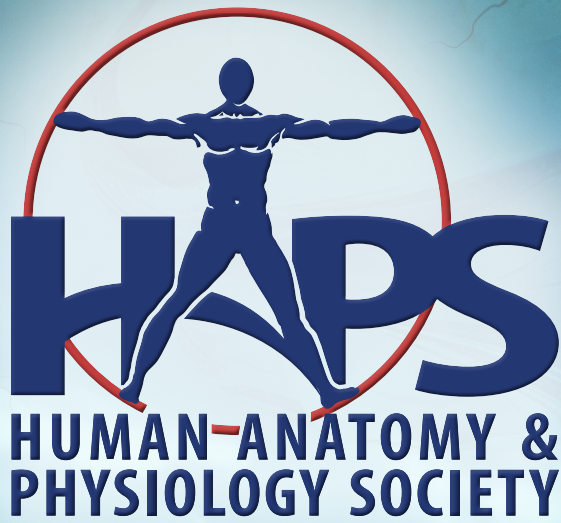


Established in 1989 by Human Anatomy & Physiology Teachers



COMMEMORATIVE
CONFERENCE EDITION

EDUCATOR

Journal of the Human Anatomy and Physiology Society

SPECIAL EDITION • AUGUST 2020

MAY 23 - 27, 2020
OTTAWA, ONTARIO

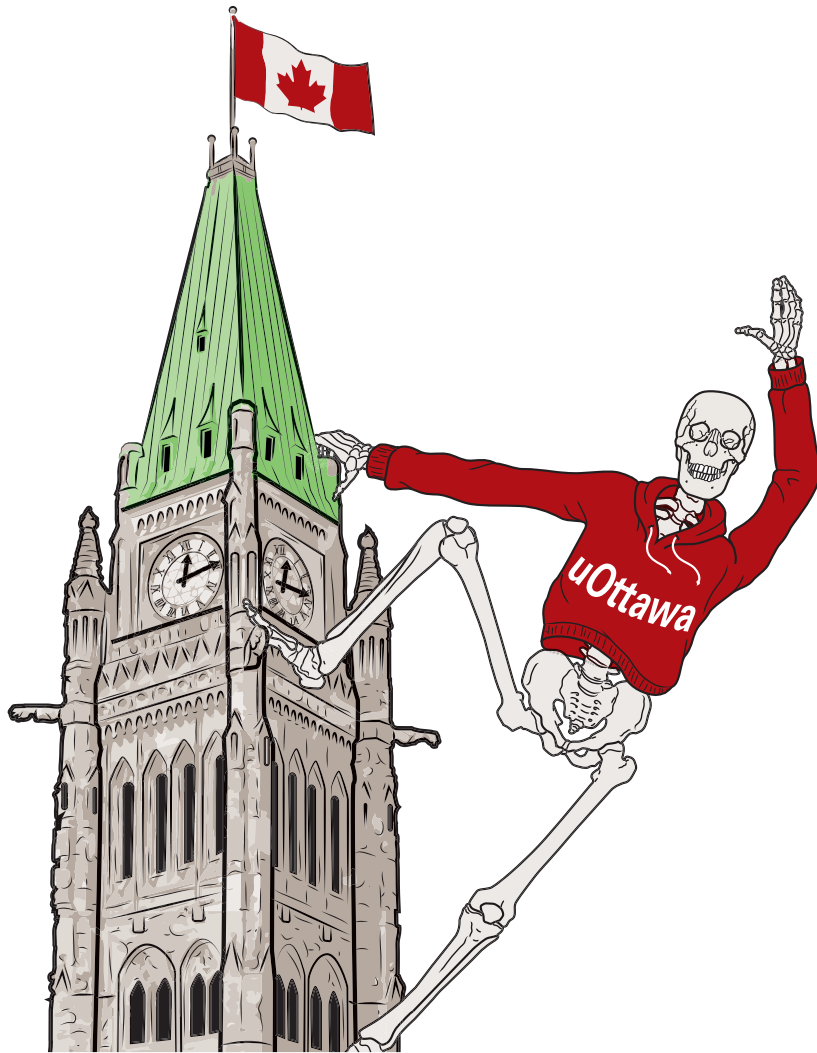


HAPS OTTAWA
2020 ONTARIO
CANADA

Promoting Excellence in the Teaching of Human Anatomy and Physiology

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HAPS 34TH ANNUAL CONFERENCE
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SPECIAL CONFERENCE EDITION

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The *HAPS-Educator*, *The Journal of the Human Anatomy and Physiology Society*, aims to foster teaching excellence and pedagogical research in anatomy and physiology education. The journal publishes articles under three categories. Educational Research articles discuss pedagogical research projects supported by robust data. Perspectives on Teaching articles discuss a teaching philosophy or modality but do not require supporting data. Current Topics articles provide a state-of-the-art summary of a trending topic area relevant to anatomy and physiology educators. All submitted articles undergo peer-review. Educational Research articles will additionally be reviewed for the quality of the supporting data. All issues of the *HAPS Educator* are freely available, and individual articles are uploaded to the Life Science Teaching Resource Community (and link to <https://www.lifescitrc.org/>) and available in the Education Resources Information Center (ERIC).

The *HAPS Educator* is published in April, August and December. The deadlines for submission are March 1, July 1 and November 1.

Submission Guidelines for Authors

Information for authors on the terms of submission, the submission procedure, formatting the manuscript, formatting the references, the submission of illustrations, and the peer review process, is available [HERE](#).

Submission Link

Use the [Manuscript Submission form](#) for *HAPS Educator* submissions.

You do not need to be a member of the Human Anatomy and Physiology Society (HAPS) to publish in the *HAPS Educator*. For more information see the complete submission guidelines using the link above.

Human and animal research subjects

Research that includes dissection and manipulation of animal tissues and organs must adhere to the Human Anatomy and Physiology Society (HAPS) [Position Statement on Animal Use](#), which states that the use of biological specimens must be in strict compliance with federal legislation and the guidelines of the National Institutes of Health and the United States Department of Agriculture. The use of humans or animals in research must fulfill clearly defined educational objectives.

Experimental animals must be handled in accordance with the author's institutional guidelines and informed consent must be obtained for studies on humans. It is the responsibility of the author(s) to secure IRB approval for research on humans.

Plagiarism

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LETTER FROM THE EDITOR



Welcome to the Special Conference Edition of the HAPS Educator!

The COVID 19 pandemic has changed the educational landscape for all of us as we head into fall, working hard to develop our online teaching approaches and to find innovative ways to maintain student engagement outside the classroom. One key disruption for HAPS members was the cancellation of HAPS 2020 that was to be held this year in Ottawa, Ontario. I was so looking forward to welcoming all of you to our city and having the University of Ottawa host our workshops. Abstracts had been submitted and accepted, workshop rooms had been identified, and music lined up for our social activities. Even the fun run had been mapped and an outdoor yoga session planned! Then borders closed, travel was restricted, and we had to rethink what to do. Peter English and Brittney Roberts did a terrific job of bringing HAPS members together virtually to share their experiences, link to online presentations by our exhibitors, participate in the annual business meeting, and to experience four wonderful update seminars. But, there remained still more to be done.

This Special Conference Edition of the HAPS Educator was developed in an effort to salvage the hard work put in by HAPSTERS as they wrote their poster abstracts and planned their workshops and to also provide some helpful guidance for all of us as we move into new ways of educating our students and assessing their learning. As you move through these pages, you will find links to those four wonderful update seminars provided by Anne Burrows, Peter Ward, Barbara Vanderhyden and Nadia Abu-Zahra and a manuscript about educational outreach written by the six graduate students who were to participate in our planned Synapse Session. You will next encounter workshop abstracts as well as several invited manuscripts from abstract authors whose workshops targeted the Conference theme of Extending Boundaries. Covering topics such as online learning, diversity, and inclusion and outreach, these manuscripts may well provide you with some innovative ideas for the upcoming academic year. This edition finishes with the poster abstracts, a final manuscript from Derek Scott discussing the use of infographics in education, and then thirty examples of poster infographics provided by some of you.

I would be remiss if I didn't give a big thank-you to the workshop authors who worked busily during June and July to quickly write and revise their manuscripts in time for this special edition. And a huge thank-you to our overseeing editors, our managing editor, Sarah Cooper, and our graphic designer, L. Katie Roberts, as well as our reviewers who worked hard during the summer months to make the special edition happen.

I wish all of you the very best as we welcome back our students, either virtually or in person, and head into a new academic year that will certainly present challenges. We will develop new ways of teaching and engaging our students as they strive to reach their academic goals. I hope that the provision of teaching ideas from HAPS members via this Special Conference Edition of the HAPS Educator will prove helpful to all of you as we move forward.

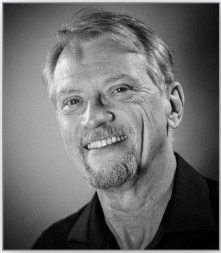
All the best,

Jackie Carnegie,
Guest Editor-in-Chief for the Special Conference Edition of the HAPS Educator

HAPS COMMITTEES AND 2020-2021 COMMITTEE CHAIRS

HAPS uses committees to further the goals and strategic vision of the Society. Below please find a brief description of each committee's role as well as the current committee chair. New members are always welcome – please contact a committee chair if interested. More information about committees can be found on the [Committee Home Page](#) on the HAPS Website.

STANDING COMMITTEES



2021 Annual Host Committee

Mark Danley

This committee is in charge of coordinating the 2021 Annual Conference to take place in Albuquerque, New Mexico.



Conference

Jennifer Burgoon

This committee actively encourages HAPS members to consider hosting an annual or regional conference. We provide advice and assistance to members who preparing to host a HAPS conference.



Awards & Scholarships

Chasity O'Malley

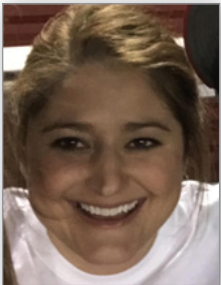
This committee administers HAPS awards and scholarships that promote excellence in the teaching of human anatomy and physiology.



Curriculum & Instruction

Rachel Hopp

This committee develops and catalogs resources that aid in anatomy and physiology course development and instruction.



Cadaver Use

Kelsey Stevens

This committee is charged with developing, reviewing and recommending policies and position statements on the use of cadavers for human anatomy and physiology education in colleges and universities.



Diversity, Equity & Inclusion

Kathy Burlison

This committee develops best practices, resources, and professional development opportunities for inclusive education in anatomy and physiology, and advocates for and ensures inclusive practices within the organization and at HAPS events.



Communication

Anthony Edwards

This committee is tasked with supporting other HAPS committees and the HAPS Strategic Plan, recruiting members via social media, and helping HAPS establish its voice in a digital landscape shaped by social media, email and blogging.



Fundraising

Stacey Dunham

This committee organizes fundraising activities, especially at the Annual Conference. Fundraising, by affecting what activities can fill the interstitial spaces of our more formal meetings, plays an important role in supporting the sense of community for which HAPS is recognized.



Safety & Animal Use

Richard Simons

This committee develops standards for laboratory safety and maintains a variety of safety documents available for download. The committee also promotes responsible live and preserved animal use in anatomy and physiology education.



Steering

Cindy Wingert

This committee consists of all committee chairs. It coordinates activities among committees and represents the collective committee activity to the HAPS Board of Directors.

SPECIAL COMMITTEES AND PROGRAM LEADS



Executive

Wendy Riggs

This committee is composed of the HAPS president, President Elect, Past President, Treasurer and the Secretary. It governs the Society and sets policy.



Finance

Tracy Ediger

This committee reviews financial reports and management policies for HAPS.

Exam Program

This committee completes, tests and approves HAPS exams for Human Anatomy and Physiology, both as paper versions and exams to be administered online.



Valerie O'Loughlin



HAPS Educator

Jackie Carnegie

This committee is responsible for publishing a quarterly edition of the HAPS Educator, the journal of the Human Anatomy and Physiology Society.



Dee Silverthorn



Nominating Committee

Kyla Ross

This committee is responsible for assembling a list of qualified candidates for election to the HAPS Board of Directors.



Janet Casagrand



Presidents-Emeriti Advisory Board

Judi Nath

This committee consists of an experienced advisory group including all HAPS Past Presidents. As well as advising, the committee adds a sense of HAPS history to deliberations of the Board of Directors.

HAPS 2020 AWARDS

The annual awards are administered through the HAPS Awards and Scholarships Committee and support the mission of the society to promote excellence in the teaching of human anatomy and physiology. This year seven different awards were offered and fifteen winners were honored.

While the 2020 HAPS Annual Conference could not be held in person, this Special Conference Edition of the HAPS Educator gives you the opportunity to learn about the award winner presentations through their submission of an abstract, infographic and/or manuscript.

THE SPONSORED AWARDS

The sponsored awards are made possible by three generous funding partners
ADInstruments, Wiley, and HAPS member John Martin.

Sam Drogo Technology in the Classroom

The **Sam Drogo Technology in the Classroom Award** is sponsored by ADInstruments in honor and memory of Sam Drogo, who was a devoted HAPS member, mentor and teacher. It is awarded to HAPS members for their innovative use of technology to engage students in anatomy and physiology. This year's award winners are:



Patrick Cafferty



Richelle Monaghan



Geoffroy Noel

Gail Jenkins Teaching and Mentoring Award

The **Gail Jenkins Teaching and Mentoring Award** is sponsored by Wiley in honor and memory of Gail Jenkins, who was an active HAPS member, a textbook author, and was also known for her creative teaching. It is awarded to a HAPS member who uses a teaching style similar to that of Gail's, including kinesthetic and active learning strategies and using inexpensive everyday props to help students understand and retain difficult A&P concepts. Award recipients also mentor other instructors to encourage their use of active learning. This year's award winner is:



Juanita Jellyman

John Martin Second Timer Award

The **John Martin Second Timer Award** is new for 2020 and is sponsored by long-time HAPS member John Martin. Award recipients must be HAPS members attending their second Annual Conference, allowing them to become more fully engaged with HAPS, to network with other HAPS members, and to give a presentation to share their teaching and/or research ideas. The award is open to both high school and college/university faculty. This year's award winners are:



Jennifer Adjodha-Evans



Heather Evans Anderson

THE HAPS AWARDS

The HAPS awards are made possible by donations from HAPS members. Thank you to all who donate to support the many activities of this society, including the HAPS awards.

The intent of these four awards is to recognize HAPS members who are gifted instructors by facilitating their attendance at the annual conference, so they will interact with other HAPS members and will share their teaching and/or research ideas by giving a presentation. Each of the awards focuses on a different group of HAPS members.

Robert B. Anthony Travel Award

The **Robert B. Anthony Travel Award** is named for the founder of HAPS, to whom we are all very grateful. The award recognizes full-time faculty during their first five years teaching anatomy and physiology. This year's award winners are:



Sarah Amugongo



Edgar Meyer



Jennifer Stokes

Full-Time Faculty Travel Award

The **Full-Time Faculty Travel Award** recognizes full-time faculty who have taught anatomy & physiology for more than five years. This year's award winners are:



Meaghan MacNutt



Krista Rompolski



Zoe Soon

Contingent Faculty Travel Award

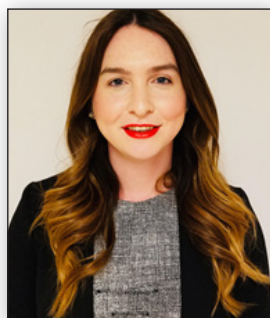
The **Contingent Faculty Travel Award** recognizes part-time faculty, temporary contract length faculty, and faculty who are teaching at more than one institution to achieve full-time employment. This year's award winner is:



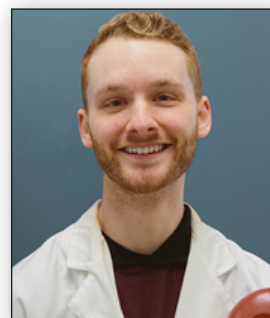
Laylonda Maines

Student/Postdoc Travel Award

The **Student/Postdoc Travel Award** recognizes full-time undergraduates, graduate students and postdocs. This year's award winners are:



Camryn Hawkins



Tyler Redway

UPDATE SEMINAR I

Anne Burrows

Sponsored by the American Association for Anatomy



Professor
Duquesne University
Pittsburgh, PA
burrows@duq.edu



Making Our Face – The Evolutionary Story of the Human Face

Abstract: Faces are ubiquitous throughout human history, being the focus of major works of art, literature, medicine, and scientific inquiry. The human face is highly specialized in both appearance and movement when we compare it to faces of other mammals. Faces are the primary way that we interact with daily life. We use faces in a variety of functions, especially in engaging in social interactions with other humans or with other mammals. Our faces are a record of the selective pressures that acted on our ancestors, but what were these pressures? How did the human face evolve to take on these highly specialized aspects in form and function? This address focuses on the evolution of the human face and the neurologic processing of faces, how our faces move from both physiologic and aesthetic viewpoints, and the role that faces have played during the co-evolution of humans and domestication mammals, such as the dog and horse.

BIO: Anne Burrows is a biological anthropologist focusing on human and primate evolution. Her research includes the intersections among comparative and evolutionary anatomy, functional morphology, and behavior. Most recently, her work has centered on primate teeth, the craniodental partnership, the primate and mammalian face, and the evolution of the domestic dog. Anne's Ph.D. anthropology is from the University of Pittsburgh and she has been a faculty member at Duquesne University since 2002 where she teaches gross anatomy. Some of her favorite things about being a scientist are working with students, both at the high school and undergraduate levels, and bringing her work to the public. When she's not doing science, she's typically being a mother to her two teenagers, hanging out with her family, walking dogs at her local shelter, or tending to the many animals in her own household.

Link to recorded seminar (copy and paste into your browser; you will need to login to the HAPS website once there and that will take you directly to the update video): <https://www.hapsweb.org/page/UpdateSpeaker1-AnneBurrows>

UPDATE SEMINAR II

Peter Ward

Sponsored by the American Association of Clinical Anatomists



Professor
West Virginia School of Osteopathic Medicine
Lewisburg, WV
pward@osteo.wvsom.edu



Pushing the Boundaries of Clinical Anatomy

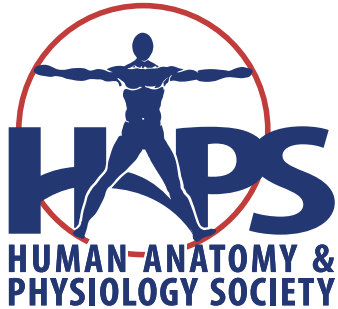
Abstract: Dr. Ward is the sponsored speaker from the American Association of Clinical Anatomists. He will provide an update about the many directions in which the AACA is pushing the boundaries of Anatomy by highlighting articles from the association's journal, *Clinical Anatomy*, as well as some of his own projects. While anatomy is often perceived as static, the boundaries of normal anatomy are being expanded as the importance of human variation becomes evident, seemingly well-described structures manifest different patterns of innervation, and even new cell types are described! The limits of clinical relevance are being broadened as under-appreciated structures like the suboccipital muscles and regional fasciae are shown to have clinical and functional importance. Institutional restrictions placed on anatomy teaching are being actively demolished as the anatomical sciences are integrated throughout the medical curriculum, including 3rd and 4th year electives. Lastly, the designation of anatomy as an exclusively scientific knowledge domain is being challenged. A sophisticated understanding of anatomy can help students (and faculty) generate new perspectives on history, art, culture, and movement arts; as well as providing new routes for assessment of student competencies outside of pure medical knowledge.

BIO: Dr. Peter Ward is a Professor of Anatomy at the West Virginia School of Osteopathic Medicine in Lewisburg, West Virginia where he has taught gross anatomy, histology, embryology, neuroscience, the history of medicine, and elective anatomy courses. He has received several teaching awards including the Basmajian award from the American Association for Anatomy and was selected as one of the five finalists for the West Virginia Professor of the Year in 2017. He has contributed to several texts, including *The Netter Collection: The Digestive System 2nd Ed.*, *Bergman's Comprehensive Encyclopedia of Human Anatomic Variation*, and recently began working on a musculoskeletal textbook for use in longitudinally-organized medical school curricula. He has served as chair of the curriculum committee, faculty council, and oversees the WCSOM plastination laboratory. He currently serves as the Association Secretary of the AACA, which is sponsoring his talk. Peter enjoys jujutsu, reading, and is extremely lucky to be married to Sarah Koressel, D.V.M. and is the father of two amazing, twin, 6-year-old sons.

Link to recorded seminar (copy and paste into your browser; you will need to login to the HAPS website once there and that will take you directly to the update video): <https://www.hapsweb.org/page/UpdateSpeaker2-PeterWard>

UPDATE SEMINAR III

Barbara Vanderhyden
Sponsored by HAPS



Senior Scientist
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Ottawa, ON
bvanderhyden@ohri.ca



Going Back in Time: Can We Reverse the Effects of Age and Other Risk Factors on Ovarian Cancer Incidence?

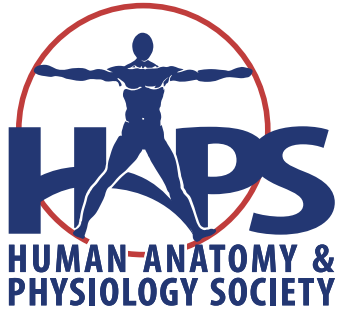
Abstract: In this talk, Dr. Vanderhyden will describe the serendipitous discovery while studying the effects of age on the structure of the ovary. The primary non-hereditary risk factors for ovarian cancer are age and the number of lifetime ovulations. These risk factors have been a long-standing conundrum because ovarian cancer incidence increases in postmenopausal women, with a median age of diagnosis of 63 years, long after ovulations have ceased. That observation suggests that ovulations leave behind changes in the ovarian structure that increase risk for cancer development. To determine how age and ovulation underlie ovarian cancer risk, she has assessed the effects of these risk factors on the ovarian microenvironment in mouse and human. Her study revealed novel evidence that ovarian fibrosis develops with age in women and correlates with immune and stromal features that are characteristic of a tumor-permissive niche. Interestingly, use of metformin, a drug commonly used to treat diabetes, was sufficient to abrogate both ovarian fibrosis and features of a tumor-permission niche, setting the stage for large-scale studies to investigate the efficacy of metformin use for ovarian cancer prevention.

BIO: Dr. Barbara Vanderhyden is a Professor of Cellular and Molecular Medicine at the University of Ottawa and a Senior Scientist in the Cancer Therapeutics Program at the Ottawa Hospital Research Institute. As the inaugural Corinne Boyer Chair in Ovarian Cancer Research, her research focuses on the factors involved in the initiation of ovarian cancer, and the generation of models that shed light on cancer susceptibility, tumor onset and progression. These models are also used in preclinical trials for the evaluation of novel therapeutic approaches, including targeted and immune therapies. Inspired by the creative talents of trainees, Dr. Vanderhyden enjoys incorporating the latest technologies into her research, most recently the use of single cell RNA sequencing to explore the phenotypic plasticity of epithelial cells. With a keen interest in enhancing the graduate student experience, she established two science outreach programs: Let's Talk Science, which brings science workshops to students in local schools, and Science Travels, which sends teams of grad students to deliver these workshops in the far north. To further enhance graduate student competencies, she developed and teaches a professional skills course on science communication. Dr. Vanderhyden is also a member of the Board of Directors of Ovarian Cancer Canada and is Chair of their Research Committee.

Link to recorded seminar (copy and paste into your browser; you will need to login to the HAPS website once there and that will take you directly to the update video): <https://www.hapsweb.org/page/UpdateSpeaker3-BarbaraVanderhyden>

UPDATE SEMINAR IV

Nadia Abu-Zahra
Sponsored by HAPS



Associate Professor
University of Ottawa
Ottawa, ON
nadia.abu-zahra@uottawa.ca



Inclusive Education: Fireside Chat about Ways in Which We Learn and the Development of Strategies to Promote Student Engagement and Inclusion

Abstract: The institutions in which we teach have many things in common. They recruit students in a process that relies at least in part on grades, they convey “content” and assess student retention of that content. Many of us have a vision for our institutions to be and do so much more, to be different from how they have been in the past and how they have come to be in the present. In this “fireside chat”, Nadia Abu-Zahra will share with Jacqueline Carnegie some of her efforts to promote learner-designed experiential learning and to foster a sense of belonging and relational accountability. We will explore notions like how and why we learn in an effort to move beyond grades, content, examinations, and hierarchies in our institutions, classes and professional relationships. We will think about who gets to be part of these institutions and who remains outside, and how learning can be open, inclusive, and toward a healthier life for all. We are not at the end of the journey, but we can share the travels so far!

BIO: Nadia Abu-Zahra currently holds the Joint Chair in Women’s Studies at Carleton University and the University of Ottawa. She is an Associate Professor in the School of International Development and Global Studies at the University of Ottawa, and a member of the Human Rights Research and Education Centre. She co-facilitates, with Professor Emily Regan Wills and project manager Diana El Richani, “Community Mobilization in Crisis”, a project that co-creates open educational resources with community mobilizers around the world in multiple languages and supports the use of the resources transnationally to build community mobilizations. She has a longstanding interest in pedagogy and learning and was a finalist for the Ottawa Network for Education’s Capital Educators’ Award. She earned her DPhil in Geography from the University of Oxford, and her MA from the University of Toronto in Geography, Environment and Health.

Link to recorded seminar (copy and paste into your browser; you will need to login to the HAPS website once there and that will take you directly to the update video): <https://www.hapsweb.org/page/UpdateSpeaker4-NadiaAbu-Zahra>

SYNAPSE HAPS!

This year's theme is diverse approaches to science educational outreach and how these experiences benefit not only those targeted by the outreach, but also the individuals leading it as well. Please join current graduate students and recent graduates as they share some of their outreach experiences.



Tyler H. Redway - Anatomy in Action: OSU x COSI

In conjunction with the Center of Science and Industry (COSI), the Division of Anatomy at Ohio State University College of Medicine has put together a workshop to pass students the stethoscope as they walk through the body systems. This hands-on workshop highlights anatomy as a crucial stepping

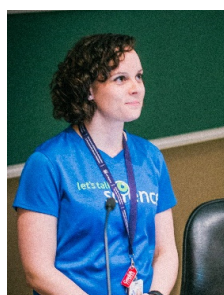
stone for the entire medical field and explores pathologies through clinical cases and hands on exploration of findings.



Kevin Steed - Anatomy Academy: Developing Service Learning to Develop Ourselves

Developing a service-learning program can have far reaching impacts for the population it seeks to influence, but as we discovered, the personal growth and development of the volunteers was equally profound. Join me as we examine the ways that this program has

impacted my life and career as well as other volunteers and participants over the years.



Pascale Robineau-Charette - Experiencing the Process: How to Get Smart Kids Into Research

At the high school level, students interested in biology and medicine tend to default to the medical school path, because their exposure to the research stream is limited. By focusing outreach activities on the process of research (rationalization of experiment, data

analysis, critical thinking) rather than the scientific knowledge, students experience and discover the skills and qualities required to be a researcher, gain respect for research and more easily consider it as a career.



Chloe Read - Educational Outreach in the Autism Community

Educational outreach through service learning in the autism community has profound effects on the young students volunteers connect with. I am a science teacher at a school for autism called Spectrum Academy whose students benefit tremendously from educational outreach. I would like to share my

firsthand experience and stories on how educational outreach benefits the students we all serve.



Renee Nelson - Beyond the Classroom: Engaging Indigenous Students in STEM

This presentation will discuss outreach strategies used to engage indigenous students in science, technology, engineering and math (STEM) fields and how it helps build confidence for students and educators inside and outside of the classroom.



David Cook - Opening the Doors to Cancer Research

While classroom science labs provide an opportunity for students to test specific scientific principles, these controlled settings often fail to capture realistic experiences of applied science. Opening the doors to academic research labs can excite students about topics beyond their curriculum and teach them

about tackling questions that lack clear answers. I will discuss my experiences of bringing high school students from all across Canada through our cancer research labs at the Ottawa Hospital Research Institute.

Science Outreach: Six Examples of Programs that Enrich the Learning Environments of Students and Educators

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Abstract

STEM-related educational outreach offers students enriching opportunities to become more familiar with science, in terms of how it relates to their daily lives and with respect to possible career paths that they might want to follow. At the same time, graduate student trainees providing that outreach act as important resources for elementary and high school teachers while they hone their teaching skills and build confidence in the classroom. In this paper, six graduate students and recent graduates share their experiences with a variety of outreach programs that link young people with science in both Canada and the United States. <https://doi.org/10.21692/haps.2020.107>

Key words: outreach, education, active learning, aboriginal, autism

Introduction

Educational outreach to K-12 students is increasingly becoming a responsibility welcomed by Canadian and American colleges and universities involved in providing STEM programs (science, technology, engineering and mathematics) at the undergraduate and graduate levels (Cao et al. 2019; Stieben et al. 2017). Outreach can take a variety of forms; it can be conducted by faculty and/or trainees and it has been linked to advantages, not only for the recipients of those educational opportunities, but also for their teachers and for the university personnel who are providing the enriched learning experiences (Laursen et al. 2007; Eng and Febria 2011; Clark et al. 2016; Stieben et al. 2017; Kumar et al. 2020).

One important goal of educational outreach programs that has been cited by those involved in its design and provision e.g. organizers of The Science Squad (Laursen 2007) and PhUn Week (Stieben et al. 2017)) is to familiarize young students with science. This is done not only by allowing them to become more aware of ways in which science links to almost everything in their everyday life but also by introducing them to scientific disciplines such as engineering and physiology as possible career goals. Some programs, such as Shadow a Scientist (Clark et al. 2016) and DiscoverE (Cao et al. 2019), encourage faculty to improve their ability to

communicate complex scientific concepts at a level suitable for the lay public.

Other programs, for example, Let's Talk Science (Eng and Febria 2011), PhUn Week (Stieben et al. 2017), and Present your PhD thesis to a 12-year-old (Clark et al. 2016), provide important opportunities for graduate students to build their communication skills and develop confidence as they plan interactive projects for their focus audiences, answer student questions, and/or enjoy the welcome experience of having these young people regard them as experts and potential role models. A final valuable component that should not be ignored are the benefits for the teachers of these young students. Networking with scientists and graduate trainees via outreach programs provides important opportunities for professional development and allows them to make long-lasting links with individuals in their communities who are involved in scientific research and/or education at the college or university level (Laursen et al. 2007; Stieben et al. 2017; Cao et al. 2019).

This paper will introduce the inner workings of six different outreach programs given by graduate students and recent graduates to young people in Canada and the United States, as described in their own words. These descriptions of

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educational outreach were initially planned to be a special update session at the 2020 Annual Conference of the Human Anatomy and Physiology Society. Since the conference was cancelled due to COVID 19, information pertaining to these programs is now being shared via this manuscript that forms part of the Special HAPS 2020 Conference Edition of the HAPS Educator. These programs have different goals, different target audiences and different STEM disciplines of focus [Table 1], but they share the common features of creating a welcoming and enthusiastic environment where students can learn by doing and where participation, be it as a learner or a teacher, provides important rewards.

