Work in Progress - Assessing Adaptive Expertise in Physiology Using Online Challenge Modules in Biofluids

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Abstract – The approaches biomedical engineering programs use to meet ABET criteria related to physiology vary. This study will test approaches to teaching physiology based on mathematical approach (quantitative vs. qualitative) and the way the content is structured (concepts-based vs. systems-based). After completing a physiology learning module presented in one of four ways: Quantitative, Concepts-based; Quantitative, Systems-based; Qualitative, Concepts-based; or Qualitative, Systems-based, participants will be observed collaborating on a challenge-based learning module centered on a topic in biofluids. Adaptive expertise in physiology will be assessed by observing how participants transfer the physiology content they have acquired. The learning management system Moodle™ and online virtual world Second Life™ are used to create a rich environment for data collection.

Index Terms – Engineering education, Assessment, Physiology, Online learning

INTRODUCTION

Unique among engineering disciplines, biomedical engineering programs must meet ABET criteria related to physiology. Programs utilize different approaches and strategies to satisfy the ABET criteria. Some require students to take physiology courses taught by engineering faculty. In other programs, students are referred to courses in life science departments. Non-engineering physiology courses tend to be qualitative in nature, requiring minimal mathematics background and skills on the part of the student. Physiology courses taught by engineering departments typically have a quantitative slant. Students may use calculus and differential equations in problem-solving. Physiology courses for biomedical engineers can also differ in the way content is structured. In most courses physiology content is structured around human organ systems (e.g., cardiovascular, digestive) exploring one system before moving to the next. An alternative approach is to structure the course around concepts (e.g., homeostasis, bioelectricity) and explore the physiology systems as they relate to these concepts. Researchers have been asking what topics should be taught to biomedical engineers [1]. A goal of this research is to address the question "How do we best teach these topics?"

STUDY DESIGN

This study experimentally evaluates how mathematical approach to teaching physiology and the structure of course content affect the way engineering students transfer physiology knowledge when learning subsequent BME topics. The physiology content required to allow participants to effectively engage in a challenge module related to a biofluids topic was determined and parsed in four ways (Quantitative, Concepts-based; Quantitative, Systems-based; Qualitative, Concepts-based; and Qualitative, Systems-based). Online learning modules were created using the open-source learning management system Moodle™ [2]. The dependent variable in the study is adaptive expertise in physiology measured as a linear combination of factual knowledge, conceptual knowledge and transfer (i.e., extension of knowledge to a new situation). A challenge-based learning module has been designed to test how participants use their new physiology knowledge as they solve a challenge related to biofluids.

ASSESSING ADAPTIVE EXPERTISE IN PHYSIOLOGY

Adaptive expertise is an outcome measure that has been useful in assessing student development in many biomedical engineering subdisciplines [3-4]. Viewing learning as the process of developing adaptive expertise fits the model of viewing transfer as preparation for future learning [5]. Adaptive experts flexibly use knowledge in new situations to modify existing procedures or invent new ways to approach a novel problem. A metric has been generated to assess adaptive expertise in the biomechanics domain that includes measures of learning gains in factual knowledge, conceptual knowledge and transfer [4]. In this study, these three components of physiology knowledge will be assessed from data collected while participants complete a collaborative challenge module created around the STAR.Legacy cycle (Figure1).
Engineering students who have completed at least two semesters of calculus and have not taken a college-level or AP physiology course will be randomly assigned to one of the four physiology training modules. Each participant will collaborate on the challenge module with two other study participants. The following challenge is presented: “You are one of a small group of interns working at the Zumahavi Wildlife Park. The park has just received word that they are about to receive a large donation from Thurston and Lovey Howell to build a new habitat for the giraffes in the park. There is one slight problem. Lovey Howell is reluctant to give the money to Zumahavi because she is concerned about the welfare of the giraffes. She insists that water troughs for the giraffe habitat be placed 12 feet in the air so the giraffes do not have to lower their heads to drink. It is up to the interns to present scientific evidence to convince Mrs. Howell that placing water at head level for the giraffe is not necessary as the giraffes will not be distressed when they bend their heads to drink.”

The online learning module guides the participant through the phases of the STAR.Legacy cycle. There are many assessment opportunities, formative and summative, inherent in the STAR.Legacy cycle. With discussion forums in the learning module and a virtual conference room, study participants can be observed collaborating to generate ideas about the challenge and test their hypotheses. In the online virtual world Second Life™ participants use avatars to meet together in real time [6]. These collaborative learning experiences can be observed and automatically transcribed providing a rich basis for qualitative data collection. Moodle™ has tracking features that allow the individual participant’s progress to be monitored as they work through the learning module. Short, interactive assessments let the researcher pose targeted questions to collect data related to the different aspects of the variable of interest.

In the Giraffe Challenge, with the online conference room, the cohort of participants can be observed brainstorming to generate ideas to solve the challenge. The researcher can trace how each individual participant navigates the Moodle™ lessons that present additional information about giraffe physiology and the anatomical nature of the challenge problem. The length of time spent on individual activities can be recorded. The online data collection environment will allow collection of more information than a series of quantitative scores can provide. The rich qualitative data collected in this study will begin to paint a picture of how engineering students build upon their prerequisite physiology knowledge to learn topics in subsequent biomedical engineering courses. Biomedical engineering education can be improved as more is discovered about how engineers learn.

REFERENCES