by the end of Fall 2020

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