Kevin Steed: Developing Service Learning to Develop Ourselves

Education has, at its heart, a profound potential to enact growth and change in both the student learner and the teacher. Many traditional teaching cognitive frameworks, such as Bloom’s Taxonomy, have mediated this change in students through a hierarchical ordering of learning categories (Bloom

1965; Anderson and Krathwohl 2001) that generally translate into pedagogical techniques and best practices. Building upon Bloom’s taxonomy, L. Dee Fink (2013) established a new paradigm (Figure 1) describing taxonomies of significant learning experiences that incorporate cognitive frameworks of human dimension (“why learning impacts my life”) and caring (“why my learning affects others”). Based on paradigms of active and significant learning, Anatomy Academy was established to address the public health concern of childhood obesity in 5th and 6th grade student populations (mentees). Through the service-learning platform, volunteer college student teachers (mentors) were given a unique opportunity to develop teaching skills such as content delivery, student engagement, classroom management and professionalism. It became apparent early on, however, that mentees experienced something more impactful than originally anticipated, which, in turn, inspired growth, and introspection within the mentors, leading to newfound career and life trajectories.

| Author | Outreach Program | Context | Location | Mentors | Mentees |
|---------------------------|------------------------------------|---|--|--|--|
| Kevin Steed | Anatomy Academy (Nutrition) | Childhood Obesity | California, USA | College Student Teachers | Students in Grades 5 and 6 |
| Chloe Read | Anatomy Academy (Autism Community) | Enrich Learning of Students on the Spectrum | Utah, USA | College Student Teachers | High School Students on the Autism Spectrum |
| Renée Baysarowich | Let’s Talk Science | Bring STEM to Remote Communities | Northern Ontario, Quebec and Nunavut, Canada | University Graduate and Upper Level Undergraduate Students | Indigenous Elementary, Middle and High School Students |
| Tyler Redway | Anatomy in Action | Promote STEM Research Possibilities | Ohio, USA | Center of Science and Industry Staff | Middle and High School Students |
| Pascale Robineau-Charette | Let’s Talk Science | Promote Interest in Biomedical Research | Ontario, Canada | University Graduate Students | High School Students |
| David Cook | Let’s Talk Science | Experience a Biomedical Research Lab | Ontario, Canada | University Graduate Students | High School Students |

Table 1. Summary of Outreach Programs.

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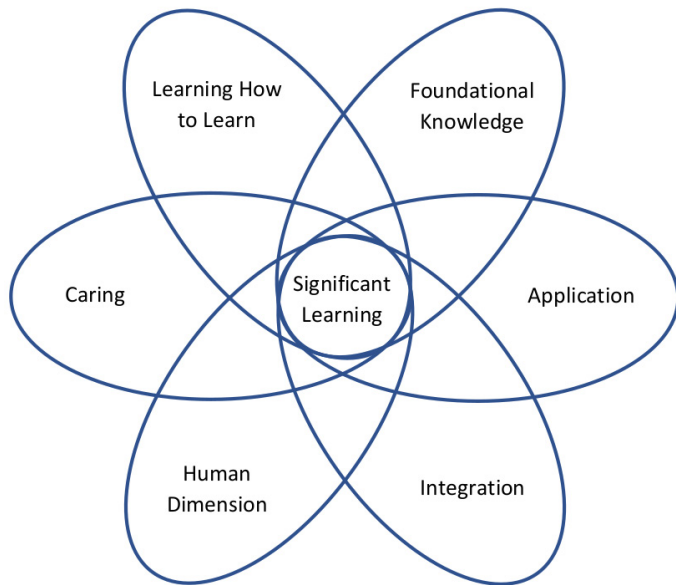


Figure 1. This schematic combines elements from Bloom's taxonomy with select personal components (human dimension, caring, and learning how to learn) and links them to a central focus of education, a significant learning experience. This arrangement highlights that learning in each of these categories is possible during the same significant experience. (adapted from Fink, 2013)



Figure 2. Students from Mana Academy Charter School enjoy the results of practicing their healthy cooking skills learned during Cooking Academy. All youth present in this photo had media releases signed by their parents or legal guardians. Mentors also provided signed media releases.

Laying the Groundwork

The service-learning program, Anatomy Academy, was developed by several public health and public policy agencies and medical graduate students under the direction of medical faculty, which gave the program a strong foundation in theory and research. With this foundation, pairs of mentors were given basic lesson plans covering anatomical and physiological systems of the body, which they expanded into active small group didactic sessions that consisted of four to eight students meeting for 20-25 minutes. This was followed by large group activities in which principles that were just learned could be applied in engaging and active games or tasks. The large groups consisted of 20-35 students meeting for 20-25 minutes. Lessons and activities took place in the mentee classrooms under supervision of their elementary school teachers (Figure 2).

The Anatomy Academy curriculum and workflow is flexible, affording the opportunity for hundreds of mentors from three local universities to tailor the provided lesson plans toward the specific and unique needs of two to three dozen elementary school sites each semester. As a result, a profound social impact was accomplished with thousands of mentees guided through the program since 2012. Survey responses were collected from mentees during and after the program. In their responses, mentees described changed behavior and an improved frame of mind concerning personal health, eating habits and choices, and activity levels. The mentors also experienced a significant impact, realizing their ability to make a difference in the world, understanding the importance of listening to students, and realizing that lives can change with "a little bit of love", in accordance with Fink's human dimension and caring taxonomies (Fink 2013).

Expanding and Changing

The benefit of a profoundly impactful program on the lives of mentors was their devotion to the teaching and learning philosophy in Anatomy Academy and investment in mediating social change through education. This was also evident in the large number of returning mentors, semester after semester, often assuming leadership and administrative roles as session leaders helping the program continue to grow and expand the service-learning opportunities for peers at their universities.

Additionally, based on their unique interactions and experiences with the mentees, some mentors saw gaps in the basic Anatomy Academy curriculum and worked to innovate the curriculum to include niche clusters of students with specialized interests. These interests included: developing a curriculum specifically for students on the autism spectrum (see Chloe Read: Anatomy Academy in the Autism Community), focusing a curriculum on the health and activity needs of dancers (Dance Academy), helping Pacific Islander families to prepare healthy meal options (Cooking Academy; Figure 2), and, devoting an entire semester

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to the musculoskeletal system with advanced mentees (Musculoskeletal System Anatomy Academy). Each of these expansions of the original program was developed because a mentor learned something new about themselves through their interactions with their mentees. In many cases, that realization caused a career trajectory shift in the mentor, whether toward medical sciences or toward a related field in education, because they had helped spark a flame of change in someone else, igniting a passion that they did not recognize before.

Chloe Read: Anatomy Academy in the Autism Community

K-12 students on the autism spectrum face challenges every day. These include learning challenges, health challenges such as obesity and food aversions, and socializing challenges such as difficulty making friends and behavior management. Educational outreach through the Anatomy Academy program helps address each of these challenges. The program empowers young students with autism in a unique and undeniably personal way. I have spent time both as a mentor in the Anatomy Academy program and as a high school science teacher inviting Anatomy Academy into my own classroom. Because I have these two perspectives of the program, I can attest that the benefits of Anatomy Academy are potent and enduring, not only for young students but also for the mentors for two reasons: mentors and mentees benefit from the formation of personal relationships and from sensory-rich, engaging learning experiences.

Personal Relationships

The true power behind Anatomy Academy's success with children on the autism spectrum lies in personal relationships. Typically, children with autism struggle socially, and Anatomy Academy provides a safe environment for children on the spectrum to develop crucial interpersonal skills. It is of utmost importance for mentors to foster a sense of trust and friendship before any sort of lesson is presented. Day one of Anatomy Academy is entirely devoted to getting-to-know-you conversations. This is done in a variety of ways, but the most successful strategy that I have observed in my classroom is a "speed-dating" set up, where mentors have five minutes with a student to chat, joke around, draw pictures, or whatever else the student is inclined to do. Once the five minutes is up, mentors rotate to a new student. This way, students get one-on-one time with each mentor without going through the stress of changing locations. Later, the mentors discuss which student they formed the best connection with and will then partner off with that particular student for all of the following weeks. Ideally, there is a 1:1 ratio of mentors to students in an autism classroom.

The bonds that are formed during Anatomy Academy are strong. For example, one of my past students had selective mutism: she had a very difficult time talking to anyone other than her own family members. When our class began Anatomy Academy, she was completely silent during the "speed-dating" rotations. The mentors tried their best to engage with her without getting much in return. One mentor, though, noticed doodles in her notebook. The mentor took out a piece of paper and started drawing her own pictures, and after a while the student drew more pictures in response. The mentor and the student silently doodled back and forth to each other, and kept at it even after the five minutes were up. The "speed-dating" continued around them, but the student and the mentor were engaged in their doodles until the end of class. This mentor continued to work with the selectively mute student week after week, and the doodles continued. This is how the mentor taught the heart valves and chambers, the mechanisms of breathing, the major muscle groups, and brain anatomy. Doodles eventually transitioned to origami, and they built 3D versions of the organs about which they had learned. They even created origami cats and speculated about how feline anatomy compared and contrasted with human anatomy.

This selectively-mute student learned more with her mentor during Anatomy Academy than I could teach her as a classroom teacher. She learned so much, but I consider the real win to be when she quietly spoke out loud to her mentor. Shockingly, by the time Anatomy Academy ended, the student was smiling, talking, and even laughing with her mentor. The relationship formed between the mentor and student proved to be powerful to the student's learning, social skills, and confidence. Relationships are crucial for educational outreach to be as successful as possible. As shown in this example, friendship with a mentor can encourage students to engage, learn, and improve both academically and socially.

Sensory-Rich Engaged Learning Experiences

Active learning is important in all types of classrooms, but I would argue that active learning is absolutely crucial in autism classrooms. Many students on the spectrum require elevated levels of sensory input in order to focus. Sensory input can come in many forms: pacing, fidgeting with a small object, chewing gum, sitting on a yoga ball or "wobble chair," or even just standing up can be sufficient to help students focus on the lesson. In the classroom, an example would be students completing a worksheet or a group activity while toying with a fidget spinner under the desk. However, the ideal scenario happens when the sensory input relates directly to the lesson and students can learn as they are getting their sensory input (Figure 3). This scenario would have students learning about the aortic valve as they are putting on gloves and poking their fingers into the aortic valve and watching as their finger comes out through the ascending aorta on a real heart specimen.

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From my informal classroom observations, when sensory input is directly tied to the lesson, there is more engagement from students with autism. This is exactly what Anatomy Academy does. In my experience, Anatomy Academy mentors have never taught a lesson to kids on the spectrum without sensory input that is directly associated with the concept they are teaching.

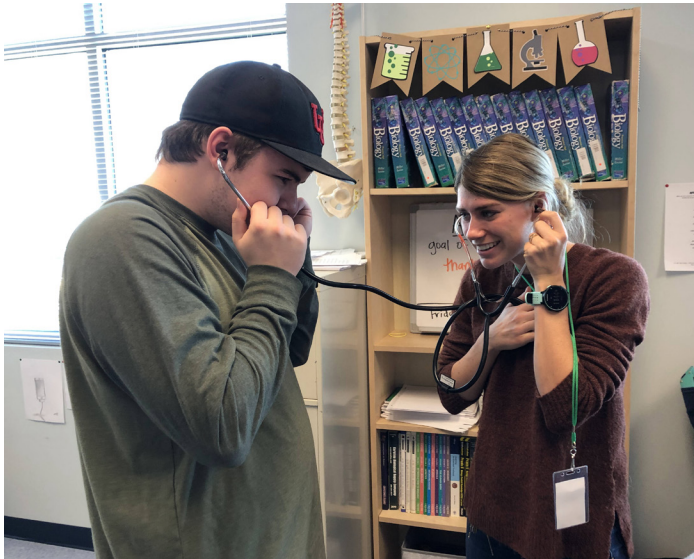


Figure 3. Anatomy Academy at Spectrum Academy Charter School in Pleasant Grove, UT. A student with autism learns about heart anatomy and physiology by listening to his mentor's heart sounds through a stethoscope. Appropriate media releases were obtained for both the student and the mentor.

A great example of a sensory-rich active learning experience is one that Anatomy Academy uses to teach the digestive system. This activity is also used in neurotypical classrooms, but I think it is especially useful in autism classrooms. The mentor presents the student with a plastic sandwich bag, a variety of food (bananas, graham crackers, oatmeal, and orange juice are some favorites), and panty hose with a hole cut in the bottom. The mentors explain that these objects represent the digestive system as food passes through, and will then encourage the students to place the food into the bag and grind and churn it up, just as the mouth and stomach do. The mentor will then encourage the students to pour the now-mushy food into the panty hose and push it through, imitating peristalsis in the intestines. The activity engages the students and provides sensory input that is directly related to the learning, meaning that the students are able to focus on both their sensory input and their learning, because they are one in the same.

Overall Benefits

Educational outreach through Anatomy Academy reaches students with autism in a truly unique way. The 1:1 mentor to student ratio that encourages friendship and the sensory-rich engagement in the activities prove invaluable in the classroom. In an autism classroom, the personal relationships between mentor and student help students progress socially and gain confidence. These relationships also aid in encouraging a student to regulate their behavior. Students are less likely to act out in front of their Anatomy Academy mentor, and as a result, there tends to be fewer negative or dangerous behaviors during Anatomy Academy, based on informal classroom observation. Furthermore, Anatomy Academy mentors do a great job at encouraging students on the autism spectrum to learn at their own pace and in their own way. For a student with learning disabilities, this type of encouragement is both empowering and necessary.

Take it from a high school teacher, educational outreach provides experiences that a single teacher cannot provide. As much as I would love to, I cannot provide the one-on-one setting or the friendship that a mentor brings. Nor can I give my students sensory-rich engaged learning activities during every class period the way Anatomy Academy can. This is what makes educational outreach so special. It provides students with opportunities that their normal classroom teachers cannot consistently provide.

Renée Baysarowich: Bringing STEM to Indigenous and Remote Communities

Over the past five years, indigenous and remote outreach programs conducted by the science outreach program Let's Talk Science at the University of Ottawa have reached over 10,000 students across Ontario, Quebec and Nunavut through two main programs: (1) week-long outreach trips to remote and indigenous communities and (2) a year-long mentorship program for indigenous high school students. During my time as both a volunteer and outreach coordinator, I have learned many strategies to ensure a successful STEM educational experience for all students and these approaches have been summarized into two main categories.

The first category involves *breaking down barriers* to make STEM inclusive, relevant, and meaningful. Students' attitudes towards STEM subjects are often negative because of their past experiences in school where there is a lot of emphasis placed on memorization of difficult concepts and achieving high test results/grades. These attitudes lead to an overall lack of interest in pursuing careers or post-secondary education in STEM fields, especially in Northern Ontario communities where there is a lack of STEM-related opportunities available. Taking these views and attitudes into consideration, our outreach focuses on making our STEM outreach hands-on and engaging, easy to learn, fun, and able to boost self-confidence.

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Our lesson plans are structured in a way that allows for a brief introduction to the subject material to ensure students have some basic knowledge of the topic at hand, followed by a hands-on activity/experiment, which is the primary focus of the lesson. As the students are progressing through the workshop, we further their learning by making observations as a group and problem solving together.

One of our most popular activities involves extracting DNA from fruit, a topic that is relevant to everyone, since our cells also contain DNA and that DNA helps explain our differences and similarities. Students get to complete the extraction process from start to finish and often feel a great sense of accomplishment at the end. Even if a student feels that they do not excel in biology, this activity is always very well received. This workshop is a great example of taking a difficult STEM topic and breaking it down to a level where all of the students can understand its importance and relevance in our world and gain the self-confidence to conduct an experiment in its entirety, something they may have never done before.

Taking into consideration the culture and environment of the specific community is also important when aiming to make our outreach meaningful. Understanding the landscape and incorporating it into activities, when appropriate, shows students that we care about their community, value their culture, and want to help be a part of the solution. In the past, our team visited a community in Northern Ontario whose river system, which the community relies upon for food and water, had been contaminated with mercury for decades, resulting in many devastating health effects in the community. Our team developed a hands-on STEM activity where students learned how water samples are collected and analyzed and went into the field to collect samples of their own. They learned about the chemistry of mercury and how it negatively affects human health. Students also had the opportunity to handle different samples of rocks and minerals. Not only were the students engaged in the workshop, but we also had teachers and members of the community interested in participating as well.

The second category of approaches to ensure successful STEM educational experience encompasses *optimizing existing resources* to provide long-lasting changes. Northern Ontario communities are sometimes equipped with some of the physical resources (i.e. 3D printers, microscopes) to complement their lessons but lack the educator expertise and confidence to utilize this equipment in the classroom. When specific gaps are identified, educators reach out to our program and we are able to find an expert in the field who can teach them how to use the equipment and how to integrate it into hands-on learning. Some isolated communities do not have this type of equipment and in these instances, we are able to provide the training to utilize resources that are easily available to engage students in hands-on activities in

addition to bringing some of the equipment to them so they can experience the technology for themselves. After this experience, educators and school administrators are often in a better position to request funding for equipment since they have experienced its capabilities and benefits.

In the past, our program had identified a need for an engineering program in Northern Ontario and Quebec and we developed a week-long outreach initiative in collaboration with the Faculty of Engineering to address those needs. Our volunteers brought 3D printers, programming kits, and solar powered mini cars to these communities and taught students about the practical applications of these technologies and how they could be used in their community. Students were able to design and build their own creations using the 3D printer, learned how to code, built solar powered cars, and were also challenged to create a plan to integrate these technologies in their community. A few communities already had 3D printers of their own, however they were not being used as there were no educators familiar with the technology. Our volunteers taught both the educators and students how to use the 3D printer, showed them how it could be used to make spare parts for members in the community, and also taught them how to troubleshoot any issues that may arise during use. After the workshops, educators reported feeling more confidence in utilizing their resources in their lesson plans and students were interested in learning more about engineering practices and experimenting with these technologies.

STEM education in remote and indigenous communities presents unique challenges but with the right approach, students and educators can greatly benefit long-term from outreach workshops and programs.

Tyler Redway: Anatomy in Action – OSU x COSI

As children we spend each day full of wonder, our young brains eager to learn new and exciting ideas as our imaginations run wild with the possibilities of the world around us. What if we hand a student a stethoscope and explain that the sounds we hear when using it are due to blood turbulence as the valves close to prevent blood backflow? What if we taught an entire class how to use a microscope and how to read an x-ray film? What if we started teaching elementary and middle school students how to be anatomists at a younger age and sparked an interest in the human body that could define a whole generation? Can we begin to build the bridge between the basic and clinical sciences earlier for the new generation?

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When a local science center, the Centre for Science and Industry (COSI), contacted the Division of Anatomy at Ohio State University (OSU) College of Medicine to help redesign a classroom experience for middle to high school students, we had all of these questions and more. We wanted to forge a new hands-on experience that students would never forget while making a subconscious connection between the basic and clinical sciences. Filled with excitement and ideas we came to the unanimous conclusion that the students needed to be the ones running the activities we constructed. We could have easily handed students stethoscopes and taught them how to listen to their heartbeats and how that relates to the heart and cardiovascular system, but we wanted to take it further. Instead, we gave students a lab coat and a medical chart and allowed them to learn by becoming a physician themselves. Through hands-on stations students were able to see up close the inner workings of the body systems to a deeper level than traditional education typically allows. They were also able to explore different injuries and conditions that can plague the human body.

Most children know fairly early in life that we have bones that give our bodies support, a heart that pumps blood, lungs that breathe in air, and a brain that controls thoughts and emotions. To take this further, our program explains topics within these body systems that many do not get the opportunity to appreciate until much later in life. Students may recognize that a heart attack is bad without knowing what it actually means, and that is exactly what we wanted students to take away from this experience. Through this program students are able to learn firsthand what a broken bone looks like on an x-ray, what cancer looks like under a microscope, how air is inhaled and then exhaled, in addition to the different types of medical professionals who diagnose and treat conditions in all the different systems. A true integration of anatomy, physiology, histology, pathology and the implications they have on the field of medicine is the goal we set for ourselves to reach. Not every student is going to come out of this program and become a doctor or an anatomist, but if we can inspire just a handful of students with the marvel of anatomy, and science in general, we believe that we have done a good job.

The best way to learn anatomy is to see it in action, and that is precisely what we are trying to achieve through our efforts to compose a new style of anatomy education and outreach.

Pascale Robineau-Charette: Experiencing the Process: A Minds-on Approach to Research Outreach

Every year, through the science outreach program Let's Talk Science, I have the privilege of meeting hundreds of high school students who already have a keen interest in biology, medicine, and disease. I believe that, too often, they are made to believe that medical school is the only worthy career path

for smart, driven students. This could be due to a simple lack of exposure to other careers that require the same qualities. I believe that introducing students to the process of scientific research, through discovery-based outreach activities, is part of the solution and that the opportunity to experience the *process* of research, rather than advanced theoretical knowledge, will keep them coming back for more.

We designed lab-based activities in which the students are intentionally given very little background information on either basic biology or the specific techniques they will be using. Groups of two to three students are given a document that contains one of three different "research projects". In our case, they were human-disease-focused projects (muscular dystrophy, breast cancer, and diabetes) with elements of genetics, genomics, and molecular biology, although the same concept could be applied to any field of STEM where experimental research is common. A very short introduction summarizes the pathophysiology of the disease and identifies the field-specific problem that their project will tackle e.g., contribution of a risk factor, generation of an animal model, or evaluating a possible therapeutic. Their projects guide them through rounds of experiments and data interpretation, eventually leading to an answer to their research question. Several technical tasks routinely executed in a molecular biology lab have to be completed in order to obtain a piece of data for interpretation e.g., pipetting, loading an agarose gel, or determining confluence of cell cultures using a microscope. With no explanation of, for example, how a polymerase chain reaction (PCR) reaction works at the molecular level, but only a one-sentence summary of what can be obtained with it, the students are left to rely solely on their curiosity and data interpretation skills to advance through the project.

We have observed various outcomes using this method. Some students are quick to make decisions and conclusions based on the evidence they have, unafraid to try an approach without the guarantee that it will work. Some students tend to discuss at length all possible conclusions, doubting every approach and wanting to make every step optimal. Both of these processes represent valuable experience of scientific thinking.

In our experience, this kind of lab-based outreach activity has numerous advantages. There will be plenty of time for students to catch up on scientific knowledge while they are pursuing an undergraduate degree. The scientific method, which the students have undoubtedly heard of, takes on much more meaning when it is experienced.

Our approach is meant to break student over-reliance on a strict protocol where the goal is to always get the right answer. Instead, focus is shifted towards asking the right questions and interpreting data to get to an answer that usually is not "black-and-white". Conveyed with enthusiasm by volunteers who

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provide help by asking the students questions and guiding them through a thought process, this approach helps them picture themselves as eventual researchers. Taking the focus away from topic-specific knowledge leads students to the realization that it is the process that counts. This is, we believe, highly beneficial to them, while it minimizes the elitism often associated with medical sciences. After experiencing these activities, some students start seeing research as a viable career option. Even students who are not convinced that a career in research is a viable option tend to leave with a strong appreciation for the process of research and its importance to society.

David Cook: Opening the doors to cancer research

What are the goals of high school and undergraduate science labs? For most, it seems that they are designed to introduce some methodology that can be used in a well-controlled experiment to reinforce concepts taught in the classroom. A benefit of this is that it shows students that the “facts” they learn in class can actually be corroborated by observations in the real world. But what is the lasting impression these labs leave about what it means to do science? I suspect if you asked students what they remember from science labs they had previously taken, you would get answers along the lines of “we dissected a frog”, “we measured color changes during chemical reactions”, or even “we lit different things on fire!”. Because of the need to be standardized, these labs become painfully focused on methodology, designed as rigid recipes of steps that consistently lead to desired end points. This teaches how experiments are done, but perhaps misses the most exciting part of science: being able to ask questions about the unknown and develop creative solutions to illuminate its depths. Methodologies are just the tools used towards this end; not the end itself. I certainly doubt many professional chefs would say the most exciting part of their job is following a recipe.

In order to inspire more students to pursue a career in science, we need to do a better job of exposing them to the realities of doing science. One way to accomplish this is modifying lab curricula to incorporate more problem-based learning as well as exercises in hypothesis generation and experimental design. This, however, will not be my focus here. Rather, I would like to argue that the association of many post-secondary institutes with academic research labs provides the opportunity to help with this issue through organized outreach to students of all levels.

During the final year of my undergraduate studies in 2014, I began volunteering with a national science outreach organization called Let’s Talk Science, providing interactive activities to local classrooms on a wide range of topics. Soon after joining, I had the opportunity to help develop outreach targeted towards high school students focused on cancer

research, which I had begun studying for my PhD. This was an interesting challenge as most high school students have only a vague understanding of how scientific research works and many of the topics actively being researched are beyond the core high school curriculum. It was clear early on that it was more important to show students how we approach cancer research rather than the specific details of what we are researching. One of the most effective ways we have found to do this is to simply open up the doors to our labs and invite students in. Since beginning this outreach only four years ago, we have brought over 1000 high school students from across Canada into our cancer research labs at the Ottawa Hospital Research Institute (OHRI) for tours and interactive workshops. Along the way, I am continually surprised by the impact that this simple act can have.

Perhaps a student’s first reaction walking into a lab is the realization that scientists are not exclusively old white men carefully examining a beaker of colorful liquid. While breaking this stereotype may seem like a minor detail, I think it is incredibly important. Science is not without systemic biases that need to be addressed urgently, but given its international scope, its workforce can be surprisingly diverse. It can bring together individuals from a wide array of cultural and socioeconomic backgrounds. Further, science is actually quite energetic and youthful with PhD students and postdoctoral fellows comprising the majority of the workforce. Exposing students to this reality early in their academic career reveals that the divide between themselves and professional scientists is much smaller than they had probably believed. This makes it feel much more relatable and attainable.

Another benefit of bringing students into real research labs is that it gives the opportunity to talk to them about open questions being actively researched. Although the specific details of these topics may be well-beyond the scope of the students’ education, most research can be explained in ways that are understandable. I have found that students are energized by discussing open questions in the field and the impact that answering these questions would have. If encouraged to do so, they may even offer up suggestions on how a question or hypothesis could be tested. Sure, the suggestion may be relatively vague e.g., “If you get rid of that protein, maybe the immune cells could kill the cancer”, but I believe that coming up with those ideas is what science truly is; the implementation of the ideas is shaped by the available technology of the time. Ultimately, it is critical for students in any biomedical field to know that *doing* science is nothing like learning about it. Scientists spend our days asking questions that no one has answers to. There are points in time where we are the only people in the world with certain knowledge. To me, this is what makes science special.

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Implementing such outreach may be perceived as difficult, and certainly every institute will have its own loops to jump through, but in my experience, it is fairly straightforward and non-disruptive to bring high school and undergraduate students into the lab. For high school students, local grades 11-12 biology classes are usually thrilled to have a class trip to a research institute, and many undergraduate students would jump at the opportunity to tour a lab if offered the chance. At the OHRI, we coordinate interactive tours for 25-30 students approximately once a month throughout the school year. Each tour lasts two hours and is run by three graduate students. After a general introduction, we divide participants into three groups of five to ten students and cycle them through three stations in our lab. Each station is focused on a different topic/methodology that they may be familiar with, such as DNA, *in vitro* culture systems or histology. At each station, we introduce the topic, but spend the majority of the time discussing how these topics apply to problems we are actively working on in the lab. This also provides the opportunity to show real data/samples from those projects. To keep participants engaged, we ensure that each station has a hands-on component. I have found that participants have really enjoyed having the opportunity to interact with graduate students and ask questions in a small group setting.

Exposing high school and undergraduate students to the realities of scientific research could attract those students who thrive at problem solving but were scared away from science because they could not memorize the Krebs cycle for an exam. Similarly, it could deter students who will spend years pursuing the career only to find they despise the field's intrinsic uncertainty. As scientists and educators, it is up to us to reform science education and work with local research groups to improve the visibility of these realities.

Summary and Conclusions

These examples of educational outreach reveal the enthusiasm with which graduate students and post-doctoral trainees embrace opportunities to share their love of science and scientific discovery with young people. These programs can enrich the learning experiences of students who are isolated, geographically or socially, and provide them with examples of potential career paths they might want to follow. All of these outreach programs draw on the creative abilities of the tutors to design engaging and active learning adventures for their students. Teachers in elementary and secondary schools are provided with insight into the postsecondary world of science and exposed to novel processes and tools they can use to animate the basic science curriculum. Finally, the tutors themselves build confidence and hone their teaching skills while reaping the rewards of being role models for future young scientists. Outreach fills gaps in educational curricula and provides important ways to excite students about science and how it might fit into their lives and career plans.

About the Authors

David Cook, MSc, is a PhD candidate in the Department of Cellular and Molecular Medicine at the University of Ottawa. His research focuses on cancer cell plasticity and he served as a cancer outreach coordinator for Let's Talk Science in Ottawa for four years.

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Pascale Robineau-Charette is a PhD candidate in Cellular and Molecular Medicine at the University of Ottawa, her research focusing on reproductive biology and placental dysfunctions. She is passionate about research advocacy and outreach and has been a volunteer and a coordinator for Let's Talk Science in Ottawa for five years.

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Workshop Abstracts - the clickable symbol “” indicates accompanying manuscript



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A & P Concepts

Workshop #1

The Fascial Planes of the Body – Understanding Patterns

Mark Nielsen, University of Utah, marknielsen@bioscience.utah.edu

An understanding of fascial planes and fascial compartments of the body is critical to a large range of healthcare professionals. The fascial system defines the connective tissue continuity of the body and the clefts/spaces through which inflammation and infection can spread. For this reason, an understanding of the fascial system is of great clinical relevance. While the plethora of anatomical nomenclature associated with this system can be confusing, there exist clear patterns of structural organization, that if understood, can simplify and clarify the teaching and understanding of these fascial planes/spaces. This presentation will cover these clarifying patterns

Workshop #2

Teaching the Brachial Plexus: A New Approach

**Cindy Wingert, Ohio State University, cindy.wingert@osumc.edu
Jeremy Grachan, Ohio State University, grachan.1@buckeyemail.osu.edu**

A standard method for understanding the formation of the brachial plexus is to draw 3 “Y”s, 1 “M”, 1 “X”, and a backslash. Although this method is the traditional approach of teaching the brachial plexus, undergraduate students often have a difficult time conceptualizing how the sketch relates to in situ anatomy. In this workshop, we will demonstrate a different approach to teaching the brachial plexus through a step by step guided video dissection of the brachial plexus. Additionally, we will discuss creative ways to help students visualize the relationships of the cords and terminal branches of the brachial plexus with the boundaries of the axilla.

