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Investigating the effectiveness of case studies in improving student learning in a 200-level Anatomy course

Jenifer Saldanha
Iowa State University, jenifers@iastate.edu

Karri Haen
Iowa State University, khaen@iastate.edu

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Abstract
Case studies have been established as an effective teaching tool in a number of disciplines, including science, technology, engineering, and mathematics. They encourage team work, constructive thinking and the application of concepts in the classroom. In this study we investigated the effectiveness of case studies in a 200- level anatomy course that employs the large lecture format of instruction. The results from this study improve our understanding on the usefulness of this approach, and also inform the future utilization of case studies in similar classes.

Keywords
STEM, Case study, case studies, Anatomy, Large Lecture, Human Anatomy, Science Education, Education Research

Disciplines
Anatomy | Educational Assessment, Evaluation, and Research | Educational Methods | Science and Mathematics Education

Investigating the effectiveness of case studies in improving student learning in a 200-level Anatomy course

Jenifer Saldanha, Karri Haen Whitmer
Department of Genetics, Development, and Cell Biology, Iowa State University.

Abstract

Case studies have been established as an effective teaching tool in a number of disciplines, including science, technology, engineering, and mathematics. They encourage team work, constructive thinking and the application of concepts in the classroom. In this study we investigated the effectiveness of case studies in a 200- level anatomy course that employs the large lecture format of instruction. The results from this study improve our understanding on the usefulness of this approach, and also inform the future utilization of case studies in similar classes.

Introduction

Efforts in recent years in Science, Technology, Engineering and Mathematics (STEM) disciplines have focused on creating an inquiry driven environment in the classroom that is interactive and collaborative (American Association for the Advancement of Science [AAAS], 2009; Woodin et al., 2009). Introductory and lower-level undergraduate courses often cover a huge amount of basic information, which might leave students overwhelmed and unable to make to synthesize concepts. One approach that counteracts this problem is the use of case studies in the class room (Herreid, 2007). Educators in a variety of fields including law, business and marketing, medicine, psychology have long used case studies or problem based learning to teach the application of important concepts (Herreid, 1994; Herreid, 2007; Lee et al., 2009; Bowe et al., 2009). Case studies can be used in a variety of formats, and range from detailed and complex scenarios to simple stories (Herreid, 1994; Herreid, 2007; Lundeberg 2008). Case Studies have also gained popularity in the STEM classroom in the last two decades for a number of reasons. Importantly, they present relatable scenarios in a story-like format, they encourage interactions, critical thinking the use of analytical and problem-solving skills (Herreid, 2007; Barry and Yadav, 2007; Lundeberg 2008).

The 200-level Human Anatomy course we worked with is a survey course which involves a lot of information and memorization of names and structures. The purpose of this course is to provide students with the basic knowledge of human anatomy and it's functioning. Unfortunately, students often resort to rote memorization for the exams and fail to make connections between the material they learn and their everyday lives. To address this issue we chose to adopt the case study method. We hypothesized that asking the students to solve short, real-world problems would help them better understand and synthesize the concepts taught in the course. Through the case studies we also aimed to encourage critical thinking, the tying together and application of concepts and to help students appreciate the nature of science.

Methods

We developed case studies based on current medical research that applied to the topics covered in each unit of the human anatomy course. The content covered in each unit and the focus of the related case studies developed has been summarized in Table 1. The questions created were directly applicable to everyday decisions and health concerns, and were designed to be simple enough for 200-level students. The questions also covered different levels of Blooms taxonomy to allow students the opportunity to identify, apply and connect multiple concepts from the unit. These case studies were used in a class of 216 students, which was the smaller of two sections. The larger section used a case study approach which was different from the one described here, therefore data from this section could not be used as a true control. The case studies and

questions were made available to the students at the start of each unit and students answered the questions in the classroom using clicker technology.

Certain questions from the case studies were also included on the exams to encourage student participation and learning. Pre and post content knowledge tests were administered to assess content-based learning gains. At the end of the semester students were also asked to provide their perceptions on the effectiveness of the case studies.

Table 1: The case studies were designed to address the content in each unit. There were a total of 5 case studies that were administered to the section of 216 students.