Workshop #3

Autoimmunity Part 1: Loss of Central Tolerance

Tynan Becker Becker, University of Alaska Fairbanks, tabecker@alaska.edu

Autoimmunity is a complex immune phenomenon that is of great interest to A&P students. This workshop will review thymic education of T cells and discuss the breakdown of central immune tolerance that leads to autoimmune outcomes. Conditions that arise due to genetic dysfunction of the AIRE gene will be used to illustrate the concepts

Workshop #4

Autoimmunity Part 2: Loss of Peripheral Tolerance

Tynan Becker Becker, University of Alaska Fairbanks, tabecker@alaska.edu

Autoimmunity is a complex immune phenomenon that is of great interest to A&P students. This workshop will review the role of regulatory T cells, immune suppressive cytokines and dendritic cell activity and discuss the breakdown of peripheral immune tolerance that leads to autoimmune outcomes. Conditions that arise due to cross reactivity to pathogens or self-antigens released from immune privileged compartments will be used to illustrate the concepts.

Workshop #5

It's More than Oxytocin

Chad Wayne, University of Houston, cwayne@uh.edu

Parturition is often described as a positive feedback loop between the posterior pituitary and the myometrium by way of oxytocin and the contractile response of the uterus. In this workshop, the endocrine control of parturition beyond oxytocin will be explored. We will examine how maternal and fetal tissues communicate that birth is imminent and how the labor process is initiated and managed.

Workshop #6

The Physiology of Marijuana

Tom Lehman, Coconino Community College, tom.lehman@coconino.edu

Students are coming to us with questions about the effects of marijuana on the body and possible health effects, and we should be ready to give them accurate answers. This presentation will describe some of the basic differences between CBD and THC, discuss the process of butane hash oil, and demonstrate some of the physiologic effects that may occur in people exposed to these materials.

Workshop #7

Integrating Metabolism and Nutrition when Teaching Metabolism.

James Clark, Los Medanos College, jclark@losmedanos.edu

Metabolism and nutrition are interrelated factors of human physiology, so much to the point that they cannot be throughout about independent of each other. Yet, the way that either nutrition or metabolism is discussed leads to questions about how well this interrelationship is understood. The purpose of the presentation is to discuss concepts and misconceptions about each concept that find their way into conversations about the science of metabolism, the principles of health and fitness and how incorporating the interrelationship between metabolism and nutrition into the discussion can combat many of the misconceptions that are perpetuated.

Active Learning

Workshop #8

Teaching Large-Scale Brain Networks to Improve Performance in Online and Large Classroom Settings

Michael Kirifides, Drexel University, mlk56@drexel.edu

To examine the academic performance between students using individual passive learning in preparation for standardized testing in a large lecture-based classroom or taking an online course and students adopting active learning methods in preparation for these exams. Students employed an active learning processes and central-executive network using a 4-step approach on an individual basis and improved performance outcome compared to passive learning methods using the default-mode network.

Workshop #9

Using Active Learning (Coupled with Backward Design) to Enhance Student Comprehension and Metacognition

Laylonda Maines, Front Range Community College- Westminister, laylondamaines@gmail.com

By utilizing Backward Design and Active Learning Cycling approaches - coupled with tools like Intelligent Agents, Checklists, Video Check in's and Lectures - I started a multi-layer scaffold of topics for each chapter for Anatomy & Physiology II using creative and hands- on practices in my face- to- face, hybrid, and online courses. Some examples are drawing, interactive assignments, in-class case studies, and other creative activities. I will share my experience of how this modification of my teaching style which incorporates interactive lectures and active learning techniques has allowed for better student productivity, retention, and engagement.

Workshop #10

New Student Lab Resources Combining Physiology and Engineering from BIOPAC

Jasmine Anderson, BIOPAC Systems, Inc., jasminea@biopac.com

Do you have students eager to apply their biology, anatomy and physiology education to a hands-on engineering project? The latest addition to the Biopac Student Lab suite bridges biology and biomedical engineering principles to create and evaluate a robotic arm controlled by the student's own EMG signal. This new lesson set delivers 10 individual labs that encourage students to use critical thinking, teamwork, and math for real-world applications. Biopac Student Lab provides educational solutions streamlining laboratory coursework for instructors and inspiring curiosity in students through captivating hands-on lessons where students learn by doing.

Workshop #11

No Body, No Problem: Teaching an Active Learning Anatomy Course without Cadavers

Stephanie Wallace, Texas Christian University, stephanie.wallace@tcu.edu

Although many instructors desire to use cadavers to teach human anatomy, this is not always possible for a myriad of reasons. In this workshop, I'll share my ideas and resources I used to teach an active-learning undergraduate human anatomy class without access to a cadaver lab. There will be time available for everyone to share ideas and ask questions.

Workshop #12

Use of Team-Based Learning to Promote Collaborative Learning In Your Classrooms

Robert Bell, University of Ottawa, rbell@uottawa.ca

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Team-Based Learning (TBL) is an innovative student-centered teaching method that can be readily employed for your undergraduate anatomy and physiology classes, and a method proven to stimulate student engagement while enhancing collaboration and communication skills in learners. The purpose of the workshop is to familiarize the audience with this method of teaching and to provide participants with the ability to experience TBL from the learner perspective. Participants will develop expertise regarding the potential implementation of TBL in their own classrooms, as well as guidance regarding navigating around common barriers to making this transition.

Workshop #13

Can Students Handle Higher Levels of Bloom's Taxonomy of Learning with only Months of A&P???

Jennifer Kong, BCIT, jennifer_kong@bcit.ca

Eva Somogyi, BCIT, eva_somogyi@bcit.ca

BCIT's PreHealth Studies is a unique course for senior secondary students interested in pursuing health care. The highlight of the course is the Sim Lab Challenge where each student team CREATES their own patient scenario and ANALYZES the opposing team's scenario by APPLYING the A&P learned. Participants will experience the preparation & execution of the Challenge from both student and educator perspectives: looking at different educator roles and the student skills fostered. We will explore how the Challenge can be executed without a Sim Lab.

Workshop #14

Flipping without Capsizing

Betsy Brantley, Valencia College, bbrantley3@valenciacollege.edu

Anne Clayton, Wayne State University School of Medicine, ef9959@wayne.edu

Have you felt pressured to do a half gainer off the high dive when you really just wanted to try something simple? "Flipping the classroom" does not necessarily mean what you think it means. It can be done by degrees. Come discuss some suggestions for just getting your feet wet - no life jacket required.

Workshop #15

A Worthy Challenge: Improving Student Perception of Active Learning

Rachel Hopp, University of Louisville, rachel.hopp@louisville.edu

Have you flipped a course and found your students grumpy with active learning and longing for a passive lecture? Students have a disconnect between their actual learning and their feelings about learning (Deslauriers et al., 2019). How do we show them they are learning more when they feel like they are struggling? This workshop will feature five highlights from two year's worth of faculty learning community discussions and research on student buy-in for active learning. Let's move from "active learning as broccoli" (Smith and Cardaciotto, 2011) to something more palatable. Participants will receive tools to persuade students and evidence-based resources to gauge student perception.

Workshop #16

Teaching a Flipped, Fully Online Class using Small Group Work

Patrick Cafferty, Emory University, pcaffer@emory.edu

Do you teach online? Are you concerned that social isolation is a barrier to completion of online courses? If so, this workshop will interest you! Here I will discuss my flipped, completely online physiology course that is comprised of an asynchronous portion, where students review course material on their own (out-of-sync), and a synchronous portion, when we meet online at the same time (in-sync). I will discuss technology that helps me recreate the small group environment of my regular classroom during my synchronous class sessions. Together, we will brainstorm ideas to keep your students engaged with small group work online.

Workshop #17

A Comparison of Problem Based Learning and Inquiry Case Based Learning in Physiology

Chasity O'Malley, Nova Southeastern University, comalle0@nova.edu

Arkene Levy, Nova Southeastern University, alevy@nova.edu

Problem based learning (PBL) and Inquiry (IQ) case-based learning are two student-centered small group approaches to teaching Physiology. Students are provided real life clinical cases and problems to solve themed around concepts in Physiology and other foundational science topics. Both PBL and IQ greatly increase student engagement and enhance critical thinking skills, as well as improve communication skills. This workshop will highlight the differences between the two approaches and will provide examples of how both approaches can be applied in the classroom.

Workshop #18

Demystifying Neuroscience

**Mario Loomis, Sam Houston State University College of Osteopathic Medicine,
Mario.Loomis@shsu.edu**

The complex details of Neuroscience can be overwhelming to students who often resort to rote memorization with poor long-term retention. The act of wondering can change this dramatically, shifting the student's perspective from passive reception of information to active investigation. When asked a question such as, "Why do we dream?" students begin to consider, propose, and analyze, even before any new information has been presented. In this workshop, we'll outline practical ways to integrate wonder into the teaching of neuroscience through framing reflective questions, interactive visuals and schematics, and a stepwise introduction of complexity.

Workshop #19

Getting the Most out of your Skeleton: Low Budget Modelling Activities for Muscles, Nerves, and Organs

Lindsey Jenny, Michigan State University, jennylin@msu.edu

Nicole Geske, Michigan State University, geskenic@msu.edu,

Ryley Mancine, Michigan State University, ryleymancine@gmail.com

Articulated skeletons can be used to teach more than just bones! We will present 3 variations of activities that use low-cost supplies (construction paper, markers, tape, and pipe cleaners) to represent muscles, nerves, and organs in different regions of the body: axial muscles, upper and lower limbs, and reproductive anatomy. Students work together to make "muscles" and "nerves" and attach them to the skeleton or craft "organs" that may be otherwise challenging to visualize. Students then use their models to explain different clinical scenarios that are linked to specific course learning objectives and assessments.

Workshop #20

The Pressure's On: Creating and Using Models of Body Systems

Jennifer Baker, Carolina Biological Supply Company, jennifer.baker@caroilina.com

Learn exciting and engaging ways to teach structure and function within body systems. Use hands-on labs to help students understand kidney function and interactions between the excretory system and cardiovascular system. Set up experiments, collect data, analyze results, and create models to build toward understanding the human body.

Workshop #21

A Kinesthetic Learning Activity to Illustrate Skeletal Muscle Contraction

Juanita Jellyman, California State Polytechnic University at Pomona, jkjellyman@cpp.edu

Concepts in physiology can be made more accessible to students through simple demonstrations using everyday objects as props. This workshop will use volunteers, curtain rods and ping-pong balls to build the functional unit of a skeletal muscle – the sarcomere. This 'sarcomere' will be used to demonstrate cross-bridge cycling, the sliding filament mechanism of muscle contraction, as well as the length-tension relationship in skeletal muscle. This engaging kinesthetic learning activity is simple and inexpensive to prepare. Moreover, it provides a welcome break during a lecture that helps students to visualize, understand and retain muscle physiology concepts.

Workshop #22

Using Group Learning to Enhance Understanding of Skeletal Muscle Fiber Physiology: From Excitation to Relaxation

Rosemary Stelzer, University of Wisconsin-Milwaukee, rveber@uwm.edu

This presentation will guide participants through a short group learning student exercise describing the steps that cause skeletal muscle fibers to contract and relax. During this session, participants will actively model this group learning approach.

Workshop #23

The Cardiac Cycle - 5 Hearts on a Whiteboard

Mindi Fried, Quinnipiac University, drfried@motiondoc.com

A lot is happening in the cardiac cycle, and the volume of events can make it difficult to grasp. This is a simplified method of teaching the events of the cardiac cycle in an interactive way, using personal whiteboards or just a blank sheet of paper for each student.

Workshop #24

Building Human Joints on a Budget

Molli Crenshaw, Texas Christian University, molli.crenshaw@tcu.edu

While it is important for students to spend time learning joint anatomy in lab, models of human joints are costly and take up storage space. I have written a series of activities where students learn to assemble the components of human joints using the bones they study in the labs, and some inexpensive dollar store materials. Attendees will get hands-on experience with these activities. I'll also provide copies of the exercises for you to use in your own student labs.

Workshop #25

A Way to Teach the Vascular System in 3D

Terry Harrison, Arapahoe Community College, terry.harrison@arapahoe.edu

Learning the blood vessels is a challenging task for college students. One way to help students learn the vasculature and understand structural relationships in a three dimensional way is to create an assignment that requests that students produce a three dimensional representation of those vessels. Join us in a guided workshop with examples that students have created and presented over the years and some guidelines on how to incorporate this experience into your own classroom.

Assessment

Workshop #26

Closing the Gap Between Learning Objectives and Assessment

Holly Basta, Rocky Mountain College, holly.basta@rocky.edu

Elizabeth Co, Boston University, eco@bu.edu,

Jenny McFarland, Edmonds Community College, jmcfarla@email.edcc.edu

This workshop will guide participants to develop learning objectives (LOs) that can be assessed using common testing methods. LOs should be clear, behavioral, measurable, and attainable. They should direct and support teaching and learning by providing transparency between instructor and student. Participants will identify common pitfalls by critiquing and correcting sample LOs. They will develop and critique their own objectives and align them to assessment items. Using backward design, participants will practice constructing test blueprints that prioritize higher order thinking and accurately assess their LOs. We encourage participants to continue this work in the "Writing and Critiquing Assessment Items" workshop. Sponsored by HHMI BioInteractive A&P Faculty Mentoring Network (FMN)

Workshop #27

Practical and Effective Techniques to Reduce Cheating in HA&P Classes

Leonore Neary, Joliet Junior College, lneary@jjc.edu

Students copying on "bubble" exams and laboratory exams has been a problem that has plagued A&P instructors for many years. I would like to share a number of practical and effective techniques that greatly reduce the ability of students to cheat on these types of assessments. I would also like to share data from student surveys and student comments regarding these techniques. Participants are encouraged to share their solutions to this problem. This is an important topic, because when we reduce cheating, we promote learning and fair and accurate assessment of student learning.

Workshop #28

Transform your Teaching of Physiology Core Concepts using Computer-Scorable, Constructed-Response Formative Assessments

Jennifer Doherty, University of Washington, doherty2@uw.edu
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Mary Pat Wenderot, University of Washington, mpw@uw.edu

Learn to use computer-scorable, constructed-response formative assessment questions to explore your students' understanding of two physiology core concepts, flux and mass balance. Questions address diverse areas of physiology, such as blood flow through vessels, ion transport across membranes during action potentials, and mass balance of intracellular calcium during skeletal muscle tetany. Learn how to interpret your students responses to gain insight into the level of understanding your students have about flux and mass balance. Using these data we will work collaboratively to create teaching interventions to help students master these concepts.

Workshop #29

HAPS Exam Program 2020 Update: Online A&P and Stand-Alone Anatomy Exams, and Development of Physiology Learning Outcomes

Valerie O'Loughlin, Indiana University, vdean@indiana.edu
Jennifer Burgoon, Ohio State University, Jennifer.Burgoon@osumc.edu,
Dee Silverthorn, University of Texas at Austin, silverthorn@texas.edu

Learn more about the HAPS Exam program and the testing services we can offer your classes and institutions! In this session, we provide an overview of the comprehensive A&P exams and stand-alone human anatomy exams, describe the online testing platform and options for remote proctoring, explain the process regarding ordering exams, and provide examples of how you can utilize these exams at your institution. In addition, we will update you on the development of the stand-alone physiology learning outcomes, and future plans for a stand-alone human physiology exam.

Workshop #30

Rethinking the Lab Practical: New Assessment Methodologies for an Old Learning Objective

Carol Britson, University of Mississippi, cbritson@olemiss.edu

Creating a hard, but fair, lab practical is challenging even for one lab section. Creating similar testing experiences over an entire week for several hundred students across two different courses and nearly twenty lab sections is a logistical headache. Getting more faculty and teaching assistants involved in resetting questions for new sections of students helps but doesn't create more lab space or additional hours in the day. I will present a method for assessing identification learning outcomes that creates comparable and unique lab practicums for each group of students, including those with testing accommodations, but requires a one-time setup.

Case Studies

Workshop #31

Living with a Vestibular System Implant

Shawn Macauley, Muskegon Community College, shawn.macauley@muskegoncc.edu

Living without measurable vestibular function following aminoglycoside ototoxicity over 20 years ago, I'll describe the overall improvements to my vision, balance, and memory following a multichannel vestibular implant. The presentation will also include a review of normal vestibular function and life changes that result from vestibular dysfunction.

Workshop #32

Case Studies – Let's get Visual and Interactive!

Zoe Soon, University of British Columbia Okanagan, zoeanne.soon@ubc.ca

In this workshop I will show participants how I created case studies that were visual, hands-on, as well as electronically interactive, enabling instant feedback and opportunities to review again. I will also share results of pre-tests, post-tests, student satisfaction surveys, and final exam grade improvements. It is well known that students find the realistic nature of case studies to be compelling and can be used to foster mastery of course content. I wanted these practice exercises to be interesting, engaging, memorable, and helpful in reviewing challenging topics. Case studies include Osteoporosis, Fracture, Heart Disease, Peptic Ulcers, Endocrine Homeostasis, and Diabetes.

Workshop #33

Head Cases - Writing Case Studies That Are Both Thought-Provoking and Realistic

John Neisser, Penn State, jxn418@psu.edu

Many of us use clinical case studies in our anatomy and physiology courses, but have you ever tried to write one from scratch? This workshop will include tips for designing your own case study and writing a compelling narrative to go along with it, as well as different methods for presenting a case and assessing student performance.

Workshop #34

Enhancing Student Learning by Creating a Case Study Format for A&P 2 Labs

Gabriele Meyer, Chattanooga State Community College, gabriele.meyer@chattanoogastate.edu

Traditional A&P labs are taught using models and simple exercises. As a result, students often fail to see the relevance of what they are learning in lab. In an effort to increase team-based active learning, the majority of our A&P 2 laboratory exercises have been modified, either partially or completely, to a case study format. Student teams actively participate in lab activities based on realistic scenarios. This provides an opportunity to increase awareness of course relevance and enhance both student learning and retention. Come and see our case study approach to the Endocrine System!

Workshop #35

Still More of our Favorite Histology Challenges

Nina Zanetti, Siena College, zanetti@siena.edu

Deborah Merritt, University of Hawaii at Manoa, dmerritt@hawaii.edu

The Histology Challenge, a dynamic feature of the HAPS website, presents patient cases with photomicrographs and an online blog where participants discuss and diagnose the disease. Cases cover a wide range of diseases, but also illustrate basic concepts in histology, histopathology and disease mechanisms. In this workshop, we will revisit some of our favorite cases, with questions and answers designed to simulate the discussion blog. We'll explore basic concepts behind each case, how the cases might be used in undergraduate courses, some of the behind-the-scene work that goes into producing the Challenge, and how you can get involved!

Curriculum Development

Workshop #36

Rethinking the Way we Teach Neuroscience

Jacqueline Van Hoomissen, University of Portland, vanhoomi@up.edu

Do we need to re-think the way we present and teach the nervous system in our anatomy and physiology courses? This question stems from an ever-increasing body of scientific literature that is constantly rewriting our understanding of the nervous system faster than we can update our textbooks or class presentations. The session will highlight how we can integrate new knowledge into the standard nervous system curriculum while simultaneously teaching the important concept of uncertainty. Participants are encouraged to bring forward ideas on how to teach the complex nature of the nervous system.

Workshop #37

Problem Based Learning (PBL) Tutoring Program for Anatomy and Physiology Students

Caroline Hanson, Georgia Gwinnett College, chanson@ggc.edu

A faculty learning community (FLC) focused on the progression of learning throughout the five pre-nursing science courses. Following course content alignment, instructor recommendations were compiled. The FLC investigated the impact of course sequencing on student success and identified the need for students to have knowledge of problem-based learning (PBL) pedagogy. PBL is frequently used in healthcare professional programs because educators recognize that students separate "theoretical knowledge" (the 'knowing that') from "practical knowledge" (the 'knowing how') leading to a 'theory-practice gap'. For this session the presenter will discuss the course alignment process and have participants demonstrate the PBL tutoring program design through examples developed for Anatomy & Physiology I.

Workshop #38

The Art of Mapping Content to Your Learning Outcome

Arianna Boulet, ADInstruments, a.boulet@adinstruments.com

Ensuring learning activities are engaging and aligned with academic standards is hard! HAPS has a new set of anatomy-only learning outcomes, so why not learn how to use them effectively? In this hands-on workshop, we'll use a free content design template that brings a structured approach to creating captivating content. We'll apply HAPS anatomy learning outcomes to the template and practice designing focused, student-centered activities that meet your needs. Join us to pick up your template and get a taste for how mapping out goals, key activities, and delivery strategies can leave you with organized and engaging learning solutions.

Diversity & Inclusion

Workshop #39

A Critical look at Struggles facing First-generation Students in Pre-healthcare Majors

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Kathleen Salmeron, University of Kentucky College of Medicine, katie.guell@uky.edu,

April Hatcher, University of Kentucky College of Medicine, april.hatcher@uky.edu

First-generation students often find themselves facing unique barriers compared to their non-first generation counterparts. A student with first-generation "status" has parents whose highest completed education is less than a Bachelor's degree. In this workshop, we will explore different populations of first-generation students within pre-healthcare studies (undergraduate nursing, pre-medical, and pre-physician assistant students). In groups, we will discuss the varying backgrounds of these students and barriers they may encounter in their undergraduate studies. We will also compare and contrast our expectations with data collected from current students, with the aim of facilitating first-generation success in healthcare studies.

Workshop #40

Beyond Binary: an Inclusive Approach for Teaching Reproductive Anatomy & Physiology

Meaghan MacNutt, Quest University Canada, meaghan.macnutt@questu.ca

Most A&P textbooks adhere to a sex and gender binary, excluding the 2.5% of people who have a body and/or an identity that does not fit neatly into a male or female category. This workshop will support educators who want to teach about reproductive structure and function in ways that help to normalize a diversity of bodies/identities and disrupt harmful narratives about gender and the body. Participants will be provided with an outline for an inclusive and socially-critical reproductive system unit, an introductory lesson plan, a gender-inclusive language guide, and additional resources about gender and sexual diversity.

Workshop #41

A Native American Perspective on Medicine, Donors and Dying: Continuing the Conversation from HAPS 2019

Amberly Reynolds, Indiana University Bloomington, ammreyno@iu.edu

Following the conversations elicited at this session last year, I am returning to once again provide a diverse perspective on medicine, donors, and dying. Native American beliefs in medicine are based on holistic experience. Interest in Native medicine has increased through Hollywood portrayals of medicine men, but what is true? If a dead body is potentially evil, what impact will this belief have on students tasked with dissecting? In this session, you will be introduced to Native medicine, participate in discussions on the handling of Native beliefs in an anatomy & physiology course and add to the discourse on diversity awareness in the classroom.

Workshop #42

Making the Invisible Visible: Let's Discuss Invisible Disabilities

Michael Goodwin, Indiana University, micegood@iu.edu

Individuals with disabilities, particularly those with 'invisible disabilities' (e.g., dyslexia, ADHD), represent a diverse group on university campuses. However, these individuals lag behind their peers regarding academic outcomes and persistence. The concept of disability, and stigma associated with being labelled as such, is a sensitive and controversial topic, which complicates existing strategies for how to best serve these students. This workshop begins with an overview of previous findings regarding outcomes and experiences students with disabilities face, followed by an open discussion forum. Participants will be asked to share their stories, insights, and strategies teaching students with different kinds of disabilities.

Workshop #43

The Culture Inside: Mutual Influences Between Anatomy and Physiology and Religious and Other Cultural Practices

Edgar Meyer, University of Arkansas for Medical Sciences, ermeyer@uams.edu

The incorporation of diversity and inclusion goals into the revised HAPS Learning Goals has been discussed, given the importance of promoting diversity, equity, and inclusion standards at institutions of higher learning. Individual cultural and religious, spiritual, or secular differences should be respected in anatomy and physiology (A & P) courses. This workshop will include brief introductions to religious and other cultural impacts on A & P throughout history. Participants will engage in activities using examples of A & P structures, terms, or discoveries to research and discuss their influences from various religions and other cultural practices and vice versa.

Workshop #44

General Anatomy and Physiology: Moving Towards Inclusive Pedagogy

Cuc Vu, Saint Catherine University, ckvu@stkate.edu

In this workshop, I will share how I designed my General Anatomy and Physiology course using best practices from online, hybrid, F2F, and flipped course to move towards an inclusive learning environment for all students. This work involves reducing the academic skills gap using CSI-St.Kate's, providing various methods of content delivery, and frequent low-stakes assessment to guide in-class discussion on topics students struggled on. This course was piloted in Fall 2019. I will be sharing what I have learned from this pilot and student feedback/performance.

Workshop #45

Representing Cultures and Diversity in Teaching A and P

Rosana Darang, Boston University, Lesley University, Endicott College, Bunker Hill Community College, redmd@bu.edu

Students find more meaning in anatomy and physiology when they see their cultures represented in their study of the course. This session will discuss teaching strategies and learning activities that will allow making connections to students' lives and will therefore motivate and better engage them. Participants will be invited to share their ideas and experiences of incorporating diversity, culture and inclusion in their lessons while still helping students learn the fundamental concepts of A and P.

Workshop #46

Weight Bias in Anatomy and Physiology Education

Krista Rompolski, Moravian College, rompolskik@moravian.edu

Weight bias is defined as negative weight-related attitudes, beliefs, assumptions and judgments toward individuals who are overweight and obese. Internalized weight bias has significant physical and psychological consequences. Attitudes about fat, and consistent recommendations from healthcare providers to reduce body weight at all costs, lead to poorer, rather than improved health outcomes, often in the form of eating disorders and healthcare avoidance. In today's society, the amount of fat on an individual's body carries numerous assumptions about an individual's lifestyle, morality and value. Unfortunately, weight stigma is highly prevalent in the healthcare professions, educators and students. A 2014 national study of over 4,000 1st year medical students found that rates of implicit weight bias were equal to bias against racial minorities, and explicit attitudes about weight were more negative than those toward racial minorities, LGBTQ, and poor individuals. As A&P educators, we have an opportunity, perhaps a responsibility, to foster integrity, respect and compassion for all people, regardless of body size and shape. In this workshop, we will define weight bias and weight stigma, discuss the prevalence of weight stigma in health professions education and society as a whole, and explain the consequences of internalized and externalized weight bias. Finally, we will discuss appropriate ways to address weight bias in anatomy and physiology courses.

Workshop #47

Addressing the Academic Support Needs of International Medical Students in a Modern Medical Education Curriculum

Tudor Chinnah, University of Exeter Medical School, t.i.chinnah@exeter.ac.uk

With increasing globalisation and internationalisation, student mobility and need for income generation, most universities in the UK now seek to attract greater number of international students. New teaching and learning approaches that are non-traditional have been incorporated in modern medical education curricula. These pose additional challenges to the international medical students. Opinions are that far more guidance and support are required. Evidence suggest that international medical students under-perform compared with home students, with odds of failure about 2.5 times higher. This workshop will explore ways to address the specific academic support needs of these group of students.

Humanities

Workshop #48

It Started as a Joke: Struggles and Experiences of Early Female Physicians

Danielle Hanson, Indiana University, dchanson@alumni.iu.edu

The medical establishment's acceptance of female doctors is a development of the 1800s. Women used social maneuvering, determination, and force of character to enter U.S. medical schools, and the process was exponentially more difficult for women from racial minorities. After earning a medical degree, they were not accepted into professional organizations, and expected to limit themselves to treating "women's issues." African American and Native American women were even more harshly judged due to racist assumptions of lower intelligence and dishonesty. The professional framework they constructed and the struggles of these early female doctors will be explored in a medicosocial context.

Workshop #49

Nazis as Anatomists, Why We Should Strive to be Ethical, and Why We Shouldn't use the C- Word

Aaron Fried, Mohawk Valley Community College, afried@mvcc.edu

What is the etymology of the C-word (cadaver)? Are there other connotations that it holds for some individuals? If you are going to be picky about the answers you accept on anatomy tests, you should also be picky in how you describe the wonderful people who have gifted us their bodies for learning. At Mohawk Valley Community College, we are trying to change how we talk about our Human Donors to be more in line with a description of the Silent Teachers model we employ with our students.

Workshop #50

The Weird and Wonderful World Hiding in the Initials of The Fabrica

John Waters, Penn State University, johnwaters@psu.edu

Nicole Squyres, Penn State University, nss28@psu.edu

Many of us are familiar with *De hominis corporis fabrica* (On the Fabric of the Human Body) published by Andreas Vesalius in 1543. The seven volumes of *The Fabrica* helped start a revolution that transformed human anatomy into a modern science. Less well known is the art and history of the historiated initials, the ornately illustrated capital letters that begin most chapters of *The Fabrica*. Workshop participants will analyze these images, which can be fanciful, gruesome, and humorous, as we explore how they reflect the experience of learning and teaching anatomy during this historical period.

Mental Health

Workshop #51

The Elephant in the Classroom– If, How and Why to Address Mental Health in Medical Science Students

Theodore Smith, IUSM, smittheo@iu.edu

Krista Rompolski, Moravian College, klompolski@gmail.com,

Edgar Meyer, University of Arkansas for Medical Sciences, ERMeyer@uams.edu

In recent years, increasing attention has been given to the stress, anxiety, and mental health of students. There is overwhelming evidence that many students are living with mental health issues, yet most curricular and classroom designs are not accommodating of these issues. Instructors may feel unqualified or ill-equipped to help students who express anxiety about their performance and potentially miss the opportunity to guide students toward critical, potentially life- saving, support systems. In this workshop, participants will work in small groups to come up with strategies to address pedagogical case studies surrounding mental health in anatomy.

Online Learning

Workshop #52

Anatomy and Physiology Flipped Classroom Learning for Physician Assistant Students using Complete Anatomy

Jonathan Wisco, Boston University School of Medicine, jjwisco@bu.edu

Engaged learning in an anatomy and physiology class is more meaningful and valuable when content acquisition is completed prior to entering the actual learning environment. We show how the 3D online learning tool, Complete Anatomy (3D4Medical, Elsevier) facilitates flipped classroom learning and prepares physician assistant students for case discussions in lecture and lab. Complete Anatomy is a comprehensive platform in which students can interact with assigned 3D models, videos, and formative assessments before and after class. The classroom, therefore, becomes an arena of facilitated discussion of concepts that inform the understanding and synthesis of clinically relevant topics.

Workshop #53

Teaching Online Anatomy and Physiology

Nahel Awadallah, Nash Community College, nwawadallah755@nashcc.edu

The online teaching predicament! Can it be done? Presentation includes options such as Connect, interactive videos and animations, a virtual cadaver with 3D rotatable models, simulated labs, assessments aligned to HAPS objectives, and exam proctoring for at-home and online exams. Tools will provide best practices for lecture and laboratory. You will learn about using superior resources to maintain rigor and course quality.

Workshop #54

Virtual Labs: More than just a Replacement

Ann Raddant, University of Wisconsin-Milwaukee, raddant@uwm.edu

Do you feel like your lecture and lab are just not connecting due to logistics or resources? Using labs online isn't just for online courses anymore. Virtual Labs offer flexibility, efficiency, and success for your A&P course. We'll share various ways a tool like Virtual Labs can help your students be better prepared for the in-person lab, fill in the gaps for a make-up lab or when resources are slim, and more.

Workshop #55

Teaching Anatomy & Physiology Lectures Online

Nathaniel King, Palm Beach State College, kingn@palmbeachstate.edu

In our changing world there are many challenges that students face, one of them being the ability to attend face to face classes. This workshop will present a perspective on how to best meet the needs of online learners. This will discuss course design, student engagement, challenges, and solutions. If you have any interest in taking your lectures online this workshop is for you. Please note: This workshop will not have a discussion on online or distance labs.

Workshop #56

Lone Star College Partners with Carolina Biological Distance Learning to Offer Anatomy and Physiology Lab Science Courses Online

**Alanna Tynes, Lone Star College - Tomball, Alanna.M.Tynes@lonestar.edu
Shannon McGurk, Carolina Distance Learning, Carolina Biological Supply Co.,
Shannon.McGurk@carolina.com**

With the rapid growth of online education, one challenge we encounter is how to teach online A&P courses that have a lab component. In this session, Alanna Tynes, Prof. of Biology at Lone Star College, will share her experience building and offering online A&P labs in partnership with Carolina Biological Distance Learning. Joining Alanna, Shannon McGurk, from Carolina Biological, will explain the logistics of using investigations that have been designed for the off-campus setting, while maintaining safety and college-level rigor, giving students the opportunity to experience the hands-on component of lab sciences taught online.

Workshop #57

Face-to-Face, Blended, or Online: A Modern Approach UTSA uses to increase Student Engagement in A&P Labs

Lucero Delgado, University of Texas San Antonio, Lucero.MartinezDelgado@utsa.edu

As instructors, we strive to find ways to engage students with content, but it becomes a burden to keep up with the trends and use of technology. The advancement of cloud-based technology has allowed students to have on-the-go access to lab and lecture materials, but the content should be appealing for students to complete assignments and revisit material for study. The Human A&P labs at UTSA have attempted to achieve this by using an online content-delivery platform that provides ready-to-use content equipped with animations and didactic, interactive questions and allows customization and creation of content. This workshop is intended to give an introduction of the platform, illustrate how activities can be built, and provide a case study of the platform's use and set up.

Outreach

Workshop #58

Using Anatomy to Engage Students in Science Outreach

Donika Rakacolli, Edgewood College, DRakacolli@edgewood.edu
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Brenda Del Moral, Edgewood College, BdelMoral@edgewood.edu

We created two activities to promote STEM and Health Science outreach to 6th-12th grade students and to aid in college recruitment. We used a clinical case study involving conjoined twins, a virtual cadaver table, and anatomical models to teach basic anatomy. We tailored the first activity to fit a variety of audiences, time-lengths and group sizes. The second activity was expanded into a week-long summer camp, where students were tasked with developing and modeling a surgical procedure to separate the twins and restore normal anatomy. These activities are consistently well received and engaging for students.

Workshop #59

Creating Extra Credit Assignments that Challenge, Inspire, and Empower Students

Anya Goldina Goldina, Elizabethtown College, goldinaa@etown.edu
Rebecca Kruse, Elizabethtown College, kruser@etown.edu

Extra credit assignments are often viewed with disdain by educators as opportunities to earn points for students that lack the knowledge to do well on exams and quizzes. However, these assignments can often serve as a platform for students to apply the course material to their own lives, optimizing their strengths and creativity, and encouraging them to take ownership of their learning. In this workshop we will discuss how we use extra credit assignments in our two-semester A&P course to develop community outreach, art exhibits, and education events to empower our students and make science accessible to the public.

Workshop #60

The Anatomy of an Outreach Session

Tyler Redway, The Ohio State University, redway.3@osu.edu

Outreach programs promote the community's access to resources in an effort to positively influence the thoughts and ideas of the next generation toward science and education. Outreach sessions with local high school students and community members is an important mission for any program and there are examples of this throughout many different universities. Sessions such as these have been a staple of the Division of Anatomy at The Ohio State University for quite some time, and we continually look to improve the existing structure in an effort to foster student learning and to increase early exposure to anatomy. This discussion-based workshop will focus on types of outreach currently utilized, existing structures of outreach sessions, with a lot of open discussion of approaches and personal experiences from attendees.

Professional Development

Workshop #61

On the Same Page with 'Dare to Lead': Inclusive, Authentic, and Brave Leadership Training

Kyla Ross, Georgia Tech, kyla.ross@gatech.edu

Elizabeth Pennefather-O'Brien, Medicine Hat College, eobrien@hapsconnect.org,

Judi Nath, Lourdes University, jnath@hapsconnect.org

Want to learn more about yourself and your working environment so that you can engage in brave conversations with your colleagues while not sacrificing your own values? If so, then join us for a workshop that explores key findings from Brené Brown's best-selling book and research on courage, vulnerability, shame, and empathy. Those attending will 1) explore the myths of vulnerability, 2) learn tools to effectively build trust with others, and 3) learn how to rise strong in the face of adversity. Join us as members of the HAPS leadership team share their own experiences with learning and applying these tools in our professional lives. Learn how you too can build a stronger, more inclusive, and more authentic community in the workplace.

Workshop #62

AnatomicalTerms.info (ATI): a Free, Wiki-Like, Reference Website Dedicated to Anatomical Terminology

Anthony Weinhaus, University of Minnesota, weinh001@umn.edu

A reliable source for teachers and learners with proper anatomical terminology with definitions, clinical terms, synonyms, eponyms, and links to imaging. Developed by Leiden University in collaboration with the Clinical Anatomical Terminology (CAT) Committee of the American Association of Clinical Anatomists. For accuracy, the terminology is derived from the International Anatomical Terminology. It is a work in progress and welcomes interested anatomists to contribute through a systematic data-entry and review program. The workshop will explore ATI with the hopes that attendees will find the site useful in their teaching, but also contribute to its growth and development

Workshop #63

The Foggy Idea of Being Crystal Clear: Transparency in Higher Education

Kristen Platt, University of Kentucky, platt.kristen@uky.edu

April Hatcher, University of Kentucky, arich3@uky.edu,

Katie Salmeron, University of Kentucky, katie.tuell@uky.edu

Promoting and achieving transparency in higher education is currently an important shared task for students, faculty, and the institution. However, it is difficult to define what transparency in higher education may mean to each party involved. The goal of this workshop is to explore undergraduate and professional student perspectives on transparency in higher education, and to use this information to encourage educators to consider the multifaceted nature of transparency at the onset of the student's learning experience. Topics such as course management, instructor behaviors and cost of education are explored under the umbrella of transparency.

Workshop #64

A Reviewer and Author Workshop for the HAPS Educator

**Kerry Hull, Editor in Chief, HAPS Educator, khull@hapsconnect.org
Jon Jackson, Burrell College of Osteopathic Medicine, jjackson@bcomm.org,
Jackie Carnegie, University of Ottawa, jcarnegi@uottawa.ca,
Carol Britson, University of Mississippi, cbritson@hapsconnect.org**

Are you interested in writing or reviewing for the HAPS Educator, the peer reviewed journal of HAPS? This workshop will guide both neophyte and experienced contributors through our peer review process and introduce our new online submission and reviewing system. We will evaluate exemplar submissions in small groups, and fine-tune the submission and review process in response to participant feedback. Potential authors can use this experience to increase the alignment between their submissions and the journal requirements. Participants will also have the opportunity to join the reviewer panel.

Workshop #65

Bring It To The Table: A College-Wide A&P Teaching Development Project

Hisham Elbatarny, Queen's University and St Lawrence College, helbatarny@sl.on.ca

In many institutions, Anatomy and Physiology (A&P) courses are offered at various levels/depth to suit different programs. Instructors usually have a spectrum of background knowledge/experiences. Generating platforms for discussion and exchanging expertise can contribute to teaching excellence and students' success. With this in mind, this college-wide project was designed. A&P instructors in different programs at St. Lawrence College were invited to participate. A questionnaire was distributed, followed by in-person then group meetings. Discussion included identifying resources, addressing challenges and needs, and sharing ideas for collaborations. In this workshop, I will explain the goals, methodology, and outcomes and share the action plan towards promoting A&P teaching at our institution.

Workshop #66

The First Year: An Interactive Discussion of Common Obstacles Encountered in the First Year

**Danielle Edwards, University of Alabama at Birmingham, dned222@uab.edu
Katie Salmeron, University of Kentucky, Katie.guell@uky.edu**

As early career faculty at large research-centered institutions, we are each tasked with teaching nearly every level of anatomy scholar. This includes students from undergraduate pre-professional, graduate and fourth year professional students in all medical disciplines. The first year as a faculty member can be exceptionally difficult to navigate. This workshop has two goals to help address these challenges. The first is to highlight some of the most common obstacles during the first year. The second is to facilitate candid discussion of these common first-year experiences, bringing together educators from different backgrounds and experience levels.

Workshop #67

Get Inspired to Write Your Own Lab Manual

**Sophia Garcia, Texas Christian University, sophia.garcia@tcu.edu
Zuzana Garcia, Tarrant County College, zuzana.garcia@tccd.edu**

Writing your own lab manual means so many possibilities! It gives you the opportunity to customize the student experience and best utilize the materials your lab is able to provide. You can offer the lab manual to your students at no cost, at a nominal cost, or for a profit. This workshop will cover the entire process from project proposal through production and implementation. Come join the conversation and learn how two faculty created their own lab manuals for Anatomy and Physiology.

Workshop #68

Community College A & P Education Research: Opportunities and Challenges

Murray Jensen, University of Minnesota, msjensen@umn.edu

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The majority of anatomy and physiology students are enrolled in two-year community colleges, but the bulk of science education research takes place in four-year research universities. The NSF-funded CAPER research project addresses this issue by providing support for community college A & P instructors who want to test the effectiveness of an instructional practice such as guided inquiry or clickers in their own classrooms. This workshop will be of interest to community college instructors who want to investigate the impact of a new classroom technique or to administrators interested in promoting research in their institutions. CAPER participants will share their experiences in their individual institutions in overcoming challenges such as achieving student buy-in and obtaining IRB approval.

Workshop #69

Writing Squares

Elizabeth Granier, HAPs Educator Board, egranier@hpsconnect.org

The HAPS Educator Board through this workshop will create small writing groups to collaborate, mentor and assist individuals with an interest in developing their writing skills.

Soft Skills

Workshop #70

Using Infographics to Help Students Understand and Communicate Anatomy and Physiology

Derek Scott, University of Aberdeen, UK, d.scott@abdn.ac.uk

Poster presentations to communicate scientific knowledge/understanding are a commonly used assessment tool for students. It can be a challenge for students (and staff!) to deliver clear information with minimal text on the poster. We sometimes found that this format didn't encourage imaginative project topics or posters. To enhance communication skills, imagination and student engagement we adapted an existing physiology research project and increased the emphasis on communication skills with the use of infographics. This workshop will provide ideas about how to get students started making their own biomedical infographics and encourage attendees to develop their own infographics during the session.

Workshop #71

Aligning NACE Competencies and HAPS Learning Goals

Tracy Ediger, Georgia State University, tediger@gsu.edu

The National Association of Colleges and Employers (NACE) has developed a list of eight competencies that determine whether college students exhibit career readiness. These competencies include broadly-defined skills such as critical thinking, leadership, communication, and teamwork. Workshop participants will discuss potential areas of overlap between the NACE Competencies and the newly-revised HAPS Learning Goals. Although the standard two-semester A&P course is content-dense, many faculty aspire to teach students additional, ancillary academic or professional skills. This workshop is an opportunity to share our collective wisdom in designing courses that incorporate at least one additional competency or learning goal.

Workshop #72

Lesson Learned from the Development and Implementation of an Interprofessional Case Learning Project (ICLP).

**Michelle Young, MCPHS University, michelle.young@mcphs.edu
Nalini Broadbelt, MCPHS University, nalini.broadbelt@mcphs.edu**

Interprofessional collaboration is essential for our student's success in their selected program/s and postgraduate life. These types of experiences have been shown to improve student's interprofessional competences - communication skills, teamwork abilities, ethical practices and understanding other team members' roles and responsibilities - as well as their theoretical knowledge and increase student achievement within their discipline. We developed and tested a unique pedagogical idea, interprofessional case learning project (ICLP) that encompassed a multi-disciplinary approach involving biology, chemistry and public health. The goal was to provide students and faculty with the opportunity to experience interprofessional collaborative practices that would encourage questioning, discredit misconception, connect concepts and make inferences, generate new ideas and encourage shared decision making.

Workshop #73

Assessing Students' Ability to Function as a Group in the A&P Lab

James Clark, Los Medanos College, jclark@losmedanos.edu

Scientists and health professionals rarely work alone, and A&P students are routinely expected to function as a group within the lab curriculum. Yet, we very rarely assess how well that group actually functions to achieve goals and learning objectives. As such, many students do not see the value of working as a group and focus solely on “their” learning of the material. The presentation here will examine how to reinforce group-learning dynamics and how group assessments can be utilized to reinforce the goals of developing skills to function within a group while still ensuring individual learning is taking place.

Student Success

Workshop #74

They Took College English- Why Won't They Read and Why Can't They Write?!

Wendy Riggs, College of the Redwoods, wendyk-riggs@redwoods.edu

In order to pass our classes, students in A&P are required to read and write about course concepts. This happens during exams, homework assignments, lab reports, essays, and even research projects. And in spite of the fact that most of our students have taken college English, biology faculty often wonder why it seems like they won't read, and they can't write! In this workshop, we'll discuss some of the unique aspects of literacy in STEM and explore strategies that help students practice the reading and writing skills they need to be successful in our classes.

Workshop #75

My Students Come Underprepared and This is How I Handle It

Stephen Sullivan, Bucks County Community College, stephen.sullivan@bucks.edu

One of the biggest challenges A&P instructors face is student preparedness. Many of us have students that are underprepared for our A&P course, class, lab, and/or exams. I use a few digital tools, both formative and summative, that minimize this issue with the majority of my students. I use data from their learning to pinpoint their challenges, so I can provide focused resources—ultimately making class time and office hours more productive and consultative.

Workshop #76

Preparing Students to be the Center of “Student Centered” Learning

Mari Hopper, Sam Houston State University College of Osteopathic Medicine, mkh036@shsu.edu

Do we place too much emphasis on the role of faculty in small group learning environments including TBL, PBL and CBL? To a large degree, the effectiveness of these teaching modalities rely on factors related to students, and thus out of the instructor's control. Perhaps it is time to take a serious look at how we prepare students to effectively contribute in small group learning environments. This session provides: 1) specifics on how one school effectively prepared students for small group learning, and 2) study data supporting the effectiveness of this training in positively impacting student behavior and learning outcomes.

Workshop #77

Back to Basics: Low-tech, 'Big Picture' Approach to Promote Student Success in A&P

Amie Yenser, Penn State Hazleton, alv10@psu.edu

Classroom technology has become pervasive over the last decade. While there are undeniable benefits of technology, pedagogy should remain at the forefront of what drives teaching strategies. This workshop highlights my transition from clickers to virtual reality back to good old fashioned paper and pen questions, group discussions, and classroom demonstrations. This workshop will include simple techniques for explaining difficult concepts from a 'big picture' scope. Scaffolded question sheets will be shared that reinforce understanding of concepts rather than simple memorization. The best part: all activities take less than 10 minutes so engaging, active learning can fit into your lectures!

Workshop #78

Human Anatomy - A Critical Thinking, Relational Approach

David Bastedo, San Bernardino Valley College, dbastedo@valleycollege.edu

Have your students stop memorizing, and start understanding. Reorganizing course content can group similar structural elements to enhance study and retention. Reorganizing can also create wholistic relationships between systems. Don't teach anything new, just reorganize content to create associations and relationships between subjects to enhance memory in your students.

Workshop #79

Using To-Do Lists to Engage Students and Increase Success in a Two Semester A&P Course

Evelyn Mobley, Chattanooga State Community College, evelyn.mobley@chattanoogastate.edu

Students taking our two semester anatomy and physiology course get overwhelmed by the volume of mandatory information disseminated by instructors the first day. Lecture instructors are expected to cover all due dates, campus policies and procedures, grading, online components etc. for the entire course during that first class meeting. Moreover, older returning students unfamiliar with technology struggle to understand how to navigate to their online assignments. This workshop will show how the use of weekly to-do lists keep students engaged and on track by focusing on weekly tasks. This increases success for at-risk populations.

Workshop #80

Student Engagement Begins Day One and Continues all Semester Long!

Krista White, Anne Arundel Community College, kywhite1@aacc.edu

Keeping students engaged during fifty-minute lectures can be difficult, and imagine if you are teaching a two hour and fifty minute class! This workshop will discuss many different ways to engage with your students and provide them opportunities to develop connections with their peers, beginning with the first day of class. We will then move on to even more techniques and activities that may be used all semester long. Some of these activities are A&P specific, while others may be used in any classroom. Be prepared to get up and move during this workshop!

Teaching Ideas

Workshop #81

How to Teach Cardiac Cycle

Valbona Hoxha, York College of Pennsylvania, vhoxha@ycp.edu; hoxha@lvc.edu

The aim of this workshop is to provide an interactive activity in teaching cardiac physiology classes. First, the students will perform an activity using water balloons, which gives a visual representation of pressure changes occurring in the ventricle. Next students will work in groups to complete a table with the phases of the cardiac cycle with six columns: (1)atrial state, (2) ventricular state, (3)state of atrioventricular valves, (4) state of the semilunar valves, (5) electrical change, and (6) ventricle volume. Students will be guided on how to complete the table in groups. Incorporating successful use of educational games and interactive learning methods, might be very useful to instructors and enhance student understanding.

Workshop #82

Hypothalamus-Pituitary and Beyond: Hormones to Memorize or Biological Design “Stories” to Tell

David Temme, University of Utah, temme@biology.utah.edu

Is the regulatory maze within the hypothalamic-pituitary axis too daunting for students to go beyond listing names and basic connections? Not if we illuminate more basic patterns! Here I focus on three: (1) Signaling connections that regulate body levels of the three lipid-soluble hormones share the same design. Why? (2) The two designs regulating body-levels of larger water-soluble hormones share a unique feature. What? (3) The two short peptides released from the posterior pituitary represent two sides of one story. Huh! Overall, the theme underlying each design centers around adjusting one of three things: readiness, timing, and/or boundaries. Discussion worthy?

Workshop #83

A Birdbrain Approach to Histology

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Effie Lambrinos, Clemson University, elambri@clemson.edu

Numerous approaches have been attempted for the study of histology, but this remained the lowest scoring segment of all practical exams. Recently we introduced a new approach modeled after that employed by birdwatchers. We have created a “field guide” which contains only pictures of histological specimens. Students are given microscopic slides, identified only by number. They are tasked with using camera-equipped microscopes to capture and identify each specimen. Their graded collections are then used for self-review. Performance has significantly improved, and histology is now the highest scoring segment on practicals. In this session we will review our approach.

Workshop #84

Immunology Stories: How Storytelling can Help us to Make Sense of Complex Topics

Jennifer Giuliani, Camosun College, GiulianiJ@camosun.bc.ca

The immune response is a wonderfully complex aspect of our physiology that can sometimes confound students and instructors alike. How do we wade through the layers of detail to help our students develop their understanding of immunology? In this workshop, I will share some of the stories about immunology research that helped me strengthen my own understanding, and improve my approach to helping students learn and understand this topic. In addition, we will explore some of the research on the power of storytelling, and how learning through stories might be a defining characteristic of what it means to be human.

Workshop #85

Playing with Your Food: Sharing a Meal to Learn Histology and Anatomy

Sandra Milligan, North Island College, sandra_milligan@telus.net

Take hands-on learning to a whole new level. What better way to understand the difference between tendons and ligaments, direct vs. indirect bone attachments, to see bone marrow and smooth articular cartilage than to share a meal of chicken and eat with your fingers. This workshop will share a small college experience where students enjoy a meal together and learn anatomy. Students go on a scavenger hunt through their meal and collect prime examples of listed items, often finding little surprises like vertebrae with spinal cord protruding. Added benefit of building community in the classroom and developing relationships!

Workshop #86

Incorporating Metacognition Practices into Coursework

Eileen Bush, Mohawk Valley Community College, ebush@mvcc.edu

This workshop will examine the processes of metacognition and how engagement in such processes can benefit learning. Workshop participants will develop metacognitive strategies for their classroom without compromising attention to course content. This will be accomplished by sharing specific “How To” strategies that participants can customize to the needs of their own courses.

Workshop #87

Billion-Dollar Ducks and the Quest to End Magical Thinking

Erin Amerman, Florida State College at Jacksonville, ecamerman@aol.com

Lourdes Norman-McKay, Florida State College at Jacksonville, l.norman@fsci.edu

Back by popular demand and quackier than ever! To effectively foster critical thinking in students, we must understand the antithesis to it—magical thinking. Join us for an exploration of the whacky ways magical thinking influences not only medicine and public health, but also education. Caution: Here there be...ducks! We'll tackle the billion-dollar ducks of homeopathy and slay other legendary pseudoscience foes as we arm you with practical tools to both recognize the features of magical thinking and brew the elixir of critical thinking with your A&P students. Get ready to venture into the classroom (or even a dinner party) to combat pseudoscience and science denialism!

Workshop #88

Wait, Wait—Don't Tell Me! A HAPS Science Quiz

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Anthony Weinhaus, University of Minnesota, weinh001@umn.edu,

Bill Perrotti, Mohawk Valley Crisis Center, WPerrotti@mvcc.edu,

Melissa Clouse, Doane University, meliss.clouse@doane.edu,

Kevin Petti, San Diego Miramar College, kpetti@sdccd.edu,

Betsy Ott, Tyler Junior College, bott@tjc.edu

We're back! Modeled on the popular NPR news quiz, this light-hearted workshop will feature audience and panel back-and-forth in friendly competition over topics germane to the history and teaching of Physiology and Anatomy. Featuring favorite segments as “Can you Bluff Enough?”, “Who's Bill This Time?”, and “Lightning Fill in the Blank,” our jaunt through the year's science headlines and discoveries will make you laugh and learn!

Workshop #89

Using Fun Activities to Learn About the Function of the Organelles

Julia Schmitz, Piedmont College, jschmitz@piedmont.edu

Looking for fun and new ways to help your students learn about organelles' functions? This workshop will engage the audience in different activities to teach about the organelles to their students. Participants in this workshop will partake in determining which object is representing which function and coming up with their own analogies. Activities include having the students come up with analogies of organelles to a city, finding objects to represent the functions of the organelles, and researching diseases that result in a malfunction of specific organelles. Interactive discussions will provide your students with an understanding of the interworkings of organelles.

Workshop #90

"Holy Anatomy Professor": Incorporating Superheroes into Your Classroom

Jeremy Grachan, The Ohio State University, grachan.1@osu.edu

In 2019, the SuperAnatomy course was introduced. This year's sequel will expand upon last year and give a follow-up, with examples from the course that ran in Spring 2020. The creative examples used will include ideas from students and faculty, but will also include clinical correlates, modern scientific innovations, and some real-life "supers" living among us. There will also be discussion and ideas presented to help your own A&P class leap buildings in a single bound to help make your students more engaged and interested in the material. This workshop will help you become the superhero in your classroom!

Technology

Workshop #91

Toward A Pedagogical Framework for Effective Implementation of Virtual Reality in A&P Courses

Monica Hernandez Valencia, Lone Star College, TX A&M, mohva@tamu.edu

While immersive technologies have repeatedly shown great potential for education, it hasn't consistently shown increases in learning gains or improved comprehension of science content. One contributing factor could be the lack of a framework for teaching that incorporates these technologies with what we already know about how the brain learns. In this workshop, we will discuss the learning theories best suited for learning science and how to best integrate immersive technologies (virtual, augmented, and mixed reality) within a proposed pedagogical framework.

Workshop #92

What's the Point? Digital Implementation the Strategic Way

Michael Koot, McGraw-Hill, michael.koot@mheducation.com

With the abundance of digital resources for the anatomy and physiology course, what is the most efficient way to organize your course for success? We will share best practices and valuable, tangible tips to set up your course and implementing some of the most valuable tools. The point? Ultimately achieving success for you and your students.

Workshop #93

Get Active and Level Up Core Competencies with Enzymes, Spectroscopy, and More!

Brandon Calderon, ADInstruments, Inc., b.calderon@adinstruments.com

John Melville, Vernier, jmelville@vernier.com

A hands-on workshop to play student for a session! Attendees will use Vernier's Go Direct® O2 gas sensor and ADI's learning platform, Lt, to carry out a guided experiment that tests the effects of enzyme and substrate concentration on the rate of enzyme activity. Prefer inquiry-based labs? Attendees will have the option to design their own experiment to test the effect of temperature or pH. We will also demonstrate the capabilities of a modern, low cost spectrophotometer and provide an opportunity to preview a diverse set of life science labs that integrate core competencies identified by Vision and Change.

Workshop #94

Integrating Technology Before, During, and After Lab

Melissa Greene, Northwest Mississippi Community, mgreene@northwestms.edu

Lisa Strong, Northwest Mississippi Community College, lstrong@northwestms.edu,

Robin Robison, Northwest Mississippi Community College, rrobison@northwestms.edu

In this workshop, we will discuss the advantages of integrating the use of readily available and relatively inexpensive technology into an A&P laboratory. We will give examples of technology we currently use in our laboratory and how these have improved student learning. We will focus primarily on effectively incorporating media into pre-lab, lab activities during lab, and post-lab assessments.

Workshop #95

Bridging the Histological Digital Divide: Two Perspectives on how to use Virtual Histology to Enhance Students' Understanding of Histology in the A&P Lab

Beth Ann Kersten, State College of Florida, Venice Campus, kersteb@scf.edu

Aura Grandidge, University of Rhode Island, afgrandidge@uri.edu

Histology is the thread that binds anatomical form and function. However, the identification of tissues in the classroom is often challenging. Many students struggle with the notion that they need to rely on repeating patterns, rather than memorization of text images, to identify tissues. During this workshop, we will share with you two different strategies that involve the use of virtual tools to enhance students' understanding of histology. One strategy is a low cost virtual only approach, and the other combines traditional microscopy with the use of virtual tools.

Workshop #96

21st Century Educators and Social Media

Alireza Jalali, uOttawa, ajalali@uottawa.ca

Basic science education has seen significant progress and innovation over the last decade. Today's students use a variety of technological tools in their everyday life and for their knowledge. One example is social networking tools, which have become increasingly popular. This workshop will help attendees learn about benefits, perils and professional behaviour regarding social media. Upon completion of this session, attendees will be able to: explain how social media can benefit medical educators with their everyday tasks (teaching, research, etc.) and describe appropriate social media online etiquette.

Workshop #97

Analytical Problems: Developing Critical Thinking Skills by Connecting Course Content with Real World Application

Kristi Zenchak, Oakton Community College, zenchak@oakton.edu

Consistent practice of critical thinking skills is an effective way to increase retention and transferability of content. These skills can be developed through analytical problems that use scenarios and questions relevant to students' lives and/or career choices. The problems are extended multiple choice questions that require written support of student understanding of concepts and content. This workshop will engage you in a variety of analytical problems that align with learning objectives of a two-semester Human Anatomy & Physiology course. These problems are designed to extend the knowledge learned in the classroom and apply that knowledge to life-relevant situations.

Workshop #98

Social Media in the Classroom

**Katie Salmeron, University of Kentucky, katie.guell@gmail.com
Danielle Edwards, University of Alabama at Birmingham, dned222@uab.edu**

As millennial professors, we have integrated a traditional lecture style with more progressive instructional modalities to meet the culture of modern Gen-Z students. We have developed a social media presence to reach these, primarily undergraduate students on those platforms while incorporating memes and sources of popular culture. We have found this increases interest and attention during class and encourages attendance in both lecture and in office hours. This workshop aims to introduce social media involvement as a means to incorporate active learning where students are truly immersed in the course material.

Workshop #99

Teaching the Musculoskeletal System by Incorporating Learning Sciences and Technology

Richelle Monaghan, Wilfrid Laurier University, rmonaghan@wlu.ca

Learning the musculoskeletal system involves studying hundreds of muscles, plus their bony attachments and actions. This task seems to be a transitional point for students in anatomy courses where they either embrace the challenge or disengage. To improve student experience and outcomes, videos using real-time guided learning create working memory chunks different from how traditional approaches present the musculoskeletal system. Memory techniques combined with picture superiority effect, random interval retrieval, self-assessment and metacognition can promote student competence and motivation. This workshop will review various learning approaches and how technology can integrate these methods to benefit student learning.

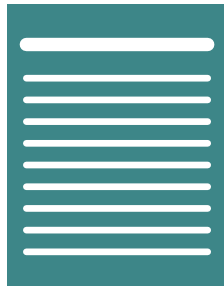
Workshop #100

Using Interactive Virtual Anatomy to Improve Student Performance

**Krystlynn Fusaro, Visible Body, krystlynn.fusaro@visiblebody.com
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Instructors who use Visible Body Courseware see significant improvements in student performance. Grades are going up a whole letter and DFW rates are decreasing! This workshop will have two parts: You'll get examples from instructors of how they used Visible Body Courseware to engage students and get increased performance. We'll include examples of using Courseware in lecture, lab, and homework. Then we will demo the easy steps to take to start a trial, review our awesome price point, and how to save money for students with open institutional access.





Workshop Related Manuscripts

Teaching a Flipped, Fully Online Class Using Small Group Work

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Abstract

The majority of my students are either out of state or international students who live on campus during the regular academic year and return home during the summer months. Thus, most students cannot attend face-to-face summer classes held on campus. In 2015, I developed a flipped, completely online human physiology course to meet the needs of these students. Human Physiology Online is composed of an asynchronous portion, where students review course material on their own (out of sync), and a synchronous portion, when we all meet online at the same time (in sync). Here, I describe the asynchronous and synchronous components of Human Physiology Online in detail, including how I use technology to recreate the small group environment of my regular face-to-face class during synchronous class sessions. I also present student feedback for Human Physiology Online from anonymous course surveys. <https://doi.org/10.21692/haps.2020.100>

Key words: Online, flipped classroom, guided inquiry

Introduction

My institution is a 4-year residential university that attracts students from across the United States and internationally. During the summer months, most students return home to visit their families and pursue internship, research, employment, and volunteer opportunities. In 2015, I developed a completely online version of my 300-level undergraduate human physiology course to meet the needs of students who wanted to take summer classes but could not attend face-to-face class on campus. Important considerations for course development included the need to teach all of the learning objectives from my face-to-face course to students in a variety of time zones. In addition, many summer students have other intensive time commitments, including summer internships and employment. Finally, few of my students had previously taken fully online classes in 2015.

To meet these challenges, I adopted an online flipped classroom model. In this 6-week class, students spend approximately 15 hours per week working on asynchronous material and attend two 90-minute synchronous sessions per week where they breakout into teams of three to complete active learning activities. The days, times, and format of the required weekly synchronous sessions is published in the institutional course atlas, making students aware of this commitment upfront, prior to course registration.