Unit	Content	Case Study Focus
1	Cells, tissues, integumentary system and development	Squamous cell carcinoma & tissue grafting
2	Cartilage, bones, skeleton, and muscles	"Bio-bots" made of human muscle cells
3	The nervous system and general and special senses	The ALS ice bucket challenge
4	Blood, Heart & Circulation; Lymphatic and Respiratory System	Bacterial plaques and heart attacks
5	Endocrine, Digestion, Urinary Systems and Reproduction	Gut microbiota and obesity

Results and Discussion

A majority of the students enrolled in this course because it was a requirement for their program. As seen in Figure 1, a strong shift was seen towards the correct answers after taking the course indicating improvement in student's content knowledge. This was encouraging since the questions used for this test were tied to several important concepts and a few common misconceptions often encountered.

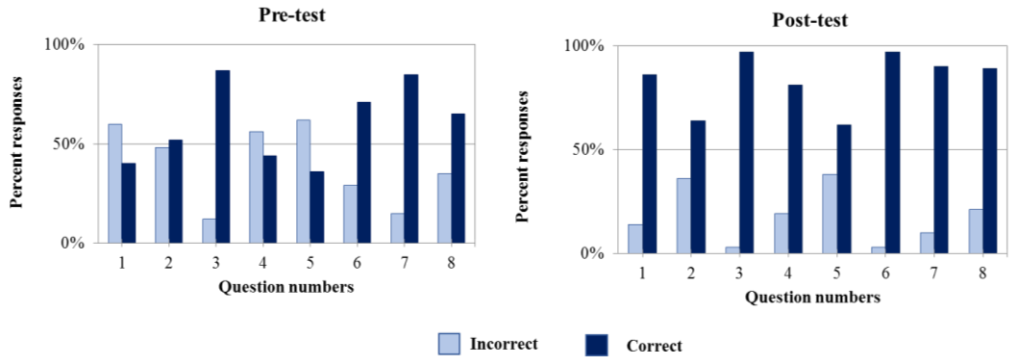

Figure1: Course Pre and Post content knowledge tests
Percentages of students who selected correct (dark blue) and incorrect (light blue) answers in the pre and post content knowledge test (n=216). Students showed positive gains in their content knowledge at the end of the semester.

Students also reported largely positive perceptions about the use of case studies in the classroom. Figure 2 shows results from two of the seven prompts that were presented to the students. They reported that case studies did have an impact on their learning and that the case studies made them link and apply concepts from different chapters in the units. These results were encouraging and indicate that students were receptive to the use of case studies in the classroom.

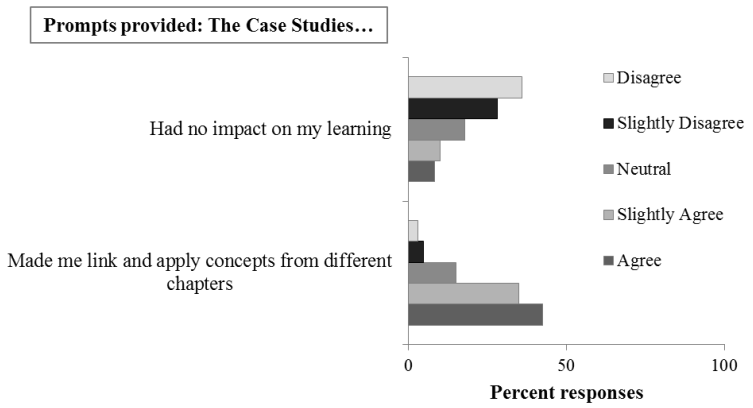

Figure 2: Influence of case studies on student interest and learning
Student perceptions about the case studies were very encouraging. Pre survey: 518 students; Post survey: 475 students.

Student responses to qualitative questions about the usefulness of the case studies were also collected. Positive responses included: "*enjoyed the case studies"; "helped me understand/apply concepts"*. Neutral and negative responses included: *"no change in interest"; "Did not learn much"; "Confusing sometimes."* These responses highlight the variety of student perceptions. They also illustrate that while there were positive responses, there is a lot of room for improvement in our approach.

Conclusions and Future Directions

Increase in student's content knowledge was observed suggesting effectiveness of teaching methodologies. Also, student perceptions about the case studies were mostly positive. The qualitative feedback received contained useful, constructive criticism, and the case studies themselves have the potential to be improved. Future directions include using more of the higher Bloom's level questions, and utilizing alternate approaches to administering the cases in large classrooms. The assessments used could also be modified to better gauge student perceptions and learning gains, and previously validated instruments could also be incorporated. Case studies are a very useful teaching tool, and there are a number of positive reasons to incorporate this strategy in the classroom (Herreid, 2007; Yadav et al., 2015). Research in the field continues to focus on establishing the efficacy, and challenges of this approach in different disciplines including STEM.

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