In face-to-face classes, the flipped classroom is an educational approach where students prepare in advance of class by, for example, watching prerecorded videos, reading, or completing assignments, while class time is spent engaged in active learning activities facilitated by the instructor (Berrett 2012; Hodges 2015; Tucker 2012). Styers et al (2018) have shown that students in flipped classes demonstrate gains in critical

thinking skills including the ability to summarize the pattern of results in a graph, and identify the suitable solutions for real work problems. These are vital skills for my students who plan to apply for medical and allied health care professional programs as well as graduate programs in biomedical research. Additionally, Styers et al (2018) demonstrated that students who are members of underrepresented minorities benefit more from the flipped class approach, consistent with work by Eddy and Hogan (2016) who showed that classes with a moderate amount of course structure greatly reduce the achievement gaps between black and white students and first-generation and continuing-generation students.

Possibly, learning gains by students in flipped classrooms may result from the greater use of active learning techniques over traditional lecture-based instruction (Jensen et al 2015). Together, these results indicate the flipped classroom approach is an effective pedagogical technique that benefits students from a broad range of backgrounds in face-to-face classes. In a recent comparison of face-to-face and online flipped formats of a graduate course in applied physics, Stöhr et al (2020) found similar average student performances, though the online flipped format led to a significantly larger spread in performance. Further work is required to determine whether this result is broadly generalizable to different types of students in other disciplines.

Online learning activities can be categorized as being asynchronous, that students complete individually on their own time, and synchronous, where students meet online at the same time to work together in sync. Asynchronous course material offers maximal flexibility in terms of when students interact with course content while synchronous sessions

continued on next page

offer students an opportunity to have questions answered and to receive social support from peers and instructors in real time. Comparing the benefits and limitations of these two educational approaches, Hrastinski (2008) concluded synchronous and asynchronous online learning activities are complementary, recommending that instructors adopt a combination of both methods in their online course design. An online flipped classroom format takes advantage of the benefits of both asynchronous and synchronous learning activities.

Asynchronous component of Human Physiology Online

Asynchronous course material for Human Physiology Online includes mini-lectures that cover the entire asynchronous course learning objectives, assignments, and quizzes, based on mini-lecture content, and midterm and final exams. I recorded all of the fifty-six mini-lectures using Screencast-O-Matic screen capture software. Each mini-lecture is approximately five to ten minutes in duration and covers one to two learning objectives. Students access mini-lectures posted on our learning management system class site. While students can download the mini-lectures as MP4 files for future use following the course, most students report saving the PowerPoint files used to make the videos for future studying for standardized exams such as the Medical College Admissions Test.

The weekly schedule for Human Physiology Online, including deadlines for asynchronous activities and synchronous class times, is found in Table 1. Prior to attending synchronous class sessions, students watch five to six pre-recorded mini-lectures and individually complete assignments on their own time. Each assignment is comprised of 10-15 multiple choice and true and false questions that are automatically graded to provide immediate student feedback. The best nine out of eleven asynchronous mini-lecture assignment grades count

toward 10% of the final course grades. In addition to mini-lecture assignments, students also complete an end-of-week assessment based on synchronous and asynchronous course content. On weeks one, three, and five of the six-week class, students take a quiz on the material covered on those weeks. Midterm exams are taken at the end of weeks two and four and a final exam is taken at the end of week six. Quizzes and exams are composed of a combination of multiple choice and short answer questions. Only the midterm and final exams are closed book and live-proctored using a proctoring service.

Synchronous component of Human Physiology Online:

Synchronous sessions are held twice weekly when students and I meet together online at the same time using Zoom videoconferencing software (Table 1). These sessions are a mandatory course component and participation in synchronous group activities is worth 10% of the final course grades. On rare occasions when students are absent and excused from a synchronous class, for example due to illness or computer failure, they can complete missed activities on their own and receive credit.

Synchronous class time begins with a review of submitted work from previous synchronous session activities and commonly missed questions from mini-lecture assignments, quizzes, and exams. Next, students spend the majority of class time working together on physiology guided-inquiry activities in teams of three in breakout rooms, sub-rooms within the class meeting that allow students to work collaboratively. Many of these activities have been modified from Brown (2016), Jensen et al (2014), and the HHMI BioInteractive website (<https://www.biointeractive.org/>).

A sample question from an endocrinology activity with representative student group answers is found in Appendix A, while an entire neurobiology activity, along with teaching

| Sun | Mon | Tues | Wed | Thurs | Fri | Sat |
|-----|--|---|-----|---|---|-----|
| | 12noon (EDT) End-of-previous week's assessment closes | 8am (EDT) Pre-class mini-lecture assignment due 8-9:30am (EDT) Synchronous class session 9:30am (EDT) Online office-hour | | 8am (EDT) Pre-class mini-lecture assignment due 8-9:30am (EDT) Synchronous class session 9:30am (EDT) Online office-hour | 7am (EDT) End-of-current-week assessment opens | |

Table 1. Sample weekly schedule for Human Physiology Online (Biology 336)

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resources and an answer key, can be downloaded from Cafferty (2019). This neurobiology activity, composed of twenty-seven multiple choice, multiple answer, and short answer questions, is aligned with HAPS learning outcome modules H 7.1, H 7.5, and H 8.3 (HAPS, 2019) and takes my students approximately one hour to complete. Synchronous session activities are built as ungraded practice quizzes into the class site on our institutional learning management system.

During synchronous sessions, students are randomly assigned into breakout rooms allowing everyone an opportunity to meet and collaborate with each of their peers by the end of the semester. Using this approach, students work with classmates from a broader range of backgrounds, are exposed to a wider range of ideas, and may build a greater sense of community than if students chose their partners or remained in the same group for all of the synchronous sessions. Once students enter their virtual breakout room, they self-select one of three defined team roles including the roles of reader, reporter, and recorder.

The team's reader reads the text of the activity out-loud to their teammates, which helps keep everyone on track. Following group discussion, the recorder types the group's consensus answers to questions into the activity. Teammates can more easily provide input to their work when the recorder shares their screen with their group throughout the activity. Finally, the reporter shares group responses to questions with the rest of the class at the end of the synchronous session.

While students follow prompts and answer questions in the group activity, I move from one breakout room to the next to monitor progress and answer questions when needed. During the final 10-15 minutes of synchronous class, students are brought together for a discussion of the synchronous activity and reminders of upcoming deadlines for asynchronous class material. More detail about the benefits and use of activity roles during small group work, and examples of alternative roles, can be found in Hoffman and Richardson (2019).

Student feedback and evidence of success:

Based on anonymous survey responses ($n = 76$) over the past three years, most students have a positive experience learning human physiology online. For example, while only 27% of students had completed a fully online course prior to taking human physiology, 91% of students reported they would enroll in another fully online course in the future. In addition, most students viewed the synchronous and asynchronous components of the course positively. For instance, 95% of students either strongly agreed or agreed with the statement, "The asynchronous mini-lecture assignments helped me in this course," and 94% of students either strongly agreed or agreed with the statement, "The synchronous group activities helped me in this course." Selected student comments regarding course components to keep or add to the class are presented in Table 2.

| One thing I would like to KEEP in Biology 336 is: | One thing I would like to ADD to Biology 336 is: |
|---|---|
| ... the group activities. I really like the aspect of going into breakout rooms because it makes the class a lot more interactive, and I have been able to meet my classmates through this. I think it is especially important to interact with classmates and make friends in the online course setting, so we can share struggles, talk about the class together, and ask/answer each other's questions. I have found online courses to be a lot of work, and having friends while studying is more encouraging and motivating. | A way to force everyone to be better prepared for group activities. A lot of the time the other group members did not know anything and I was left to figure things out which didn't help me too much in terms of talking out the material and working as a team. |
| The mini-lectures were really cool and provided a good experience for the asynchronous activities. | Less group activities and spending that time more on lecturing about confusing concepts and/or answering questions. |
| The in-class activities. It is always helpful to review out-loud with other students to re-inforce learning. | More synchronous session teaching. |
| This was more organized than any class I've taken before! So the organization is a keeper. In terms of content, I really (struggled through and then) enjoyed the cardiac physiology unit. | An easier way to cover all this information. |

Table 2. Selected student responses to anonymous survey questions.

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Discussion:

Offering Human Physiology Online has successfully increased the availability of this course to students who do not live locally, including to students who have taken the class from Belgium, China, India, and Taiwan. Course survey results reveal 60% of Human Physiology Online students would not have been able to take this course on campus for a variety of reasons, including not being able to afford the additional housing costs necessary to remain on campus over the summer, having family obligations in their hometowns far away from campus, or having the opportunity to participate in summer undergraduate research programs at research institutes across the United States and beyond.

However, the requirement of synchronous session attendance might present a technological barrier for students who lack Internet connections strong enough for live videoconferencing or who live in time zones that make class attendance difficult, for example, students in the Pacific Time Zone must attend synchronous sessions at 5am local time. To accommodate students who cannot participate in synchronous group work for these reasons, a future section of Human Physiology Online may be offered using modified online group activities for asynchronous completion.

O'Brien (2020) has modified guided inquiry activities for an asynchronous chemistry class and recommends making activity completion a collaborative team effort. Alternative ways of providing social support to students will also have to be incorporated into a completely asynchronous section of Human Physiology Online as past students have reported enjoying synchronous group work as a way to meet, interact with, and share their course experience with their peers (Table 2).

I have taught my online human physiology course every year since 2015. The discussions I observe while facilitating synchronous group activities are consistently insightful and draw upon information from asynchronous course material. In addition, online students perform similarly or better on the same final exam as students in my traditional, face-to-face classes (unpublished findings). Together, these observations suggest online students are thoughtfully engaged with the material both during independent and group work and are learning as much content as students in the face-to-face class.

Acknowledgment

PC would like to thank ADInstruments and the Human Anatomy and Physiology Society for supporting this work with The ADInstruments Sam Drogo Technology In The Classroom Award.

About the Author

Patrick Cafferty, PhD, is a Senior Lecturer in the Department of Biology at Emory University in Atlanta, Georgia. He teaches courses in Introductory Biology, Human Physiology, and Developmental Neurobiology.

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APPENDIX A

A sample question from an endocrinology synchronous session activity aligned with HAPS learning outcome module J 9.1 (HAPS, 2019) is presented in Figure A1. Sample responses by two different student groups are shown in Figure A2. To answer drawing questions in synchronous session activities, students are invited to use any drawing software of their choosing, or alternatively may hand-draw illustrations and take pictures of their work. Students can upload their responses as JPG or PDF files into the activities.

Endocrine disease can result from changes in hormonal secretion or altered responsiveness of the target cells to hormone.

- Alterations of hormonal secretion can result too little hormone (a **hyposecretion** disorder) or too much hormone (a **hypersecretion** disorder).
- Altered responsiveness of the target cells to hormone can arise from reduced responsiveness to a hormone (a **hyporesponsiveness** disorder) or increased responsiveness to a hormone (a **hyperresponsiveness** disorder).

Two types of *diabetes mellitus* exist. The most common form of diabetes is the hyporesponsiveness disorder, *type 2 diabetes mellitus* (also called adult-onset diabetes mellitus). Individuals with *type 2 diabetes mellitus* produce the hormone insulin, however, their cellular sensitivity to insulin is reduced. A less common form of diabetes is *type 1 diabetes mellitus* (also called juvenile diabetes mellitus) results from insulin **hyposecretion**. This disease results from a reduction in the number of active pancreatic β cells.

Question: Draw a model to show the pathophysiological states of:

1. *Type 1 diabetes mellitus* for an individual who has a reduction in the number of active pancreatic β cells that secrete insulin.
2. *Type 2 diabetes mellitus* for an individual who has reduced cellular sensitivity to insulin.

Hint - If you're unsure where to begin, first draw a homeostatic reflex arc to reflect normal glucose homeostasis. How can this arc be modified to reflect the pathophysiological states of types 1 and 2 diabetes mellitus?

Upload your model here.

Figure A1. Sample synchronous session activity question

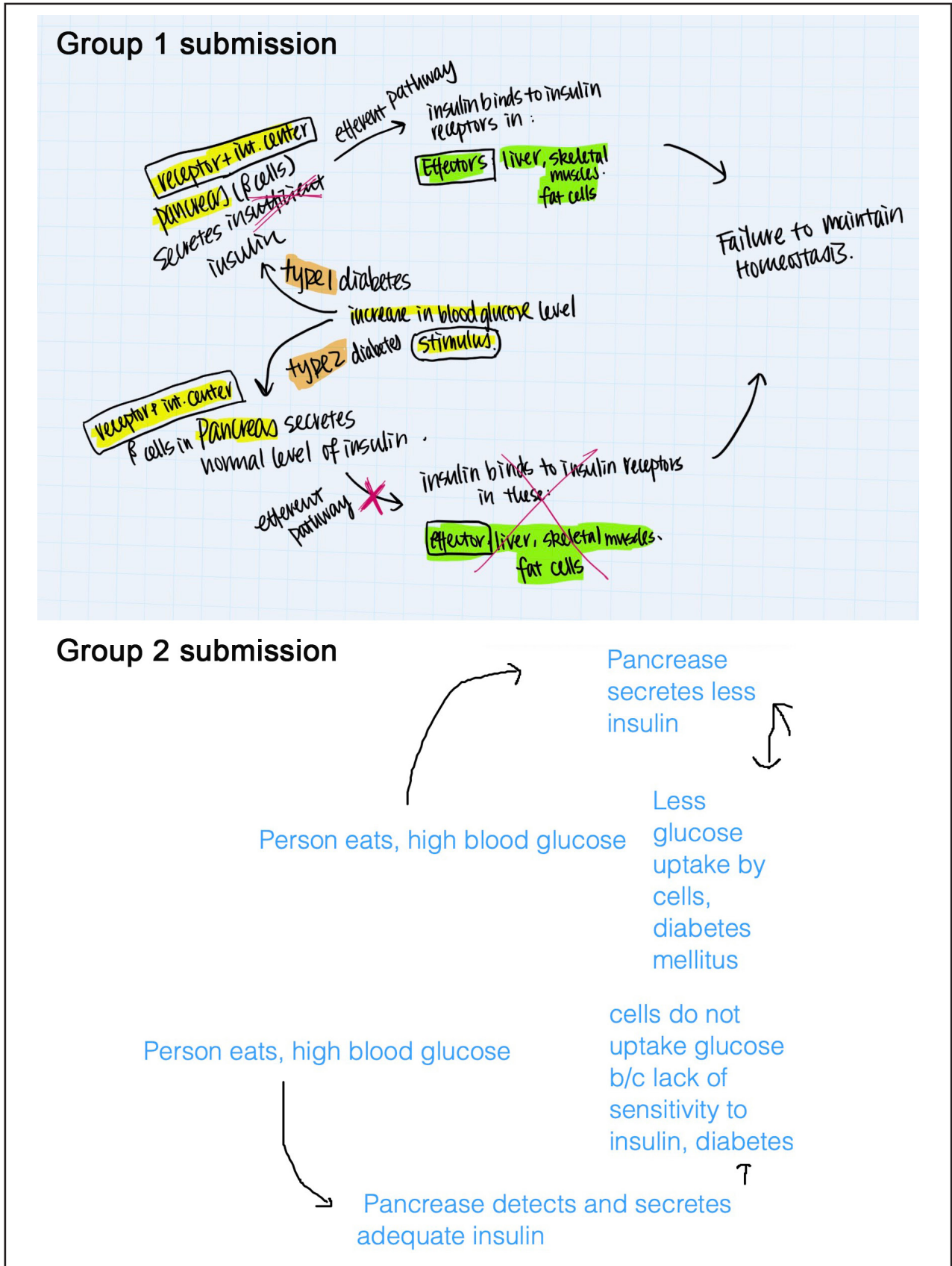


Figure A2. Sample submissions of two student groups to synchronous activity question

Making the Invisible Visible: Let's Discuss Invisible Disabilities

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Abstract

Despite the passage of laws aimed at increasing access and equitable opportunities for students with disabilities in postsecondary education, issues related to disability continue to be rarely discussed in topics related to diversity, inclusion, and educational reform. Disability represents not only an immensely diverse section of the general population, it is a term that is problematic to define, and a term embroiled in controversy, both historically and from a current day perspective. This short piece invites readers to consider the history of how disability has been defined, explores specific issues faced by those living with 'invisible disabilities', such as learning disabilities and attention deficit hyperactivity disorder (ADHD), increases awareness of how these issues may affect educational outcomes, and encourages educators to seek best teaching practices that can address the specific needs of particular students in their classes. <https://doi.org/10.21692/haps.2020.101>

Key words: Invisible disabilities, students with disabilities, equitable opportunities

Introduction

Access to higher education for individuals with disabilities has increased steadily since the 1970s, especially in recent decades. In 1995-96, nationally representative data found that students with self-reported disabilities represented approximately six percent of the overall undergraduate population in postsecondary education (Horn 1999), while in 2015-2016, the proportion of undergraduate students with any form of disability had risen to just under 20% (National Center for Education Statistics 2019). The significant increase in enrollment rates for students with disabilities at postsecondary institutions can be especially attributed to the passage of civil rights based federal laws, particularly Section 504 of the Rehabilitation Act of 1973, and the Americans with Disabilities Act (ADA) of 1990 (amended in 2008), which forbid discrimination against the inclusion and acceptance of students with disabilities at educational institutions that receive public funds. Furthermore, it ensures that students with disabilities have access to reasonable accommodations should appropriate documentation be provided, ensuring equitable access to learning opportunities, regardless of ability, or impairment (Burgstahler 2003; DaDeppo 2009; Oslund 2013; Cortiella and Horowitz 2014).

Nevertheless, while the passage of these laws has been instrumental in providing a means of equal access for students that was once impossible due to discrimination, students with disabilities continue to face challenges related to educational outcomes and support. Lennard Davis' (2011) article in the *Chronicle of Higher Education* notes that while discussions related to diversity should be commended, and higher education has improved its ability to provide accommodations and services to students with disabilities, disability as a topic is often missing from dialogues pertaining to inclusion, diversity,

and curriculum reform, instead being relegated to webpages dedicated to accommodations and services. Central to his argument, Davis (2011) notes that within his own field of literary theory and cultural studies, one publication contained only one essay dedicated to disability (which he authored) and found was subsequently removed from future editions.

This point has been echoed more recently by Trybus and colleagues (2019), who cited studies that found of the total number of educational development articles and presentations dedicated to inclusion, diversity, and social justice, published over a span of two decades, less than one percent mentioned disability. Within Davis' (2011) article, he also recalls an incident where after giving a presentation focused on disability and diversity, he was challenged on whether the oppression of people of color could ever be comparable to those living with disabilities. He replied that the notion that disability shares parallels with cultural differences and minority group status is not a new one and that other researchers have argued that framing disability as an aspect of human diversity, and as its own minority group, would be beneficial as a means of social justice and empowerment, rather than viewing one's impairments as a negative condition that requires charity or pity (Anastasiou and Kauffman 2012; Banks 2015).

However, concerns related to how disability is defined, and who chooses to identify as disabled within identity politics represents only a small part of concerns within disability studies and addressing the needs of people living with different kinds of disabilities. Disability remains a controversial, and vaguely defined aspect of human diversity. How the term is defined can have a profound impact on who chooses

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to identify as disabled or not, and it remains a heavily under researched area, including studies investigating STEM fields. These factors make addressing the needs of students with different kinds of disabilities extremely difficult.

This article briefly examines the history of disability rights in education, how society's perception of the meaning of disability can affect the willingness of people with different types of disabilities to identify as such, and how this can subsequently affect postsecondary educational outcomes for students, their willingness to seek accommodations and other support services, faculty teaching practices, student-faculty relations, and future employment opportunities for students with disabilities. Given that little research has been conducted into understanding the needs of students in specific STEM fields such as anatomy and physiology, this article is deliberately broad, and will attempt to reference articles related to STEM fields and medical education where possible. Because disability studies within STEM fields remains an under researched topic however, this piece is not intended to offer definitive solutions, and instead hopes to encourage educators to reflect on their own teaching practices and any potential biases of how they view students with particular disabilities, and to seek professional development opportunities where possible.

A Brief History of Disability Rights, Access to Education, and Concerns Related to Diversity, and Identity

The etymology of the word disability roughly translates to 'loss of power', and although the concept of what it actually means to be disabled has been vigorously contested over the last century, it is irrefutable that people with disabilities have long suffered from negative connotations associated with their impairments, or being classified as disabled, even when holding positions of power. For example, President Franklin Delano Roosevelt suffered from partial paralysis from the waist down a result of being previously infected with polio at age 39, and this required him to use a wheelchair for much of his life including his entire time in office. However, Roosevelt took extraordinary steps to hide his condition from the public eye; he staged photographs to maintain the illusion that he was able bodied, and sought to suppress publication of photos from journalists when seen in a wheelchair, as he feared such exposure would show him in a "weak state" (Fleischer et al. 2012; Porter 2019).

Throughout history, people living with disabilities have had their abilities and opportunities to contribute to society censored or denigrated, encouraged to hide their conditions, or have had their status in society relegated to a passive recipient of care; a burden on society who must be cared for by the able bodied, or removed entirely from public view. Contemporary views of disability however are far

more complex, and controversial. This next section briefly introduces the origins of two competing models of disability that continue to have a major impact on how disability is viewed by the members of the public, and from a legislative standpoint.

There is evidence as early as the period of Plato's Republic (around 427-347BC) that the ability to think and act rationally was viewed as the spirit of human embodiment. Individuals with physical and intellectual disabilities were actively excluded from being able to participate as full members of society and were often killed. Members of the Republic viewed the presence of a disability as a sign of dysfunction and injustice that should be purged from society (Kiefer 2014). Biblical interpretations of physical or intellectual abnormalities have at times also characterized such conditions negatively, from a sign of evil spirits being present, to an act punishment against an individual or their family for sinful behavior (Oslund 2013).

These early beliefs have had a lasting impact on how disabilities have been viewed over the last century, from popular culture representations to political discourse, although there have been some differences from a geographical standpoint. For example, Oslund (2013) noted that 19th century views of people with disabilities in the United Kingdom tended to view those with disabilities as 'idiots' to be left behind. At the same time, in the United States, some attempts were made to put those with disabilities to work, or to educate them to a point of self-sufficiency, albeit often at the expense of segregation and institutionalization, or exposure in the form of circus freak shows (Oslund 2013; DiNunzio et al. 2016).

Furthermore, it is important to appreciate that eugenic principles previously espoused during Plato's Republic have also affected the lives of those with disabilities as recently as the 20th century. Modern eugenics, most often associated with Nazi Germany war crimes, may have in part been influenced by medical procedures carried out in the United States at the time (Hansen and King 2013). One such example was the widespread implementation of forced sterilization laws aimed at people with disabilities, and other 'undesirable' traits; rhetoric largely founded on ethnic, and racial prejudices (Stern 2005; DiNunzio et al. 2016). A common premise shared by these examples is that early conceptions of disabilities were based on variations in structure and function that are outside of an expected or accepted norm. This fundamental attitude of disability as a state of difference that requires correction or remedy is commonly referred to as the 'medical model of disability' (Bickenbach et al. 1999; Shakespeare 2006; Wasserman et al. 2016; Trybus et al. 2019).

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During the early-mid 20th century, issues regarding access to education for persons with disabilities began to emerge. In addition to the already limited opportunities to access education, people with disabilities who sought educational opportunities were not protected from being excluded because of their conditions. Universities and colleges could not only reject applications based on an individual's disability status; they also did not have to accommodate the needs of certain students into the architectural design of their learning spaces, such as the construction of ramps for wheelchair access (Madaus 2011; Oslund 2013).

Genuine access to education for persons with disabilities, along with the advent of disability support services and accommodations many of us may be familiar with today, were born out of the disability rights movement, which itself was a product of the civil rights movement during the 1960's. As Oslund (2013) noted, those participating in the disability rights movement were not just individuals with disabilities themselves. Many advocates were parents of individuals with disabilities, who rejected the long held notion that their child should be kept away from the public eye, or reduced to a minimal role in society (Shakespeare and Watson 2001; Oslund 2013).

Similar to other minority groups of the civil rights movement, people with disabilities protested against a lack of equality and systemic discrimination, and rejected the long held belief that medical professionals, and able-bodied individuals were the most reliable judges of what was best for their lives (Shakespeare 1998). The central argument of many disability advocates at the time was that disability was a condition imposed upon them on top of their impairments, rather than merely due to the impairments themselves. In other words, the main reason they were restricted from engaging in daily activities was because society had failed to incorporate their needs as a result of social prejudices and ignorance, a competing theory that became known as the 'social model of disability' (Shakespeare and Watson 2001; Oliver 2013; Oslund 2013; Foundation for People with Learning Disabilities 2019).

The social model of disability soon became and remains the dominant theory of what it means to be disabled. It directly competes with the older medical model of disability and advocates for the removal of social barriers. In its most extreme form, it rejects the existence of limitations on daily activities caused by bodily impairments, is dismissive of intervention measures such as special education and accommodations, and demands that those with disabilities advocate as a homogenous, unified group, rather than focusing on differences related to disability type and severity (Shakespeare and Watson 2001; Shakespeare 2006; Thornton and Downs 2010; Anastasiou and Kauffman 2012; Oliver 2013; Oslund 2013).

The disability rights movement proved to be a powerful force for change in the lives of those with disabilities. Aside from challenging the long-held doctrine that impairments were a wholly internal defect to be remedied, it challenged society to be aware of its privileges and implicit biases, and gave a voice, and positive identity to those with disabilities. In the United States, it led to the first federal laws dedicated to addressing the needs of students with disabilities, such as the Architectural Barriers Act of 1968, which focused on addressing the needs of those with physical disabilities, but later saw implementation of the Rehabilitation Act of 1973, and later the ADA of 1990, which together have expanded the rights granted to those with disabilities, by covering a broad range of conditions and impairments, including those with disabilities that are 'invisible' to the naked eye (Madaus 2011; Oslund 2013). Examples of 'invisible disabilities include specific learning disabilities such as dyslexia, dyscalculia, dysgraphia, and other conditions such as attention deficit hyperactivity disorder (ADHD) (Oslund 2013).

Since that time, the social model's influence on the concept of what it means to be disabled has been the subject of great debate and controversy; some people with learning disabilities for example refuse to use the word 'disabled' to describe their condition, preferring to instead refer to their condition as a learning 'difference' or 'difficulty' (Goodley 2001; Denhart 2008), while other scholars have argued for seeing disabilities as a cultural aspect of diversity, as mentioned at the beginning of this article (Shakespeare and Watson 2001; Bampi et al. 2010; Davis 2011; Anastasiou and Kauffman 2012).

Since the debate of whether disability is more of a medical versus a social phenomenon began, there are some important paradoxes that should be noted. Firstly, it is ironic that the laws designed to protect the rights of people with disabilities still define disability from an ableist, or medical model viewpoint. Within the ADA, disability is 'any physical or mental impairment that substantially limits one or more major life activities' (United States Department of Justice 2009), while access to special education, or accommodations as stipulated within the Rehabilitation Act of 1973, and Individuals with Disabilities Education Act (IDEA) of 2004, also go against the social model's conceptual framework (Anastasiou and Kauffman 2012; Mole 2013; Holt et al. 2019; Trybus et al. 2019).

Furthermore, some researchers have been critical of the inflexibility of the social model's focus on social barriers and framing disability as a form of human diversity, citing incongruencies. As Shakespeare (2006), and Davis (2011) point out, while the overarching goals of equality, and being seen as normal, may be shared between persons with disabilities and other minority groups, equating disability with diversity can be problematic. It seemingly goes against a central notion of diversity and inclusion that minority group identities such as gender, race and ethnicity, are not debilitating in

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their own right, but only due to social prejudices. Arguably, this cannot be true for some with impairments that are debilitating in themselves, such as a neurodegenerative disease. Furthermore, Davis (2011) contends that this central idea within diversity dialogue of sameness within differences, leaves it unable to celebrate disability as an empowering identity, or a uniqueness we could imagine choosing for ourselves. This also leads to some people embracing one group identity, but rejecting the other; gay individuals, and those who identify as African American for example, are more likely to resist the label of disability (Shakespeare and Watson 2001; Wagner et al. 2005; Newman et al. 2009).

Anastasiou and Kauffman (2012), and Shakespeare and Watson (2010) are also critical of the attempts of social model proponents and multicultural theorists to categorize people with disabilities as a homogenous group, irrespective of the type of disability, or its severity; ironic given that diversity is synonymous with variety. As Shakespeare and Watson (2001) note that the Union of the Physically Impaired Against Segregation (UPIAS) granted membership to those with only physical disabilities. Disability is a term that represents a tremendously heterogenous group of conditions, some more obvious to the naked eye than others. For example, at Indiana University, disabilities are grouped around seven broad categories: visual, mobility, auditory, neurological, cognitive, medical, and psychological (Indiana University 2019). In addition to differences based on type, and severity, disability can also be considered a fluid term as opposed to a fixed aspect of one's life (Shakespeare and Watson 2001). While some conditions may impose limitations that affect an individual for large parts of their life, some conditions can present themselves at only certain points of life, such as in elderly individuals, or also be episodic in nature, such as multiple sclerosis.

The concept of disability is complex, controversial, and demands an understanding of the socio-historical contexts in which it is defined. The heterogeneity surrounding the vagueness of disability, and the many different types of barriers that exist, is compounded by the fact that both the medical, and social models fail to encompass the specific experiences of those living with particular disabilities.

It is my personal view, that an adequate lens for approaching and studying disability need not be focused on one perspective. I concur with the opinions expressed by Shakespeare & Watson (2001), and Anastasiou and Kauffman (2012), that a more holistic and interactional viewpoint is required to understand the lived experiences of those with disabilities, and these should encompass the variability of human experience related to aspects such as bodily, psychological, cultural, and social factors, rather than focusing on whether existing barriers are purely social or medical in

nature. Nonetheless, the heated nature surrounding the term disability still resonates, and reconciliation between the social and medical models seems unlikely for now.

Competing Ideologies: The Impact of Classifying Disability on Disclosure Rates, Postsecondary Educational Outcomes and Employment Opportunities

Understanding the history behind why modern discourse surrounding the term disability is filled with controversy can help us better understand the lingering impacts that being labelled as disabled has on students with certain disabilities; particularly their willingness to identify as disabled, the effectiveness of laws designed to prevent discrimination, the impact of faculty knowledge of a student's disability, and the efficacy of solutions such as accommodations. Each aspect ultimately has a profound impact on the educational and employment outcomes of students with disabilities.

Before delving into what the literature suggests about educational outcomes for students with different kinds of disabilities, it is important to understand that the overall picture remains unclear. In addition to being an under-researched topic, low disclosure rates for those with non-physical conditions such as learning disabilities can negatively affect the representativeness of samples in disability studies conducted at postsecondary institutions, and privacy restrictions make it difficult for researchers to identify eligible participants. When data is readily available, disability is sometimes reported as a single category, rather than considering differences by disability type, and there remains a paucity of data available regarding outcomes for students with disabilities within specific STEM domains such as anatomy and physiology. Finally, although the term invisible disabilities can be used to refer to a range of conditions, most of the works I cite will focus on studies in students with learning disabilities and these statements should be interpreted with caution and are not necessarily representative of all invisible disabilities.

Enrollment rates, faculty knowledge and disability disclosure rates

Since the passage of laws such as the ADA, the proportion of students with learning disabilities enrolling at postsecondary institutions has increased substantially, with 34.5% enrolling at a postsecondary institution within four years of leaving high school in 2005, compared to just 11.4% in 1990 (Lightner et al. 2012). Furthermore, within eight years of leaving high school, students with learning disabilities enroll in some form of postsecondary education at approximately the same rate (67%) as the general population (Cortiella and Horowitz 2014).

However, students with learning disabilities are twice as likely to attend two-year colleges compared to four-year colleges, attend four-year institutions at approximately half the rate as the general population (Cortiella and Horowitz 2014),

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and pursue postsecondary education at four-year colleges at a significantly less rate compared to students with other disability types, including speech/language impairments, hearing impairments, orthopedic impairments, autism, and deaf/blindness (Wagner et al. 2005, Newman et al. 2009). Despite these discrepancies, national data has shown that students with invisible disabilities, including learning disabilities, ADHD, and psychiatric conditions, are now the most common disability groups enrolled at postsecondary institutions (Raue and Lewis 2011).

With regard to enrollment rates of students with disabilities in STEM fields, recent data has shown that students with disabilities pursue STEM majors at a slightly higher rate than the general population, albeit at two-year colleges as opposed to four-year institutions (Lee 2011). One possible reason for the enrollment discrepancy between two-year and four-year colleges may relate to previous findings by Burgstahler and associates (2001), who reported that students with disabilities enrolled at two-year institutions experienced a greater number of personalized services and accommodations and more supportive faculty compared to students with disabilities at four-year institutions.

Negative stereotypes surrounding disability remain a significant life-long problem for people with learning disabilities. National data has shown that parents of young children with signs of a learning disability are more likely to wait and see if their child will grow out of it, rather than seeking a diagnosis early on, and approximately half the general public believe learning disabilities are the result of laziness (Cortiella and Horowitz 2014). Similar negative views have been found in faculty members in higher education settings (Thurston et al. 2017).

There has been a suggestion that faculty members in the basic sciences may be less accommodating and understanding of the needs of students with disabilities compared to faculty in other fields such as education, social sciences, and business (Burgstahler 2003). Previous studies of views held by postsecondary STEM educators have revealed that faculty members can hold negative stereotypes of and expectations of students with disabilities in STEM classes, show a lack of understanding and acceptance of students with disabilities, may be hesitant to cooperate with implementing accommodations, and display a lack of preparedness to teach students with disabilities (Love et al. 2014; Thurston et al. 2017; Banks 2019).

Other studies have found that postsecondary faculty educators who display a greater interest in knowledge about disabilities and a willingness to adapt their methods of instruction can have a positive impact on academic outcomes for students with learning disabilities (Hedrick et al. 2010; Thurston et al. 2017; Banks 2019). While those

who are more understanding of the needs of students with disabilities are also more likely to seek professional development opportunities, they also lament that it is harder to accommodate students with invisible disabilities, since they are difficult to identify and contact, due to privacy restrictions embedded within federal laws (Love et al. 2014; Thurston et al. 2017).

Given that there remains a broad and significant lack of understanding of the difficulties faced by students with invisible disabilities, it is perhaps not surprising that students with learning disabilities report experiencing stigma surrounding the nature of their condition, feel that they are viewed as lazy, and that are they trying to cheat the system by seeking accommodations (Denhart 2008; Lightner et al. 2012). Crucially, this can have a significant impact on how students in higher education view their condition as they transition from K-12 to postsecondary education, and their willingness to seek disability support services (Grasgreen 2014).

It is important to note that as a student enters postsecondary education, some laws and regulations that had granted them special education services and accommodations in K-12 education no longer apply and that the onus of disclosing a disability to the university and seeking accommodations is now the responsibility of the student rather than the school (Burgstahler 2003; DaDeppo 2009).

For students with learning disabilities, nationally representative data has found that of students who received special education services in high school, only 35.5% will disclose their disability to their postsecondary school, and an additional 7.8% who consider themselves to have a learning disability will not inform the school of their condition. (Wagner et al. 2005; Newman et al. 2009). Furthermore, the postsecondary rate of disclosure for students with invisible disabilities, including learning disabilities and emotional disturbances, is around 1.5-2 times less than disclosure rates reported for other disabilities, including hearing and visual impairments.

Reasons for why students may choose not to disclose their condition or wait to seek services vary. For those entering postsecondary education from high school who choose not to disclose, most do so because they do not consider themselves to have a disability and the likelihood of a student choosing not to disclose their disability for this reason is higher in African American and Hispanic student populations than for their Caucasian counterparts (Wagner et al. 2005; Newman et al. 2009).

For those with learning disabilities who delay seeking assistance until after enrolling at postsecondary institutions, reasons include a lack of knowledge and self-advocacy to seek disability services, a desire to forge an identity away from

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their disability, cost concerns for testing related to obtaining appropriate documentation, a lack of support from faculty and staff members, and a perception of shame and cheating for seeking assistance (May and Stone 2010; Lightner et al. 2012; Grasgreen 2014).

A reluctance for individuals to disclose their disability is not just confined to educational settings. One study reported that a majority of people with learning disabilities choose to not disclose their condition to their employer, despite nearly three-quarters of respondents also mentioning that their disability impacts their work (Madaus 2006). Furthermore, Madaus (2006) found that approximately one-fifth of respondents feared repercussions for disclosing their disability, and one-third of those who requested accommodations were declined.

Graduation and Attrition Rates

Despite improved access, national statistics broadly show that students with disabilities remain much less likely to obtain a postsecondary degree compared to the general student population (U.S Bureau of Labor Statistics 2015). Understanding difficulties that specific groups of students with disabilities face completing a postsecondary degree, such as those with invisible disabilities, is extremely difficult, as little is known about how rates of graduation vary by disability type. Many studies will refer to students with disabilities as a general group rather than considering disability types. Furthermore, trying to understand graduation, and attrition rates for students with different types of disabilities in specific STEM fields is even more complicated due to a lack of available data.

Based on nationally representative data in 2016-2017, high school graduation rates for students with disabilities in general, are significantly less than the national average (67.1% vs. 84.6%) (National Center for Education Statistics 2018), while 2015 data from the U.S Bureau of Labor has reported that of surveyed households, 41.9% of those a disability had completed some form of postsecondary education, compared to 61.4% of those without disabilities. Furthermore, completion rates were even lower for colleges, with 16.4% of surveyed respondents with a reported disability completing a Bachelor's Degree, compared to 34.6% of those without disabilities (U.S Bureau of Labor Statistics 2015).

For those with learning disabilities, the dropout rate reported at colleges is near 70% (Lightner et al. 2012). While data concerning attrition rates by STEM sub-fields does exist for the general postsecondary student population, data related to graduation, or attrition rates by disability status in STEM fields does not readily exist (Hawley et al. 2013). While this lack of data is particularly true for undergraduate degrees, limited data from 2010 concerning research doctoral degree attainment has shown that students with disabilities in general were less likely to have completed their degree in a science or engineering field than those without a disability (60.2% vs. 69.8%) (Hawley et al. 2013).

Furthermore, it should also be noted that the rate of students with disabilities entering postgraduate school is lower than those with no disability status (2.1% vs. 3.5%) (Hawley et al. 2013). This is also true for students pursuing postgraduate degrees in medical education, with only 2.7% of the student cohort consisting of students with disabilities in general, although the majority (92%) of these are students with invisible disabilities (Meeks 2019 Jul 2).

Academic achievement, study skills, self-efficacy, and integration factors

Previous studies that have attempted to understand potential reasons why completion rates for those with disabilities are significantly lower than for the general population. Attempts to identify potential factors that predict success and persistence have yielded mixed findings. While a number of factors have been found to be important, their impact on academic success and persistence as single measures should be interpreted with caution. Sometimes the amount of variance explained for such measures may be quite large within single studies (Kirby et al. 2008); at other times it may account for only a small amount of total variance when controlling for other factors (DaDeppo 2009; Bergey et al. 2017). The role of multiple factors and possible interplay between each should be stressed, as well careful consideration of the quality of a sample containing students with disabilities given that disclosure rates at postsecondary institutions are extremely low.

Regarding the impact of GPA on academic success and persistence, studies have shown that high school GPA is correlated with college GPA for both students with learning disabilities, as well as the general population (Vogel and Adelman 1992; DaDeppo 2009; Marrs et al. 2009). Furthermore, college GPA has been linked with the likelihood to persist and graduate from postsecondary education (Vogel and Adelman 1992; Herbert et al. 2014).

However, college GPA has been shown in recent studies to not significantly differ between students with or without learning disabilities, or between students with learning disabilities that do or do not receive accommodations, with the exception of first year college GPA among students that do or do not receive accommodations, and between younger and older students with learning disabilities enrolled at postsecondary institutions (Hall and Webster 2008; Lightner et al. 2012; Hen and Goroshit 2014; McGregor et al. 2016). Given that graduation rates are much lower for students with disabilities, despite no apparent difference in college GPA, this raises questions about whether college GPA may be considered a reliable predictor of persistence and intent to graduate for these populations. To the best of my knowledge, no study has explored this question in greater depth.

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A number of studies have attempted to compare differences in measures for study skills, self-efficacy, and metacognition as possible explanations for differences in academic success and GPA differences between students with or without learning disabilities, but with little consensus on what seems to work for students with specific disabilities. Compared to their non-disabled peers and despite no apparent differences in GPA, students with learning disabilities have been found to score lower on study skills survey measures related to emotional intelligence, self-efficacy, metacognition, selecting main ideas, and use of test taking strategies (Hall and Webster 2008; Kirby et al. 2008; Hen and Goroshit 2014) while scoring significantly higher for measures related to the use of time management strategies and study aids (Kirby et al. 2008). Kosine (2006) also noted that students with learning disabilities who scored lower for measures related to metacognition also tended to report a lack of self-awareness regarding the nature of their disability and were more likely to delay seeking assistance until signs of academic failure.

Other factors put forward as impacting college GPA and persistence in students with learning disabilities, including race/ethnicity, gender, disability type, and matriculation from the same campus versus transferring from a two-year college, have yielded conflicting results (Johnson et al. 2008; Mamiseishvili and Koch 2011; Herbert et al. 2014). Integration, and external factors external to GPA have also been found to uniquely impact a student's likelihood to persist, although their influence by disability type is still unclear.

Cortiella and Horowitz (2014) cited cost as one of the most prevalent reasons for why students with learning disabilities do not complete postsecondary education, while DaDeppo (2009) found that factors related to social, and academic integration at college were unique predictors of intention to persist in students with learning disabilities, including the role of informal contact with faculty on social integration. Another study by Feldman and colleagues (2016) found that integration factors related to hope could mediate feelings of loneliness and self-efficacy, although its impact on academic performance was not considered.

Other studies have found that while academic and social engagement for disabilities in general are associated with persistence, their role within this more general grouping has been shown to not hold significance when controlled for demographic variables, such as race, gender, and age, and other university characteristics such as GPA (Mamiseishvili and Koch 2011). Nevertheless, some studies have been critical of the limited predictive value associated between GPA and measures for cognitive achievement, study attitudes, and study habits (Murray and Wren 2003).

Qualitative studies, or the use of mixed methods approaches may provide an alternative method for understanding the

specific experiences that affect student performance, and persistence. Previous qualitative research studies have demonstrated the positive and negative roles of faculty, peers, and family for students with likelihood to seek assistance, develop confidence and self-advocacy skills, and managing anxiety (Denhart 2008; Jenson et al. 2011; Lightner et al. 2012; Love et al. 2014).

Accommodations, compensatory strategies, and universal design
Despite their apparent shortcomings in skills related to self-efficacy, study habits, and metacognition, it is welcome news that students with some forms of invisible disabilities are still able to academically succeed at postsecondary institutions. Academic support for students with disabilities, such as learning disabilities, have included the use of academic accommodations, assistance from academic support centers, and universal design principles, but their efficacy is still not well understood.

The use of accommodations is probably the most well-known example of support granted to students with disabilities. Gaining access to accommodations however is not always easy for eligible students and there are concerns as to who is more likely to receive accommodations. Cortiella and Horowitz (2014) noted that the cost of obtaining appropriate documentation from diagnostic testing can be a potential barrier to students receiving accommodations, particularly those with learning disabilities who must prove their need for support (Lightner et al. 2012).

Students with learning disabilities receiving accommodations are much more likely to come from wealthy to upper middle class socioeconomic brackets (McGregor et al. 2016). A lack of uniformity between postsecondary institutions regarding support services available and mismatches between the appropriate documentation needed to access accommodations at postsecondary institutions compared to high schools are also potential barriers (Cortiella and Horowitz 2014). There is also a lack of definitive evidence that accommodations can be beneficial to student performance, particular in postsecondary settings.

One study conducted at a liberal arts college by Trammell (2003) found that students with learning disabilities received lower end of term grades when given accommodations related to extra time, taking exams in a separate room, and having access to recording of books and classes, while the reverse finding was true for students with ADHD, and students who were labelled as having both a learning disability, and ADHD reported minimal gains in end of term performance.

McGregor and colleagues (2016) also found that differences in GPA were non-significant between students with learning disabilities who did or did not receive accommodations. While this may suggest limited efficacy with use of accommodations, a lack of difference between those who do, or do not receive

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accommodations may instead suggest that those who need accommodations the most are receiving appropriate support that brings them up to a comparable level of performance with their peers (Ricketts et al. 2010; McGregor et al. 2016; Meeks and Jain 2017).

Within the scope of anatomy, Meeks and Jains (2017) also noted that the use of extended time for laboratory examinations may not address the needs of certain students who may require other forms of accommodation such as the provision of assistive technology and visual aids. Even if the efficiency of particular accommodations granted to students with specific disabilities does hold some value, concerns remain for those students who do not disclose their disability to their postsecondary school.

While students with learning disabilities may score lower for measures related to study habits, and awareness of their learning difficulties, students with learning disabilities have been shown to score higher in some attitudinal, and self-regulatory measures, including initiative, resilience, and hope (Trainin and Swanson 2005; Hall and Webster 2008; Feldman et al. 2016). With the additional use of compensatory study strategies, the combination of these two factors may explain in part why students with some form of invisible disability are still able to succeed academically.

What specific methods tend to be beneficial are not well understood and sometimes demonstrate conflicting results, but some studies have suggested that teaching compensatory strategies at postsecondary institutions, and accessing academic support services on a regular basis can be beneficial to students with learning disabilities (Holzer et al. 2009; Troiano et al. 2010).

While the use of some compensation strategies has at times been negatively correlated with performance measures, such as GPA, or reading ability (Ruban et al. 2003, Kirby et al. 2008), a similar argument related to the use of accommodations may instead suggest that students who need the most support are using appropriate strategies in an attempt to earn a comparable grade (Ruban et al. 2003). A previous study by Reis and colleagues (2000) in high achieving students with learning disabilities included a comprehensive list of compensation strategies cited by students, including note taking, time management skills, memory strategies, and use of word processors, although the authors importantly note that the efficacy of such strategies may be more related to the individual needs of each student, as opposed to one-size-fits all solutions. Perhaps most important, the authors note that the use of such strategies were beneficial for students because they enabled them to focus on their strengths, as opposed to remediation of content-related deficits (Reis et al. 2000).

The incorporation of compensatory strategies into wider teaching practices, such as universal design, is not well understood. Furthermore, the use of compensatory strategies may lead to struggles later on for students when the pace of a curriculum overwhelms their ability to compensate, and even impact on their ability to secure accommodations (Rosebraugh 2000).

Universal design for learning (UDL) has been consistently touted as an appropriate framework for optimizing teaching practices to benefit all students, regardless of background, or ability. It represents using a range of approaches for assessment, expression, and strategic engagement (Izzo and Bauer 2015), although there is a lack of quantifiable evidence in postsecondary settings related to what UDL methods can provide beneficial outcomes for students with specific disabilities.

With regard to assessment, studies in medical schools have suggested that multiple choice exams provide the fairest means of testing for students with learning disabilities (Rosebraugh 2000). Engagement in STEM classes has been linked to the use of in class videos, animations, and access to lecture recordings (Izzo and Bauer 2015). Although quantitative measures regarding the efficacy of UDL are still lacking, studies have generally shown that both students and faculty support UDL implementation, although discrepancies in faculty attitudes compared to self-reported actions have been noted (Lombardi et al. 2011; Black et al. 2015), suggesting that there is a greater need for professional development workshops for faculty dedicated to understanding UDL principles and disabilities (Burgstahler 2003; Thurston et al. 2017; National Academies of Sciences, Engineering, and Medicine 2018; Meeks 2019 Jul 2).

UDL principles have been incorporated into disability support services frameworks at some universities, although this implementation is not widespread (Thornton and Downs 2010; Mole 2013). As an additional means to providing accommodations, this may be beneficial as a means of improving collaboration between disability services and faculty throughout campuses, as it may help faculty to consider implementing universal design principles while maintaining academic integrity (Black et al. 2015).

An overreliance on UDL principles to solve all issues related to disability is ill advised however by some researchers. Shakespeare and Watson (2001), stress that although the removal of social barriers (in this case a lack of faculty knowledge) is an important consideration, UDL cannot account for all the barriers and difficulties that people with disabilities face, suggesting that the idea of a barrier-free utopia with UDL could be considered an unsustainable myth.

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Concluding Thoughts

Improved access to postsecondary educational opportunities for students with disabilities have proven beneficial for students with a range of conditions, and while improvements in access, and some measures of academic achievement are welcome news, lagging graduation rates, a lack of knowledge regarding outcomes for students with disabilities in STEM, a lack of appreciation for specific issues faced by students with particular disabilities, and persistent negative connotations associated with disability are troubling.

As instructors, we have a duty of care to understand who is in our classroom, and to be flexible with our teaching methods and assessment. Focusing solely on the effects of impairments at the expense of what we can do to improve as instructors is just as inadvisable as finding one-size fits all solutions that do not consider the needs of students with specific disabilities.

Utilizing techniques that can address the needs of all students, such as UDL, is an important strategy that has some merit. However, while it may be unrealistic to expect teachers to be aware of all the issues faced by people with different kinds of disabilities, understanding specific issues faced by students with particular types of disabilities is important. As Oslund (2013) noted, the social model's insistence on disabilities being addressed as a single group ignores complex nuances seen among individuals with physical disabilities, compared to those with invisible disabilities. On occasion, there are tensions between these two different groups. Those with physical disabilities are often fighting to prove their abilities, while those with invisible disabilities are often fighting to prove their disability (Oslund 2013).

As an able-bodied individual, I acknowledge that I may lack an understanding of the needs and concerns of students with specific disabilities. Furthermore, as a PhD student I do not pretend to understand the complexities that full-time faculty may face when trying to incorporate UDL solutions into their classrooms, when constraints related to the physical space of a classroom, time, and class size may impact the feasibility of incorporating the needs of all different kinds of students. Nonetheless, it is my opinion that faculty should be more cognizant of the language they use around people with disabilities, be challenged to consider the kinds of students that are in their classroom, including those with unseen disabilities, and, where possible, to seek professional development opportunities that can benefit students with disabilities in addition to the need for academic accommodations.

Given its link to persistence and graduation rates, future research in disability studies could perhaps consider whether there is a critical value, or range for college GPA that could be used as an early identification measure for students with different types of disabilities that may require additional support, whether or not they are receiving accommodations.

The role of specific study strategies that can prove beneficial as a compensatory technique for students in STEM classes could be explored further, and perhaps even be stressed as an avenue for universal design principles given that rates of disability disclosure in postsecondary institutions are generally low. Qualitative research methods could further probe the impacts on persistence related to a range of factors, including attitudinal factors, pre-postsecondary educational experiences, support from family, peer, and/or faculty, differences based on the age of diagnosis, stigma, workload, age etc.

The topic of disability in STEM fields such as anatomy and physiology remains a heavily under researched topic. While we do not yet have the answers to how we can improve postsecondary outcomes for students with some forms of invisible disabilities, nor how these outcomes differ within STEM fields, there is no doubt that the time has come for disability to demand a greater say in conversations regarding inclusion, diversity, and professional development.

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Addressing the Academic Support Needs of International Medical Students in a Modern Medical Education Curriculum

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Abstract

With increasing globalisation and internationalisation, student mobility, and a need for income generation, most universities in the UK and other parts of the world now seek to attract greater numbers of international students. Non-traditional approaches to teaching and learning delivery have been incorporated into modern medical education curricula. These pose additional challenges to the international medical students compared to their home student counterparts. Evidence suggests that international medical students underperform compared with home students, with odds of failure about 2.5 times higher. It has been proposed that far more guidance and support are required, but little attention has been given to the students' specific academic support challenges. This paper explores ways to address the academic support needs of this group of students.

<https://doi.org/10.21692/haps.2020.102>

Key words: glocalization, international students, medical students, academic support

Introduction

Most Universities in the UK and other parts of the world now seek to attract a greater number of international students to reflect globalisation and internationalisation agendas and increasing student mobility. Increasing the number of students also helps to generate more income for the school. Recruitment of international students enhances the diversity and multicultural mix of the student population (Bennell and Pearce 2003; Egege and Kutieleh 2004; Yates and Nguyen 2012; Page and Chahboun 2019). The University of Exeter Medical School is a multi-campus modern medical school in which the undergraduate medical education curriculum is integrated with a problem-based learning (PBL) approach. The Medical School defines its international students for the purpose of academic support as students whose culture is significantly different from the British and for whom English is a second spoken language. They also include EU students and other students who may be UK citizens by naturalisation but whose parents' cultural background is not British. The medical school admits international undergraduate medical students from approximately 42 nationalities. With increasing diversity of students and changes in delivery of medical education curricula, far more guidance and support are now required by students (Gibbs and Simpson 2005; Lenz et al. 2018).

Medicine and allied healthcare services are highly regulated professions. Recommendations from the UK General Medical Council (GMC) and other considerations that include patients' expectations, have informed current changes in modern medical education curricula resulting in a paradigm shift in both design and delivery (GMC 2009, 2018, 2019). Modern medical education curricula now include early patient contact, which involves communicative interactions, small

group teaching and learning, increased self-directed learning, development of scientific and reflective writing skills and less traditional didactic teaching.

The general challenges faced by international students have been well articulated and documented in the literature (Ryan and Carroll 2009-2011; Treloar et al. 2000; Egege and Kutieleh, 2004; Yamada et al. 2014; Huhn et al. 2016; Lenz et al. 2018). Some of these challenges include acculturative stress, psychological distress, language and cultural barriers, study skills, culture shock, and ethnic stereotyping. In addition to these general challenges, international medical students also encounter more specific sociolinguistic academic difficulties, which are related to the nature of the medical degree programme. These students face language and communication barriers that are further complicated by regional accents (Huhn et al. 2016; Lenz et al. 2018). The linguistic communications encountered with the local population are part of their medical training and summative assessment, rather than for social interactions as might be the case for other international students.

International students also face study skills challenges with a change from teacher-centred to student-centred learning and a need for strong writing skills, particularly scientific and reflective report writing. There is also the complex issue of cultural barriers, which may involve some sensitivities to asking questions, "respect" for the teacher, and reticence to pose questions or challenge a teacher's opinion. Furthermore, international students may be less involved and engaged in team and small group work or discussions due to a lack of confidence in language, use of idioms, syntax, colloquial

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expressions, and vocabulary. Students may reveal sensitivities or reluctance to seek pastoral support. They can also experience “culture shock” when integrating within small group learning due to problems with shyness or feelings of isolation, even alienation from peers, perceptually linked to religious beliefs and values (Egege and Kutieleh, 2004; Lenz et al. 2018). International students may have very little contextual knowledge of the complexities of working in the UK National Health Services (NHS), particularly with regard to how it relates to a patient’s referral pathway and subsequent journey, and the differences within the NHS among countries within the UK.

Most of the discussions on learning support for international students have been very generic. The medical degree programme involves learning in both academic and clinical settings. However, unlike other programmes, this requires formally assessed direct professional encounters with the local population as patients. Evidence suggests that international students are more likely to underperform compared with home students and that the odds of failure are about 2.5 times higher (Woolf et al. 2011; Huhn et al. 2016). It has been suggested that issues related to the contextualised nature of the medical education curriculum contribute to the underperformance of international medical students and to the higher dropout rate compared to home students (Woolf et al. 2011; Man et al. 2010). It is within the teaching and learning environment outlined above that a new undergraduate international medical student is expected to succeed in learning and studying medicine and the question remains as to how to best support this group of students (Lenz 2018). This paper describes possible targeted academic support provisions developed by the University of Exeter medical school to address this challenge.

Academic Support Provisions for International Medical Students in the University of Exeter Medical School

A needs assessment focus group discussion and survey of the international medical students on academic support were undertaken when the medical school had its first intake of international students. Insight into the needs of these medical students experience was gained from comments such as those shown below:

“...expressing views, and evaluation, conveying emotional intelligence can be quite hard due to socio-cultural-language barriers... we are assessed on this compared to everyone else...”

“... It took me a while to cope with learning in a group work ...”

“... problems of communicating with patients in local jargon and being able to communicate complicated medical information between healthcare professionals...”

“...being articulate in presentation of the cases ... it is almost impossible to be able to achieve an ‘excellent’ on the criteria when compared with a native speaker.”

“... we have higher failure/repeat, ... and possible dropout rates than our home students’ counterparts ...”

In tackling these academic support needs, the University of Exeter Medical School adopted the approach of a deficit model, which is still a prevalent perspective for providing academic support (Page and Chahboun 2019). In the deficit model, the challenges faced by the international medical students are framed in terms of not meeting a predetermined set of expectations and are seen as deficits that need to be corrected or remediated (Page and Chahboun 2019; Egege and Kutieleh 2004). Education is cultural and learning and teaching are done within a cultural context. International students who come from learning cultures that do not conform to that of his or her study host country are perceived as inadequate and they represent a problem to be resolved (Egege and Kutieleh 2004). An understanding of the cultural language and communication skills in the country of study are part of the required and expected professional training of a medical doctor. Indeed, there is an expectation that the students will actively acculturate, that is, adapt to the culture of the home country where they are studying with minimal opportunity to be grounded in their own native country’s culture, in order to achieve success (Kashima and Loh 2006; Egege and Kutieleh 2004).

Using the deficit model of approach to address the challenges faced by international medical students, the University of Exeter Medical School developed targeted academic support schemes. First, students were individually assigned to an academic tutor and a designated international student’s tutor was also appointed to co-ordinate the academic support activities. The international medical students and their academic/designated tutors ran routine one-to-one needs assessments and progress monitoring meetings, which enabled referral of students, where necessary, to the University Academic Support Unit. Following performance in an exam or test, a one-to-one remediation meeting was also held with the student, as appropriate.

In addition, the Medical School, in collaboration with the University Insessional Unit (INTO), developed four English for Specific Academic Purposes (ESAP) workshop topics that were primarily intended for medical students who are non-native English speakers. Adopting a socio-cultural approach and in consultation with the Medical School educators, the Insessional team designed workshops to target the needs of international medical students. For example, in preparing the reflective writing workshop, the team first observed a workshop on reflective writing led by a medical school educator, and then incorporated more practical elements

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into their workshop design. A literature search provided the basis for a glossary of popular medical terms (Parkinson 1991), and development of activities for the workshop in problem-based and small-group learning (Davis and Harden 1999; McMahon 2013). The Medical School's Special Study Units (SSU) Handbook for Students and Providers presented useful guidance regarding academic style. The workshops adopted a common methodology of awareness raising, useful input, and practice activities using authentic materials. The workshops were reflected in the students' general timetable and each session was one hour in duration. The workshops are summarized below.

Workshop 1: Medical Language Communication Skills

Students are encouraged to reflect on the different factors (socio-economic, cultural, and circumstantial), which might affect a person's idiolect and oral performance. This is followed by a discussion of strategies for dealing with communication breakdown. Medical language, common phrases and the equivalent colloquial expressions commonly used in public medical discourse in the UK context are introduced. A glossary of these terms, accompanied by recorded audio files, is uploaded to the website as a permanent resource. This session focuses on interactions with patients and possible areas of misunderstanding. It considers 'Patient Speak' (including colloquial and medical jargon) in an effort to explain why it is sometimes hard to understand patients and to offer some strategies to manage these difficulties. It looks at some specific areas of vocabulary and considers how to handle interviews with patients by asking effective questions. Students are encouraged to bring questions arising from their experiences in clinical placements and examples of challenging encounters relating to communication.

Workshop 2: Reflective Academic Writing

Students begin by discussing the nature of reflection and its importance to being a doctor. They describe their understandings of reflection, including the extent to which reflective thinking had played a part in their prior learning experience. Students are encouraged to think about how this process might benefit their studies and the importance of developing a reflective disposition. This workshop examines key features of reflective writing using examples. Students are helped to develop strategies for effective reflective academic writing, with a particular focus on language details.

Workshop 3: Scientific Academic Writing Skills

This workshop refreshes student understanding of the conventions and expectations of academic writing. It examines the structure of scientific reports and essays, referencing styles, strategies for in-text referencing, paragraphs, and sentence structure. The generic characteristics of academic writing are summarised using a PowerPoint presentation. Students are encouraged to consider how conventions and expectations

might differ across disciplines, given the multi-disciplinary nature of writing in the SSUs, and are directed to their SSU handbook for guidance. This workshop also looks at some examples of good practice and introduces some useful online resources. Students are encouraged to bring along samples of their written work and any feedback they have received.

Workshop 4: Group Work and Team Learning Skills

The timing of this workshop in the middle of the second term enables students to discuss their experiences with group work and team learning in the context of PBL. It offers a forum for discussion and strategies to develop a positive attitude towards working in multi-national groups by inviting reflection and discussion on small group learning (e.g. PBL) with emphasis on the perspective of international medical students. It also considers how different cultures approach working in groups, problems that can arise, and strategies that are used to overcome the problems. Students are encouraged to bring their views and concerns to the workshop and are able to reflect on the challenges of working in groups with home students, including how language and intercultural issues might have impacted their experiences. Literature, both empirical and theoretical, are referred to in order to provide a context and framework for discussion and strategies to enable students to participate fully in group learning are introduced and discussed.

The workshops were seen to respond to particular needs including: the unfamiliarity of international medical students with popular medical jargon, making it difficult to understand patient speak in workplace settings, their minimal prior experience with reflection and reflective writing as instruments of learning, the need to refresh their understanding of scientific writing, and the novelty of learning in groups in the context of PBL. The University Language/Academic Support Unit also runs weekly one-to-one writing tutorial sessions which are also available to the international medical students.

The feedback from the students following evaluation using free text questionnaires and focus group surveys affirmed that most of the participants found the workshops useful as are suggested by the following quotes:

"... I really enjoyed the small group discussion we had from that workshop. Now I feel I am not the only one who were not talkative in PBL or Jigsaw sessions. I will really try to get involved in group work more from next session".

"The session on scientific research was also helpful. As an international student, I did not have to write essays during my A-levels so I felt insecure when SSU was approaching. ... This made me more confident to do my SSU".

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"... some of them are really useful and relevant to my course. ... the communication workshop ... common phrases and wordings that used by the with British people. ... for me to realise the culture and language difference prior to the clinical placement. The most useful session would be the one-to-one tutorial as my grammatical mistake is my biggest problem. ..."

"... the sessions have been relevant and tailored to what we need for support. ... The sessions also gave me a chance to voice out my difficulties and I would feel empowered every time I leave the session. ..."

Coming from the US, ..., British English and American English have many subtle differences ... addressed the British English colloquial and language usage. These sessions were excellent! ... I learned what a "funny right turn" meant, ... learned something which has saved me from embarrassment on many occasions. In the US trousers are ... "pants," while in the UK, "pants" refer to underwear. This small difference ... make a very big impact on doctor-patient trust as well as clear communication. These sessions have greatly helped me in the clinical aspect when dealing with patients..."

"Medical English for International Students is vital for my placement. It built up my confidence. Now I know that I am going to be able to communicate better with my patients in terms of medical language."

"..., I had attended three workshops ... and I found them very useful to my learning in medical school. ... different ways could people use to describe their feelings and pains in clinical setting. ... we could not learn it from textbook or lectures. Being a non-native speaker, ... found that it was difficult for me to understand ... this workshop, ... help me a lot in my clinical skills and communication skills with patients in the future. ... this definitely was relevant and useful to support my learning challenges as a non-native speaker"

However, not all the participants found all of the workshop sessions particularly useful, mostly because the workshop topics were only one snapshot sessions that should not have stopped as the feedback quotes below suggest:

"... I don't think attending the sessions was very helpful. The sessions were good as an introductory class but in the long term, they were not useful. This is because when I had to write my essays or to participate in a group discussion, I would face so many other challenges that were not covered. ..."

"I think international students have their own perception about language and culture before they come to England to study. I think the scheme has not done very well in helping the student to identify their own mistakes because there is a lack of continuous monitoring and feedback to students ..."

The majority of the students would have liked the workshop sessions to be sustained throughout their first two years of study to monitor progress as the quotes below suggest. However, this would have had substantial financial implications for the medical school budget.

"I hope the program could teach us more colloquial language used in UK. As international students we may be used to formal English, but sometimes when people speak too fast or use slangs/ local words I may not understand"

"... I could not find a similar support for group discussion from the scheme. I ... hope that there were more group discussion opportunities where I could receive feedback right after the discussion session ..."

"I thought that I will be able to learn much more if there are more of these sessions that I could attend as this will provide us with more time to ..."

Challenges of Delivering Targeted Academic Support Schemes for International Medical Students.

The development and delivery of academic support schemes to address the needs of international medical students have a number of challenges. Studies have questioned the appropriateness of the 'deficit model' approach. There are debates regarding the pros and cons of this model (Page and Chahboun 2019; Egege and Kutieleh 2004; Bond 2018; Green 2006; Smit 2012) particularly from the perception of the international students generally as sojourners rather than migrants (Page and Chahboun 2019; Wu and Wilkes 2017; Robertson et al. 2018). The 'deficit model' approach has been associated with a number of disadvantages including the perpetuation of stereotypes and the alienation or marginalisation of students (Page and Chahboun 2019; Egege and Kutieleh 2004; Bond 2018; Green 2006; Smit 2012; Wu and Wilkes 2017; Robertson et al. 2018; Klingner and Harry 2007). However, the current study and others have found that the 'deficit model' approach can yield some positive results (Green 2006).

International students have multi-layered complex support needs because the issues involved are multi-factorial, interwoven, and to some extent vary from student to student ((Egege and Kutieleh 2004; Smit 2012). It is difficult to isolate and address multi-layered issues as individual support needs. A suggested alternative is to acknowledge variations in attitudes to knowledge acquisition that stem from different cultural perceptions and understandings (Egege and Kutieleh 2004; Bond 2018). This also has its own complexities and challenges. Inclusive teaching and universal design for learning approaches have also been suggested (Gradel and Edson 2009 – 2010; Bond 2018; Imperial College London Education Development Unit 2020).

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Inclusive learning and teaching recognises that all students are entitled to a learning experience that respects diversity and allows for meaningful engagement with the curriculum (Imperial College London Education Development Unit 2020). In line with inclusive teaching and learning, the concept of universal design for learning advocates the use of multiple goals, methods, tasks materials, and assessments to meet students' needs and address the academic learning challenges students face (Gradel and Edson 2009-2010).

While the concepts of inclusive teaching and universal design for learning are very relevant and appropriate in dealing with academic support challenges of international students generally, and for international medical students in particular, they are fraught with logistical challenges as these issues are time sensitive due to the students' early contacts with patients and the high stakes of their assessments. Adopting the 'deficit model' provides a more pragmatic approach that begins to immediately address the learning challenges of international medical students, its disadvantages notwithstanding. There is also the challenge of the availability of resources for providing continuous longitudinal support and progress monitoring. In a multi-campus medical school like that of the University of Exeter, logistics for the delivery of academic support workshops is a sizable challenge both for staff and the students attending academic support sessions. Additional challenges come from timetabling constraints for the workshops within an integrated small group teaching and learning curriculum, where students are assigned to different learning groups and different time slots. There are issues with variable uptake of available provided support schemes by the students. This variable uptake may arise from differences in the perception of support needs between the teachers and students, and workshop sessions timetabling complications. The teachers' approach is to identify students needing support early in the programme, in line with a 'deficit model' concept, but the students would not particularly like to be treated differently from the home students. International students tend not to think that they have challenges until they start to struggle with exams; by that time, it may be too late to remediate. There is also a perceived stigma attached to seeking support. Given that the international medical students are characteristically high-fliers who are not used to failure, this is not surprising.

Conclusions

Education to a great extent is cultural just as the practice of medicine is both a science and an art. The professional practice of the art of medicine is influenced by the culture within which it is practiced. Language and communication skills form important parts, but not the whole, of the cultural art of the practice of medicine.

Although most of the students found the academic support workshops sessions useful, it is difficult to evaluate and ascribe credit of the impact of the support schemes on the overall performance of our international medical students. However, most medical educators feel that this group of medical students need proactive targeted academic support and it is logical to advocate for it even though it is an imperfect approach.

The support needs of international medical students are multi-layered and complex and vary from student to student; they cannot easily be isolated and addressed as individual needs and there are no easy solutions. It is pragmatically and logistically challenging to provide support schemes that address perceived culturally based academic differences without adopting a deficit or assimilationist approach.

Further research should focus on devising appropriate and effective ways to define and clarify the full academic challenge experiences that international students face, and the form and nature of the support needed. Are the issues much deeper than support for language and communication deficit? To what extent does the framing of the academic learning challenges affect the participation by international student and encourage the stigma associated with seeking language and academic literacy support?

Acknowledgment

The author would like to acknowledge the contributions of the University of Exeter Insessional Support Team at INTO and, in particular, Dr John Straker and Dr Denise Parker, in the design of the support workshop sessions for the international medical students.

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Teaching Anatomy and Physiology Lectures Online

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Abstract

In our changing world there are many challenges that students face, one of them being temporary inability to attend face-to-face classes. This paper presents a perspective on how to best meet the needs of online learners, including such topics as course design, student engagement, challenges, and solutions. The information in this article may be helpful in this time of having to move our courses online. <https://doi.org/10.21692/haps.2020.103>

Key Words: Online, Lecture, eLearning, Distance

Introduction

Anyone might be hesitant to take the content-heavy Anatomy and Physiology I or II from the traditional face-to-face format to an online or hybrid format. Initially, it might appear an insurmountable feat that would not yield the results necessary for students to feel confident moving onward in other related courses that use Anatomy and Physiology as a foundation or when student performance is compared between traditional delivery and that which is online. Having experienced teaching online courses in pathophysiology, it was apparent that a different approach would be necessary for the content-heavy Anatomy and Physiology course. When taking on the challenge in fall of 2016 to convert some sections of Anatomy and Physiology to an online modality, it proved to be a rewarding journey filled with great students and adventures in developing content along the way.

With COVID-19 upending the spring semester of 2020, having lecture courses prepared online allowed for breathing room in an uncertain and evolving pedagogical landscape. While everyone was scrambling to figure out the best way to execute online or remote learning for their classes, the author was able to assist colleagues in getting their courses ready for students. There are many different modes of online learning, with some institutions requiring synchronous or remote learning and some giving the freedom to transition a face-to-face course to asynchronous online learning. The experiences of the spring-2020 semester will undoubtedly shape the delivery of both face-to-face and online courses in the future.

This article will discuss the challenge and benefits of online teaching and present ideas for improving online pedagogy. The content of this article was initially developed as a workshop to be presented at the 2020 HAPS Annual Conference in Ottawa, Ontario, Canada.

Challenges

Some educators who have never taught a course online would believe it is easier than teaching a face-to-face course. This could not be further from the truth as moderating and assisting students in online classes takes as much if not more time than what is required for face-to-face classes. This thinking stems from the belief that one would be relegated to only administering the course and grading the assignments after the initial development of the course is complete. However, one must prepare to invest time and effort into making online classes a success.

Another common misconception about teaching online courses comes from the pervasive idea that online courses are less rigorous than face-to-face courses. When designing online courses, the desire is to ensure that the level of rigor would match that of face-to-face courses and to protect the validity of the course, allowing it to remain intact semester after semester.

Students deserve an engaging and challenging online learning experience that leaves ample room for improvement while delivering the course content in a meaningful and impactful way.

Benefits of Online Learning

For a myriad of reasons, students today have more wide-ranging demands placed upon them by their work, families, and loved ones. This leaves little time for a student to attend a traditional lecture course. Many students also travel for work, which makes attending a traditional lecture nearly impossible. The flexibility offered by online learning is a great benefit to these students, provided that their learning is rigorous.

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Online learning can open up the world to a student who may have never traveled outside their own hometown, growing their perspective and expanding their horizons (Appana 2008). Students may find that their peers in online classes have differing backgrounds and perspectives; interacting with them helps students develop as individuals who possess empathy for others and their situation, an essential skill for any healthcare professional.

Online learning allows the student to, within reason, move through the course at his/her own pace. Students should still have a set schedule but they should be given the freedom to complete their work when it is convenient for them. This does not change the fact (at least from personal experience) that the majority of students will wait until the last day to complete and turn in their work.

Online learning has been shown to increase the writing skills, overall communication, and computer literacy of students (Weiner 2003). Many students will learn ways to be more productive in all their classes by using the skills developed in their online courses.

Solutions and Best Practices

Having outlined the challenges in bringing Anatomy and Physiology lectures online, it is time to break down how to tackle these challenges. Many institutions have an approval or certification process for teaching courses online. Check with the institution's distance learning department to determine institutional requirements before beginning the design of the course. The institution may even have resources to assist in course development so that the process goes more smoothly. Examples of assistance might include course templates and ideas for assignments and activities. When reviewing these resources, focus on what would work best to deliver the content and assess the learning; not every idea works for every concept. There are many guides available with a quick Internet search on best practices for online teaching, but some of the best resources may be sitting down the hall. Do not be afraid to ask for help from colleagues who have more experience.

Connecting with Students

One of the best practices shared for online learning is for the students to know the professor is present in the course (Boettcher and Conrad 2010). Carve out time to interact with students and get to know them. One way to be present is to have videoconference office hours dedicated to online classes. Zoom™ and Collaborate™ have been used with success for online office hours, but any video conferencing tool would work. Zoom is preferred as it allows the instructor to share more media types (Computer Screen, Application, iPad/iPhone, Whiteboard) natively inside the application. From experience, roughly 25-50% of students will attend at least

one online office hours session during the semester. Varying the time of office hours will allow more students to attend, as many of them chose online learning to take advantage of the flexibility it offers. Having online office hours also helps with getting to know students and putting a face with a name when answering emails.

Assignment Due Dates

When considering course design, make assignments due on a day when checking email is a regular occurrence. Choosing a specific day of the week as a due date for assignments leaves more opportunity for students to ask questions and receive a response on other days of the week. It also allows time to address any technical issues that may arise, as most technical support is only available during weekdays. Avoid making assignments due on holidays and having due dates that are different every week as this could be confusing to students. Remember: the simpler the better.

Assignment Selection and Submission

When I first started developing online courses, I required students to complete an outline of each chapter. The specific requirements of the assignment were left intentionally vague so as to allow students to complete the assignment in the way that best suited their learning style. After receiving mixed reviews for this type of assignment, I changed the assignment to make it more flexible in terms of what was acceptable as an outline. Some students had never learned how to outline a chapter before they completed the assignments for this class. Some students were thankful for the experience and began to apply the skill to other courses. Other students perceived the outlining assignment to be a waste of time. Learning from this experience, I assigned more study content that was offered from the publisher of the course textbook (Pearson's Dynamic Study Modules). In addition, regular homework activities were extended in length in order to give the student more chances to comprehend and retain the material. The addition of these activities has improved student comprehension of course material as evidenced by better exam scores.

One of the challenges presented by online pedagogy is the assignment submission process. Students will submit assignments in slightly different formats even with well-designed templates. This leads to minor frustrations during grading, prolonging the process. One method to reduce this frustration is to use quizzing features within the learning management system for students to turn in their assignments. Using this method, students are given a worksheet or activity to complete, which can include multiple choice, short answer, matching, and essay questions. Students upload the worksheet to unlock the quiz that will assess their knowledge. This is achieved by using adaptive release within the learning management system. The quiz is designed to pull a random selection of questions from the worksheet and requires

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students to input the answers from the completed worksheet. For essay questions, students may copy and paste directly from the uploaded worksheet. Allowing only a short time for the submission of this quiz keeps students honest about completing the worksheet before attempting the assessment. An example of a worksheet used in this activity is presented in Appendix A.

Institutional Guidelines, Rigor, and Course Validity

One of the guidelines that exist at many institutions is the requirement that any online course must be supplemented with content generated by the professor. To satisfy this guideline, the author provided lecture videos, to which many students had a positive reaction. Most of these lecture videos are 45 to 60 minutes in length. However, data supplied by YouTube analytics revealed that most students watched on average only about 25% of a lecture video. With this data in mind, future videos are planned to be shorter and to focus on major concepts within a chapter.

Videos can be created in many ways, but I found it worked best to use an iPad with an Apple Pencil to either narrate a Power Point presentation or draw from scratch as one would on a whiteboard in class. There are many software solutions that offer the ability to record the screen on the iPad with audio, but I found the app Explain Everything™ worked best for me. Explain Everything offered the functionality to meet the needs of recording, editing, and exporting videos. An external Lavalier microphone was used to enhance the quality of the audio. Lecture videos can also be used to supplement face-to-face courses so that students have an easy way to catch up on material they might have missed due to illness or absence.

To maintain rigor in online courses, one must constantly adapt and change the material as one would in a face-to-face course. One way to maintain rigor is to use many of the same questions, assignments, and exams that are used in face-to-face courses. Validity is another concern for instructors and institutions alike. One way to maintain validity is to use monitored proctoring of exams, either in person proctoring or remote proctoring. It is essential to use this in online classes to assist in curbing academic dishonesty. Tools such as Turn It In™ or Safe Assign™ can help to guard against plagiarism. However, one should use these tools to inform and educate and not strictly as a punitive tool. Setting clear expectations of students with regards to citations in assigned work is essential to maintaining academic honesty. Other general guidelines include using large randomized test banks, using pooled questions, and consistently adding to or modifying the course to make a better experience each semester.

Future Directions

There are always areas for improvement in any course. Finding new ways to connect students with their peers and with the instructor is a top priority. A student who connects with their peers and feels that they have membership in the college is more likely to persist with their studies (Tinto 2016). Many instructors and students are now much more comfortable with video conferencing due to COVID-19. Video offers a great way to connect with students in online classes.

Another tool that could be implemented in future online classes is Slack™ (<https://slack.com>). Slack is a software tool that allows for chat rooms, direct messaging, and file sharing in real time. A colleague from the math department suggested slack to the author. Slack is used regularly to hold discussions and to allow students to assist each other with difficult concepts. Ask any student in an online course how they feel about discussion boards and one will quickly find a copious amount of discontent. In discussions with the instructor who suggested Slack, it was revealed that there was more student participation when Slack was used since students could easily interact with Slack using their computer or mobile device. With more interactivity, students feel more connected to each other and to the instructor. A list of software and hardware solutions used can be found in Appendix B.

Conclusion

Stepping outside of one's comfort zone is something all educators should strive to do. Transitioning from a traditional lecture to a well-designed and streamlined online experience for students is a great way to remain current with novel pedagogical practices. In addition, it is important to continue to improve the course. A stagnant course that does not grow and adapt with the pedagogical landscape quickly becomes obsolete. In online courses, connecting with the students is the most vital component of student learning. It takes work to develop and deliver an online class, but the connections with students should be just as rewarding as in a face-to-face course.

About the Author

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APPENDIX A: Sample Worksheet Used to Unlock Assignment Quiz

There are various ways to code these questions into the Learning Management System. A commonly used program is Respondus 4.0™ (not the lockdown browser) to convert carefully formatted word documents easily to formats that are useful for Blackboard™, Canvas™, Desire2Learn™, and others. Reach out to the distance learning department at your institution to see if this software is available.

This assignment centers around neurophysiology (HAPS Learning Outcome: H:7-8).

Neurophysiology Worksheet

Finish each of the following sentences, use the word bank below (some words may be used once, more than once, or not at all):

1. The membrane potential of an undisturbed cell is called the _____.
2. A change in the resting membrane potential produces a(n) _____, this will decrease in magnitude as the distance from the stimulus increases.
3. If a graded potential is sufficiently large it will produce a(n) _____.
4. A(n) _____ produces graded potentials in the plasma membrane of the post synaptic cell.
5. At the end of an axon _____ are released into the _____ to cause a change on a _____.
6. The postsynaptic cell can make decisions based on the stimulus received. It can either be excitatory or inhibitory. This is termed _____.
7. The inside of the cell is considered to be _____ compared with the outside of the cell.
8. The _____ is responsible for maintaining the resting membrane potential.
9. Sodium leak channels will allow sodium to leak _____ to/of the cell, while potassium leak channels will allow potassium to leak _____ to/of the cell.
10. Voltage gated sodium channels have two gates a(n) _____ and a(n) _____.

Word Bank:

Action potential, Activation Gate, Graded potential, In, Inactivation Gate, Negative, Neurotransmitters, Out, Positive, Postsynaptic Cell, Presynaptic cell, Resting Membrane Potential, Sodium Potassium Pump, Synaptic activity, Synaptic Cleft, Integration

For each of the following questions please answer in complete sentences:

11. Describe the three types of gated ion channels discussed in the book in module 11.8. Give an example of where you might find each.
12. What effect would a chemical that blocks voltage-gated sodium channels in a neuron's plasma membrane have on its membrane potential?
13. Describe how each of the neurotransmitters in the table in module 11.14 of the textbook will exert its influence in the body.
14. Describe the difference between an EPSP and an IPSP and discuss how they combine to aid in information processing.
15. If a single EPSP depolarizes the initial segment from a resting membrane potential of -70mV to -65 mV, and threshold is at -60mV, will an action potential be generated? Explain your answer, what principle is in play here?

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APPENDIX B: Technology and Software Used or Mentioned

The author currently uses or has used these software and technology solutions to develop and deliver online courses. This is in no way an endorsement or advertisement by the author, affiliated institutions, HAPS, or publishing body, but a list of software that the reader may find useful.

Hardware Used in Video Creation: Apple iPad (6th Generation), Apple Pencil (1st Generation), Purple Panda Lavalier Omnidirectional Microphone (Any microphone would work at improving sound quality)

Video Recording/Editing Software: Explain Everything (iOS and Android), Notability

Learning Management Systems: Blackboard, Canvas, Desire2Learn

Remote Test Proctoring Software: Respondus Lockdown Browser and Monitor, Honorlock

Test/Quiz Generation: Respondus 4.0, TestGen

Video Conferencing Tools: Zoom, Collaborate, Skype, Cisco WebEx, GoToMeeting

Communication Platforms: Slack, Microsoft Teams

Plagiarism Detection: Turn It in, Safe Assign



Creating Extra Credit Assignments That Challenge, Inspire, and Empower Students

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Abstract

Extra credit assignments are often viewed with disdain by educators as opportunities to earn points for students that lack the study skills to do well on exams and quizzes. However, these assignments can serve as a platform for students to apply the course material to their own lives, optimizing their strengths and creativity, and encouraging them to take ownership of their learning. In this paper we discuss how we used extra credit assignments in a two-semester Human Anatomy and Physiology course to develop community outreach, art exhibits, and education events to empower our students and make science accessible to the public. <https://doi.org/10.21692/haps.2020.104>

Introduction

Among educators, extra credit assignments can be a controversial topic. For those that oppose the practice, the rationale is that if the student cannot complete the required work, when and how will they be able to complete anything “extra”? Other, well-supported reasons for not offering extra credit may include not wanting to inflate grades, the possibility of discouraging students from doing their best by providing the cushion of extra credit points, and the creation of assignments that do not enhance student learning while increasing the burden of grading for the instructor (Dunn and Halonen 2019). For those that support extra credits, justifications are many and varied. Supporters view extra credit assignments as opportunities to reinforce content, to motivate and enhance participation, and to decrease student stress (Dunn and Halonen 2019). In practice, the value of extra credit is dependent on its structure, the method of implementation, the extent of integration of extra credit into the course, and the intentionality of the extra credit assignment.

Good extra credit assignments must connect to course content and support the course objectives. They must be clearly explained, stating in the syllabus the maximum range of points that can be earned by doing extra credit in addition to other course assignments and policies. The deadlines for extra credit must be explicitly stated and adhered to, as they are for all other assignments. By including the extra credit assignment in the syllabus, the instructor offers this opportunity to everyone in the course, without prior knowledge of the academic progress of individual students in the course. Similarly, by clearly describing the assignment and its worth, the instructor creates a set of expectations that are available to all students; this can help students assess whether they are willing to put in the extra effort to earn the extra points, plan their time accordingly, and discourage special last-minute requests (Dunn and Halonen 2019).

In our experience, extra credit assignments can serve as a reward and as an opportunity to apply course content outside the classroom. While the assignment itself can require effort, it can also be an enjoyable, enriching activity that gives students agency and choice, is educational, and gives students the means to connect with the material in a whole new way. The extra credit assignment can also be an opportunity for faculty and students to collaborate and develop interdisciplinary projects that reach beyond the classroom and have a positive impact on the community. It is these latter reasons on which we have capitalized when incorporating extra credit in our Human Anatomy and Physiology two-semester course at Elizabethtown College.

Description of the Assignment

Elizabethtown (ETown) College is a private, liberal arts institution with approximately 1700 students. The Human Anatomy and Physiology course at Etown is a two-semester course, taken primarily by Pre-Health and Occupational Therapy majors in their sophomore and junior years. The only prerequisite for the Anatomy and Physiology course is successful completion (grade C- or better) of General Biology 1. Like most Anatomy and Physiology courses, lectures and labs consist of face-to-face biweekly meetings. Lectures include traditional lectures, demonstrations, group discussions and activities. The lab component is station-based, where students are introduced to various aspects of the skeletal and muscular systems with teaching assistants as facilitators. In our course, lecture and lab must be taken concurrently, with lab making up 45-50% of the course grade. The variation in the lab grade percentage reflects differences in assignments and their weights in different semesters and in different years.

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Each semester, students in Goldina’s class are given the opportunity to complete up to two extra credit assignments. The assignments are divided into two categories; students can complete only one assignment from each category (Table 1). Category One includes reflective/analytical assignments, such as explaining how a specific topic in Anatomy and Physiology directly relates to a student’s life, or researching whether a particular popular idea about the human body or process is a myth or supported by scientific evidence. Category Two is a more creative option where students are asked to use their knowledge of Anatomy and Physiology and apply it to another field by creating an artistic piece using any medium they like, developing a song/poem, choreographing a dance or a skit, or writing a children’s book to represent a specific topic or theme in the course. Detailed descriptions of these assignments, as well as their point values are included in the syllabus and students are aware of their options from the first day of class.

| Category 1 – Reflective | Category 2 - Creative |
|--|---|
| 1. Page discussion of how a topic from this course relates to everyday life | 1. Write and/or choreograph a song/dance/skit about an A&P topic. Be prepared to perform the piece in class. |
| 2. Interpret a recent scientific finding relevant to the topics covered in this course. Explain the significance of the work. | 2. Create artwork of an anatomical structure, system, or process. Use any medium and style you like. |
| 3. Myth buster. Use knowledge of A&P and primary literature to dispel or support a common belief about human anatomy and physiology. | 3. Write a children’s story, develop a children’s activity to address a specific A&P topic. The story must have a clear question, plot, characters, dialogue, and action. |

Table 1: Description of Extra Credit Project Options. Students may choose one assignment from each category.

The extra credit assignments are usually open-ended and intentionally vague. Students completing extra credit from Category 1 can earn between 0.5 and 1% added to their total grade. Category 2 assignments are more laborious and require more creativity, and time investment. Depending on the complexity of their work, accuracy, depth, attention to detail, and quality of execution, students can earn an additional 1-2% towards their final grade. Thus, completing both extra credit options, can potentially improve the student grade by 3%. This increase is not significant enough to replace poor quality

of work on exams or quizzes, which might reflect lack of content knowledge. Despite the very small grade boost these assignments provide, up to 94% of students participate.

The original impetus for creating these specific categories was to encourage students to think about the course content outside of the classroom and to recognize the relevance of the material in their daily lives. Many Etown students are very creative; they minor or major in music and art and learn various crafts in their Occupational Therapy classes. Being able to apply their passions to material with which they do not necessarily feel comfortable allows them to take ownership of the content. By connecting the seemingly impossible content with their strengths and passions (i.e. dancing, art, music) and allowing students to take this difficult material into their skill set, students are less intimidated by the subject and are empowered to think deeply, critically, and creatively about basic science. This creative process also requires higher levels of cognitive ability, as represented in Bloom’s taxonomy (Figure 1; Anderson and Kratwohl 2001). Depending on the type of extra credit they choose (Table 1), they must be able to apply, analyze, synthesize, and evaluate the material, not simply memorize and understand.

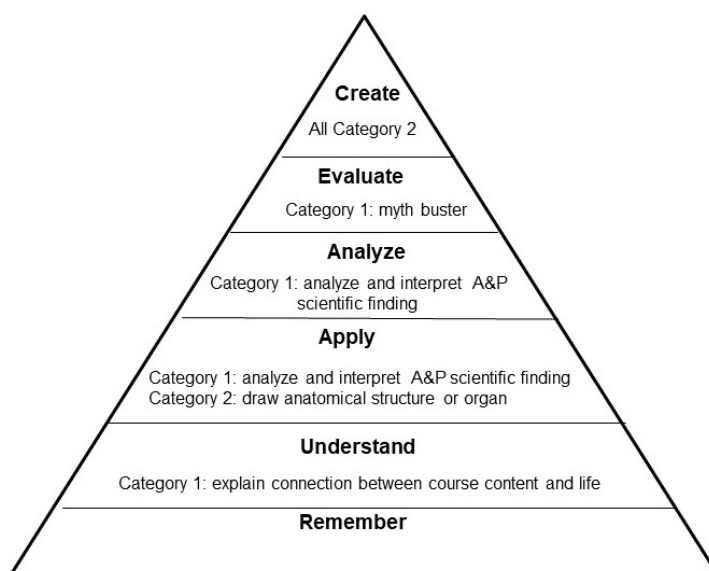


Figure 1: Anatomy and Physiology Extra Credit Assignments and Bloom’s Taxonomy of Learning. Extra credit assignments encourage the development of higher levels of learning classified according to Bloom’s taxonomy.

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Extra Credit Projects - Impacts Beyond the Classroom

Importantly, the extra credit projects from Category 2 have served as an opportunity to help students recognize the interrelationships between the sciences and the arts, develop the skills and courage to think creatively, and apply these skills in real world applications (McNealy 2013).

The projects inspired interdisciplinary collaboration between faculty and students and outreach events in the community. Through interdisciplinary collaboration between faculty (P. Licona in Education, P. Ricci in Fine Arts, and A. Goldina in Biology), we developed multiple educational events to share our students' work and their passion for science. Importantly, Etown students participated in developing and executing all of the events described below. Briefly, we have held exhibits on campus in a library and in an art gallery, in the North Museum of Nature and Science in Lancaster, PA, and in the Lancaster Science Factory, a children's science center. These exhibits were advertised by the college and the by museum to the community. Students in the Fine Arts program installed the artwork, while students minoring in Spanish designed a bilingual Spanish-English exhibit program for the public.

We worked with Etown undergraduate Education majors to adapt the children's activities developed by students in the Anatomy and Physiology course into a week-long Anatomy mini-unit in a local kindergarten. The Education majors developed lesson plans that met state-mandated learning objectives. Many students from the Anatomy and Physiology courses participated in running these lessons, thus seeing their original ideas transformed into tangible activities that were implemented in the classroom. Similarly, the individual art pieces students created for class impacted the public by becoming part of an exhibit that highlighted the presence of anatomy, and science by extension, all around us (Table 2). Thus, all the outreach activities that resulted from these extra credits (Table 2) not only showcased the talent and creativity of the students, but also allowed them to further improve their science communication skills.

| Extra credit types | Events they inspired |
|--|---|
| Art in various forms <ul style="list-style-type: none"> • Paintings / drawings • Sculptures • Clothing • Toys (crochet/ sewn) • Jewelry | Art exhibits "Anatomy Everywhere" held at the North Museum of Science and History in Lancaster, PA. - 2019 "The Anatomy of our Lives" held in the Lyet Gallery of Elizabethtown College, in Elizabethtown, PA- 2019 |
| Written word <ul style="list-style-type: none"> • Poetry • Short stories • Comics/Cartoons | "The Anatomy Chronicles" exhibit held in the High Library of Elizabethtown College - 2020 |
| <ul style="list-style-type: none"> • Children's books • Children's games/ activities | <ul style="list-style-type: none"> • Anatomy mini-unit in local kindergarten - 2019 • Activity tables at the Lancaster Science Factory, in Lancaster, PA - 2019 |

Table 2. Outreach Activities that were Inspired by and Incorporated the Extra Credit Projects

Summary and Conclusions

In our Anatomy and Physiology course, we have taken a voluntary assignment and transformed it into an activity that can empower students and enrich the community. While, quantitatively, the extra credit projects offer a very small boost to each student's grade (up to 3%), the complexity and quality of projects that the students produced demonstrates that their motivations for doing the assignments went beyond a simple grade boost. We are currently conducting a study to understand the impact of these assignments on students.

Furthermore, the assignments we described can be implemented in various classes, be topic-focused or broad, and be flexible enough to take advantage of the resources and strengths unique to each institution and local resources. For example, in an area where access to museums and art galleries is scarce, it might be possible to do an exhibit in a local library or even on campus. It might also be possible to create a

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day where students share their work with each other. In our experience, students really enjoy seeing each other's work and really look forward to the assignment due date. Importantly, in this current climate, where teaching in person might not be possible, these assignments can be completed and submitted online. In the Spring semester, when most of the semester ended up being online, many of our students took advantage of the various online resources to develop digital art, music, and videos. Finally, as an extra credit, this assignment does not require reworking of the syllabus. Thus, an instructor has a cushion to try multiple reiterations of this assignment to develop the criteria and activities that maximize student and institutional strengths, interests, and resources.

From a pedagogical perspective, these extra credit assignments are important for helping students develop critical and creative capacities, which are essential for their future. Increased reliance on scientific progress and technology in our everyday lives is contrasted by a sharp decline in participation and interest of students in science-related fields (Ledbetter 2012). Our failure as scientists and educators to engage non-scientists has a direct impact on future science policy, government funding of research, and ultimately, the ability of individuals to correctly interpret the relevance of scientific development in their personal lives.

Thus, as scholars and educators, we face the challenges of recruiting and retaining students in the sciences, as well as developing students who, while not scientists, will still be able to utilize, apply, and advocate science to the public. We need to develop innovative, creative thinkers who have the skills to recognize and solve societal problems that we cannot yet foresee. These individuals must be able access a "multidisciplinary toolbox" to develop solutions to complex problems and get support from their communities to enact positive change.

The ability to think across disciplines fosters creativity and innovation. While many students do not initially consider science to be a creative process, and definitely do not recognize connections between art and science, these fields have relied on and inspired each other for centuries. The works created by our students to complete their extra credit reflect their ability to apply their passions, creativity, humor, and artistic abilities to science. By incorporating extra credit projects into our Human Anatomy and Physiology courses, we have not only given students an opportunity to boost their grades, but also empowered them to be positive forces in their communities and to share their skills and talents with those around them.

Acknowledgement

The Elizabethtown College Collaborative Interdisciplinary Scholarship Grant awarded to A. Goldina, P. Licona, and P. Ricci funded the events described in this paper.

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Immunology Stories: How Storytelling Can Help Us to Make Sense of Complex Topics

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Abstract

The immune response is a wonderfully complex aspect of our physiology that can sometimes confound students and instructors alike. How do we wade through the layers of detail to help our students develop an understanding of immunology? In this article, I will share some of the stories about immunology research that helped me strengthen my own understanding and improve my approach to helping students learn and understand this topic. In addition, we will explore some of the research on the power of storytelling, and how learning through stories might be a defining characteristic of what it means to be human. <https://doi.org/10.21692/haps.2020.105>

Key words: storytelling, immunology

Introduction

I have been trying to understand the immune response for a long time. Like many Anatomy and Physiology instructors, I did not have an immunology background beyond what was covered in my undergraduate physiology courses. When the time came for me to teach students about the immune system, I relied heavily on the information presented in our textbooks. I was able to present students with the key pieces of information and help them to remember a few facts, and the students did well on their exams. However, I felt that perhaps I was missing the point; perhaps I was not helping them truly understand the immune system. Maybe this was because I did not actually understand it very well myself.

One summer, I had the opportunity to take the American Association of Immunologists (AAI) Introductory Course in Immunology. After six intensive days full of lectures on the immune system, I had learned many new facts and gotten a sense of what the “hot” areas of immunology research were at that time. It was 2016 and the majority of participants were researching cancer immunotherapy treatments. In some way I felt a lot more competent in my understanding of immunology, but I still felt like I was missing the bigger picture.

Then one day I heard a radio interview with Daniel Davis about his 2018 book *The Beautiful Cure*. It sounded interesting, so I picked up a copy from the public library and started to read. I enjoyed it so much that I soon found myself telling everyone I knew about it, and soon after I read his earlier (2014) book, *The Compatibility Gene*. These two books greatly improved my own understanding of the immune system and helped to transform my approach to teaching these topics as well. What was so special about these two books that they had such an impact on me? It was the stories. Not just stories about how our immune system works, but stories about the researchers that shaped our current understanding of immunology.

My personal journey to develop a better understanding of the immune system was a compelling reminder to me of the power of storytelling. Suddenly I saw examples of storytelling everywhere that I saw authentic learning. In this article, I will share some of what I have learned about learning through stories, some of the fun and fascinating immunology stories from Davis’ books, and my current approach to helping students understand the immune response.

Learning through stories

Once I had recognized the link between stories and my own learning, I started to see examples of it all around me. I also did some reading to learn a bit more about the research that has been done on the power of storytelling. In her recent book, *Transcendence: How humans evolved through fire, language, beauty, and time*, Gaia Vince (2020) writes about how it has been a combination of genetic and cultural evolution that has transformed our species. Using language to share information through story, between individuals and between generations, has been essential to our ability to survive times of significant environmental change, including a great ice age 20,000 years ago (Vince 2020).

As described by Vince, “our brains evolved with reflexive use of narrative as a part of our cognition. Stories shaped our minds, our societies, and our interaction with the environment” (Vince 2020, p.82). Not only do we appear to be hard-wired to use stories, we use more regions in our brains to process information told through a story rather than from a list. Language processing areas of the brain (including Broca’s area and Wernicke’s area) will be active in both cases, but when the information is told through story, other areas of the brain are also involved, including areas of the motor cortex for stories that involve movements, and areas of the sensory cortex for stories that include descriptions of physical sensation (Vince

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2020). All of this brain activity might be why information told through story can be up to 22 times more memorable than the same information given in a list (as summarized in Vince 2020).

Humans have been telling stories for tens of thousands of years, and storytelling continues to be an important way of learning and sharing knowledge among indigenous peoples. Vince (2020) describes the songlines of Aboriginal groups in Australia, oral stories that serve as archives to describe things such as ceremonies, laws, and geographical information. In describing the roles of the songlines, she writes "This explains the prevalence and importance of human stories: they work as collective memory banks, storing detailed cultural information encoded in narrative" (Vince 2020, p.82). Ancient stories can convey facts and information, but they can also help to provide perspective and perhaps shape our thinking. In her book, *Braiding Sweetgrass: Indigenous wisdom, scientific knowledge, and the teachings of plants*, Robin Wall Kimmerer, a botanist and member of the Citizen Potawatomi Nation, writes:

"In the public arena, I've heard the Skywoman story told as a bauble of colorful 'folklore'. But, even when it is misunderstood, there is power in the telling. [Can we] understand the Skywoman story not as an artifact from the past but as instructions for the future? Can a nation of immigrants once again follow her example to become native, to make a home?" (Wall Kimmerer 2013, p.9).

I am sure that I am not alone in telling short, personal stories and anecdotes when I teach. It helps me to feel more engaged with my students, and students often report that they "enjoy" the stories; it helps them to connect to the course material and remember it better. In my experience, it also helps to create a class environment where students feel more comfortable sharing their own stories, so that we all have the opportunity to learn from these new examples and ideas.

Moitra (2014) describes how the use of stories to convey course content in a genetics class helped to increase student engagement, and other studies have shown that when post-secondary students have the opportunity to tell their own stories as part of an assignment or project, they feel more engaged in their studies and their college experience overall (Everett 2017). While there is a considerable amount of research about the effectiveness of storytelling in the education of younger children (see Engel et al. 2018 for example of storytelling in children's science learning), storytelling has also been shown to be effective in higher education (Abrahamson 1998; Rossiter 2002). Aside from conveying information, research has shown that when teachers share personal stories, their students find them more approachable and authentic (Johnson and LaBelle 2017), and scientists can increase comprehension and engagement in their "nonexpert audiences" by using narrative and storytelling

(Dahlstrom 2014; Saffran et al. 2020). It is no wonder, then, that as a "nonexpert" in the field of immunology I would find myself engaged in the stories of immunology discovery.

Some immunology stories

Daniel Davis' two books, *The Compatibility Gene* (2014) and *The Beautiful Cure* (2018), contain many engaging stories. Some of the stories describe how landmark discoveries in immunology were made, sometimes in dramatic "ah ha" moments, but more often through slow, steady progress and collaboration between creative individuals.

One discovery story that had an impact on me was about the work of Charles Janeway. When teaching students about the scientific method, we tend to teach them that you start with an observation which leads to the formation of a hypothesis, and then you design experiments to test that hypothesis. However, in Janeway's case, his observations on the role of adjuvants in vaccines led him to predict that there was (at that time, in 1989) something "missing" from our understanding of the immune response (Davis 2018). He hypothesized that there must be some sort of "pattern recognition" that enabled our body to determine when non-self-molecules were a sign that potentially dangerous pathogens were present, and to then stimulate our adaptive immunity. There was no way to test his hypothesis at the time. "Quite simply, at the time, nobody could say if Janeway's ideas were revolutionary or fanciful bunkum" (Davis 2018, p.19). It would take nearly another decade for researchers to develop experiments that could prove Janeway's hypothesis and increase our understanding of the role of innate immunity (Davis 2018). This later work was not without controversy, involving the collaborative efforts of many individuals, only a small subset of whom were awarded the Nobel Prize for this work on innate immunity (Davis 2018).

Other stories were memorable simply because they made me shout out, "that's so cool!" and then proceed to share that story with anyone who was willing to listen. One such story was about fever in cold-blooded animals. Even though cold-blooded animals cannot change their body temperature by altering their metabolic activity (like warm-blooded animals can), they can change their body temperature by changing behavior and seeking out a warmer environment. They increase their heat-seeking behaviors during an infection. Even more amazing is the fact that medicines that reduce fever in warm-blooded animals reduce the heat-seeking behaviors of cold-blooded animals (Davis 2018; Evans et al. 2015). "This means that at least some of the chemical and biological processes causing a reptile or fish to seek a warmer habitat during an infection are similar to those within us during a fever" (Davis 2018, p.112).

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Most of the stories in *The Compatibility Gene* (Davis 2014) describe the discoveries and functions of our MHC (major histocompatibility complex) genes. Collectively, the stories in this book helped me to gain a greater understanding of how MHC genes (and MHC proteins) work, and how their variation contributes to differences in susceptibility to different diseases and infections. One well-documented example describes the connection between one MHC gene variant (HLA-B*27), susceptibility to the autoimmune disease ankylosing spondylitis, and protection against AIDS. People who have inherited HLA-B*27 are more likely to develop ankylosing spondylitis than people with other forms of HLA-B, but are they are also more likely to be HIV Controllers, individuals who do not progress to AIDS after HIV infection.

The research on ankylosing spondylitis was performed many years ago (see Brewerton et al 1973, for example), and the research on HIV followed many years later (The International HIV Controllers Study 2010), but the two were woven into one cohesive narrative that helped to explain the connections between the two, and the overall significance of variation in our HLA genes. As Davis (2014) explains, the different forms of HLA genes result in slightly different-shaped proteins in the region of the HLA (MHC) class I protein that presents antigen. Differing antigen presentation between individuals can make one individual have a strong immune response to a certain antigen compared to a different individual; differences that could lead to inflammatory disorders or affect susceptibility to infection (Davis 2014).

While most of the discussion of HLA-B*27 is found in one chapter of the book (Chapter 5: Differences between us that matter), Davis returns to this in the book's epilogue, with a story about how he and his wife had a genetic test done to determine their own HLA genes. With much humor related to other aspects of these results (including some friendly competition about whether their results were "common" or "rare"), he also describes their reaction when it was revealed that his wife has the HLA-B*27 gene (Davis 2014). Does it mean that she is likely to develop ankylosing spondylitis? No. However, will they consider this possibility if she were to start developing back pain, in the hopes that they could begin appropriate treatment early? Yes.

Through these stories, and the others in these two books, I was able to see immunology in a new way, and the big themes became more apparent. As Davis writes in *The Beautiful Cure*: "Textbooks about the immune system tend to discuss the role of each molecule or cell in turn, but that's like explaining a bicycle by describing what a wheel is, and then what a handlebar is, and then what a brake is. None of these single elements are properly understood without the others; their meaning lies in the relationships between them." (Davis 2018, p.5)

By reading these immunology stories, I gained a deeper appreciation and understanding of both the marvelous details and the overarching themes of our immune response.

My approach to teaching immunology now

"Someday we may find a grand unified theory of the immune system, a few principles that capture precisely how it all works, or one diagram that fits on a T-shirt. But that dream may never work out. And it might even be the wrong thing to aim for." (Davis 2014, p.196)

In all of my earlier endeavors to understand the immune system, I had been aiming to learn enough to be able to create one, magical summary of the whole immune response that I could then share with my students. Eventually, I realized that this was not really possible, and that it would probably not be very helpful either! I did make a variety of summary drawings, flowcharts, and other diagrams to help put things together for myself, but just giving one of these summaries to students deprives them the opportunity to put it together and figure it out for themselves.

Of course, the problem is that they do not have nearly enough time as a student in a typical Anatomy and Physiology course to study the details, discover the big themes, and then put it all together for themselves. That process would probably take months. In the end I decided on a compromise: guide them through a visual summary of the immune response to bacterial infection, share some of the stories I have heard and read to help provide some context and generate additional interest in the topic, describe a reasonable amount of detail (cell types, receptors, etc.), and introduce them to some of the big themes.

There are four big themes that I use as anchors for the information I share with students in class, as well as for my own ongoing learning about the immune system.

Innate vs. adaptive immunity. There can be a tendency among students and instructors to overlook the importance of our innate defenses and focus instead on the details of our adaptive defenses. However, it is worth remembering that our innate defenses essentially keep us alive long enough for our adaptive defenses to be activated. I also try to remind students that it is not a matter of "either/or" but "both/and". Innate and adaptive defenses work together in many aspects of our immune response.

Cell-mediated vs. antibody-mediated immunity. This theme is often emphasized in first-year Anatomy and Physiology textbooks as well. This can be a helpful way of categorizing and thinking about adaptive immunity and the different cell types that are involved, but as with the innate vs. adaptive dichotomy described above, it is helpful to remember that there are some overlapping elements here as well.

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Systemic vs. mucosal immunity. I do not spend much time in the first-year Anatomy and Physiology classes I teach discussing systemic vs. mucosal immunity, but it is something that has interested me since I took the AAI Introductory Course in Immunology. The majority of research into the immune response has focused on the body's response to antigen exposure through the skin (systemic immunity). But the majority of infections that the body must fight involve antigen exposure through one of our mucous membranes (Parham 2015). And while there are many similarities between systemic and mucosal immunity, there are many important differences too. I think it is worth highlighting this fact while teaching immunology as part of an Anatomy and Physiology class, even if we do not study many details of mucosal immunity, because it could at least prime the students to know that what happens at the mucosae will not be exactly the same as what happens at the skin. It can also help to set the stage for topics that may be covered in pathophysiology courses, which many Anatomy and Physiology students will eventually take as they continue in their program of study.

The balance between illness, immunity, and autoimmunity. For me, this really is the big picture idea that we should keep in mind while studying the immune response. Our ability to fight infection, prevent cancer, and yet avoid excessive inflammation and destruction of "self" cells is at the heart all aspects of health and disease. With any luck, my students will remember these "big ideas" in immunology, even if they forget some of the finer details.

Has my personal journey to learn about immunology helped me to develop a better understanding of the immune response? Yes, but with one significant caveat: I am not an expert. But I am OK with that. I will continue to read about immunology, broaden my knowledge and deepen my understanding. I will continue to revise how I approach these topics in the Anatomy and Physiology courses that I teach. And I will keep telling these stories.

About the Author

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Using Infographics to Help Students Understand and Communicate Anatomy and Physiology

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Abstract

Poster presentations to communicate scientific knowledge/understanding are a commonly used assessment tool. It can be a challenge for students (and staff!) to deliver clear information with minimal text on the poster. We have found that this format did not encourage imaginative project topics or posters. To enhance communication skills, imagination, and student engagement, we adapted an existing physiology research project and increased the emphasis on communication skills with the use of infographics. This paper describes how students may produce their own biomedical infographics and discusses the issues that educators may need to consider when integrating infographic assessments into their teaching. <https://doi.org/10.21692/haps.2020.106>

Key words: infographics, biomedical, assessment

Introduction

Infographics (information graphics) are a method of communicating complex information visually to a broad audience. Infographics usually use diagrams, color, symbols, graphs, or art to convey ideas to an audience, with only minimal text. They have been increasingly used by various organisations to communicate science or technical information to the general public through a variety of media such as newspapers, websites and posters (Rogers, 2012).

Health providers may use infographics to help patients understand how to improve their health, seek help, or prevent disease (Arcia et al. 2016; NHS Digital 2019). Infographics benefit from a strong visual component that can make it easier for a viewer to understand the messages (Majooni et al. 2018). Davidson and Hargis (2016) have argued that infographics can be effective tools for second language learners. Infographics can be shared easily via web/social media platforms, thus increasing the reach of the author's message (Brunnering 2020). Common examples of infographics include the periodic table of elements, transit maps (e.g. London Underground Map), and electoral maps. Infographics have been used to assess understanding, and creative and communication skills of several student populations (Krauss 2012; Davidson 2014; Polman and Gebre 2015; Falk 2016; Gebre and Polman 2016).

Undergraduate anatomy and physiology students are commonly asked to undertake literature research projects, reporting their results in the form of a traditional scientific conference style poster (Krulowicz and Downs 1999; Andraos-Selim et al. 2010). However, this style of assessment may only train a student in how to communicate science in that format and to a specific audience type. Increasingly, academic researchers are required to deliver their research outcomes to

non-scientific audiences to encourage wider dissemination of information and outreach. Many institutions aim to provide students with broader skills to be able to communicate scientific and complex information to a range of populations, and infographics can provide a vehicle by which this can be achieved.

In addition, many students do not wish to follow a traditional scientific research career path (Choate and Long 2019) and may find that developing a traditional scientific poster is less engaging. To help students become more engaged with a physiology literature research project, we revised an existing assessment to involve students designing and developing an infographic poster to communicate their findings. We were inspired by the apparent simplicity of infographics to convey complex information. Our approach was supported by VanderMolen and Spivey (2017) who reported enhanced research skills, communication, and approach to learning when their students undertook an infographic-based assignment, with 80% of respondents preferring an infographic assessment to a written short paper. In this article, we report our experiences of this type of assessment and explain how others in our school have adapted this initial idea to meet the needs of the students in their own programs.

Materials

Students were provided with a range of different types of infographic examples they could find online and a list of references they could use to explore what is or is not effective in terms of communicating scientific ideas. A simple search engine search for 'physiology infographic', 'anatomy infographic' or 'medical infographic' revealed numerous examples. Learners were also encouraged to explore social

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media, newspapers, or websites to understand how such outlets use infographics as part of their published content (Figure 1).

There are a range of books that focus on the use of infographics, which help to illustrate how science can be communicated effectively using such an approach (Brunning 2015; Parker and Baker 2016). Students were also directed to various online resources to help them develop infographics of their own, even if they had limited digital experience or access. There are YouTube videos that focus on drawing infographics using software such as MS PowerPoint or Google Draw, which many learners can access, as well as free versions of specialist

infographic software such as Piktochart, Canva and Venngage, to name but a few.

Students were advised that they did not need to pay for more specialist access or resources, and that they were free to choose any resource they felt most comfortable with to develop their infographic. If students had issues with IT/ internet access, they could use a simpler approach of hand-drawing or crafting an infographic on paper or card. The assessment was designed to incur minimal costs and use only basic or free software so that it can be used by as many instructors and students as possible.

What to do

- Develop a question relating to a physiological problem.
- The infographic should be able to:
 - Give some background to the subject/question
 - Make it clear what the question is or why this is important
 - Use real scientific data from research papers to provide evidence
 - Come to a final conclusion or answer the question
 - Communicate complex information quickly to a wide audience so they actually remember what your point was and what you found, even after they go home that night!

This physiological question could relate to any of the following areas:

- Clinical
- Sports-related
- Pharmaceutical/pharmacological
- A special situation such as pregnancy, hypoxia, high-altitude/pressure, heat, cold etc
- A comparison with physiological processes/function with other species
- Infection/Immunity
- Disease/Injury
- Evolution/developmental
- Nutrition
- Or anything else you find interesting and can find data about!

Figure 1. An excerpt from the guidance provided to students when starting work on their infographics. This is part of a more extensive document that attempts to provide students with detailed instructions, structure and focus at the start of their project.

Methods

This work was undertaken at a Scottish 'ancient' university where students study on a 4-year BSc (Hons) program. The majority of students enter directly from school, but there are also students who enter at different stages from technical/further education colleges, and there can be international/exchange students who are in the class for a semester or academic year. This course (PY3002 Integrative Physiology) takes place at the beginning of Year Three of the students' degree programs. In Scotland, this would equate to Level Ten of the Scottish Credit and Qualifications Framework (SCQF) (SQA, 2020). The course is compulsory for students majoring in physiology and is a common elective for students studying sport-related programs and neuroscience. It is also offered as an elective for exchange students with a relevant academic background. Students must have previously taken courses covering fundamental cellular and organ system physiology, and they are required to have some knowledge of biochemistry and physiology.

The focus of this course is to get students thinking about how physiological systems integrate, and how we apply physiology in 'real-life' situations, for example in pathophysiology, athletic training, and adaptation to stressors, etc. The average class size has been approximately 50 students over the past three years. The project is led by one member of academic staff, with other staff coming to view student projects at the end of the course during a student symposium, which can be done virtually rather than as an actual physical event.

The course lasts for 11 weeks with an extra week for exam revision or final assessment activities. The course assessment involves a final exam on course material that constitutes 67% of the final grade, with the remaining 33% coming from continuous assessment activities. Students undertake three short-answer case studies in their own time (10%), two all-day practical classes involving human data capture/analysis (8%), and the infographic project (15%). The traditional heavy weighting towards a high-stakes written exam is being reviewed across our entire institution and will likely be changed for the next academic year due to the COVID-19 pandemic necessitating changes in how we teach and assess learners.

Students were instructed to research a topic in anatomy or physiology that they choose to investigate over the period of their research project (Figure 2). Our students undertook this activity individually, but it could be completed as a group exercise if required. The project period lasts for nine weeks in our institution, but it can be as short as three to four weeks, depending upon other time commitments and workloads of the students. Guidance on the types of topics students might find interesting are provided, along with examples of what previous learners have produced.

Students were told they can assume their audience are non-scientists who may have the equivalent biological knowledge of a high school graduate. Students were provided with the grading rubric to be used to assess their final infographic. Students were told to use peer-reviewed literature to inform their research and were asked to provide outline ideas about what they will research by week two of the project.

Initial feedback on the project topic is provided so that students can progress with their research and infographics. Students were also encouraged to ask family and friends to provide informal feedback on the effectiveness of their infographic throughout so they can assess whether they are pitching the content of their infographic correctly for the audience for whom it is intended. This interim feedback approach has been used by VanderMolen and Spivey (2017), and was considered by Blackburn (2019), to mitigate any concerns by students with regard how to tackle what can be a very different form of assessment for them. We stressed that this is not an art assignment, a concern that had been raised in the study undertaken by Blackburn (2019) when working with chemistry students.

At the end of the project research period, students sent the file or link to their infographic to the instructor for assessment. The infographic could either be printed out for viewing or posted on a class virtual learning environment/social media account (e.g. Twitter). The infographic was then graded by the instructor using the published rubric. We encouraged peers (for 5% of the final assignment grade) to provide a wider range of constructive feedback and also display the infographics on poster boards during a 'mini-symposium' so authors can gather opinions from a range of peers, graduate students and faculty. Finally, to more formally assess student writing skills, students submitted a one-page abstract summarising the content of their infographic and providing detailed supporting evidence for the content. The grading rubric for this abstract was published in advance. The final grade for the assignment was derived from the following elements:

1. Instructor's grade for the infographic poster - 75% of assignment grade.
2. Peer grade for the infographic poster - 5% of assignment grade.
3. Formal written abstract to summarise project - 20% of assignment grade.

Similar grading rubrics to assess student infographics have been used by Blackburn (2019), Davidson (2014), and Davidson and Hargis (2016), with Blackburn (2019) also stressing the need to include some written component of assessment if students are expected to demonstrate mastery in future learning activities. All learning/guidance materials for the entire assessment were placed on the learning

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management system/virtual learning environment so that students could access them at any time.

Ethics/IRB approval was not required for this project as all data discussed were derived from the University's central anonymized course review that was conducted independently from the authors. Any material from this course review can be published and is freely available. This material was also an audit of an assessment activity that was already taking place. All quotes were derived from the course review documentation or the student-staff liaison meeting, again where the authors were not present to influence any comments. Anonymised material from these meetings may be published and are freely available. In addition, examples of student work included in this study are permitted to be published and have already been made publicly available via the class social media account. The examples provided have been anonymised by the authors.

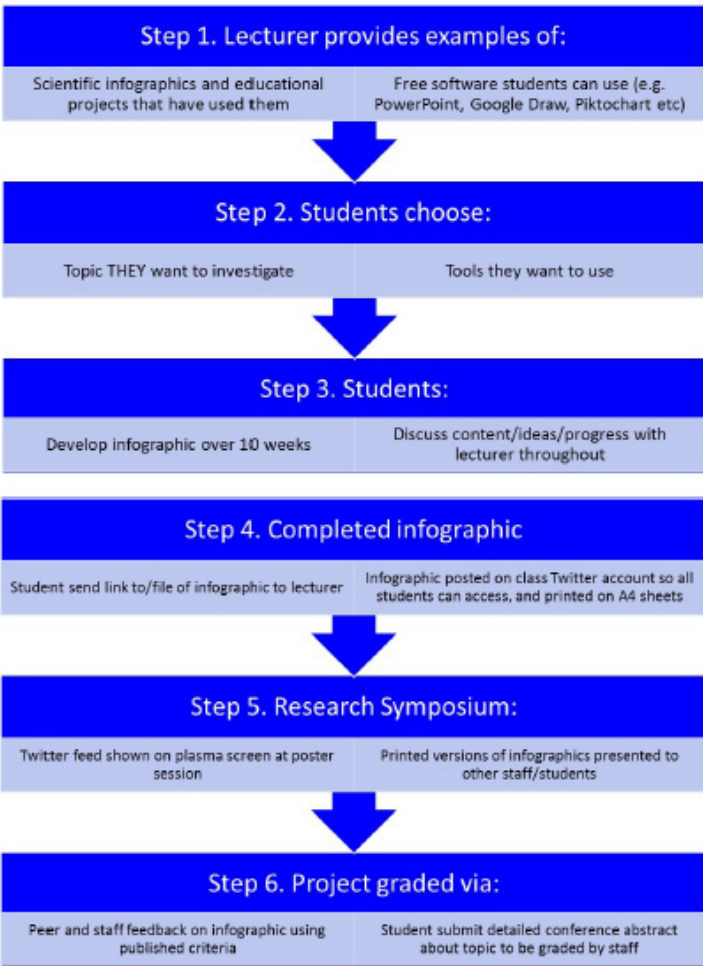


Figure 2. Outline of the infographic project process. This is one approach but it could easily be modified to suit different student cohorts or course requirements/resources.

Assessment

The grading of this activity can be based upon criteria such as participation, acquisition of new skills, completion of required tasks, demonstration of understanding of the topic, strength of the peer-reviewed evidence, ability to communicate ideas/concepts effectively, awareness of accessibility issues when designing the infographic (e.g. for those with color blindness/visual impairment). An example rubric that can be used by instructors or peers is provided in Figure 3. The rubric was provided to students at the start of the project to ensure that they clearly understood how they would be assessed.

School of Medicine, Medical Science & Nutrition – Infographic Grading Rubric

Course: PY3002 Integrative Physiology

Infographic Project Title: Assessor:

Date:

Grade poster according to criterion.

Students should use this to monitor their progress and help enhance their work as they progress through their project. This will help you understand how you will be assessed at the end of this assignment.

| Criterion | High | 5 | 4 | 3 | 2 | 1 | 0 | Low |
|--|--|---|---|---|---|---|---|--|
| Opening | Good introduction and outline of Presentation | | | | | | | Poor introduction and no outline |
| Use of peer-reviewed information | Valid facts, interpretation and appropriate analysis | | | | | | | Inappropriate/aneecdotal data and poor analysis |
| Appearance | Appears well prepared | | | | | | | Appears poorly prepared |
| Clarity | Easy to understand | | | | | | | Unclear |
| Sequencing and linkage of materials | Excellent | | | | | | | Poor |
| Coverage of material | Subject area well covered, main points emphasized | | | | | | | Poor coverage, lacks emphasis |
| Illustrations | Effective/Appropriate | | | | | | | Poor/Inappropriate |
| Conclusions | Good summary of content and appropriate conclusions | | | | | | | Poor summary of content and inadequate conclusions |
| Is it authored in a way that can be understood by the target audience? | Good | | | | | | | Poor |
| General Impression | Excellent | | | | | | | Poor |

Overall Mark:

Additional Feedback and Comments:

Figure 3. Example grading rubric used by faculty and peers to assess infographic.

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This activity can enable students to achieve multiple **HAPS Learning Outcomes** depending upon the specific topic/organ systems that they choose to investigate. In addition, this assignment allows students to meet all the **HAPS Content Integration Goals and the Cognitive Skill Development Goals** (HAPS 2020). The most prominent of the **HAPS Goals** achieved by students are:

1. Use appropriate terminology to discuss anatomy and physiology.
6. Propose evidence-based hypotheses to explain physiological responses or the functions of anatomical structures.
7. Apply knowledge of anatomy and physiology to real-world situations.
9. Interpret and draw appropriate conclusions from graphical and other representations of data.
10. Apply information literacy skills to access and evaluate peer-reviewed resources.
11. Approach and examine anatomy and physiology issues from an evidence-based perspective.
12. Adapt information to effectively communicate with different audiences.
13. Recognize that our individual differences (ethnicity, gender, culture, etc.) shape our understanding of anatomy and physiology.
14. Foster respect for individuals across differences within educational and professional settings.

Overall, the assessment approach should help students understand expectations about the balance between demonstrating academic knowledge and understanding and imparting that knowledge in an easily digestible format for a non-specialised scientific audience.

Student Feedback on Activity

The first cohort of students to undertake this exercise reported in class that they wanted clear criteria regarding the audience for the infographic. They felt this would make it easier for them to make decisions about the content of the infographic, the amount of detail required, and the overall design of the infographic. For example, an infographic for a young child might use different images/language/color than one designed for an older professional with more knowledge of science. Based on this feedback, more detailed guidance was provided. A similar approach was used by Davidson and Hargis (2016) when their students requested more context to help stay focused when creating their infographics.

Further detailed feedback on this activity has been gained through student-staff liaison meetings and anonymised course evaluation forms over the last five years, with modifications/improvements being made to the assessment to enhance the

learner experience. This activity is used with a class that has a diverse student population including:

1. Students who have studied at the institution for the past two years
2. Students who have come directly from a further education (community) college into this course.
3. International exchange students.
4. Students majoring in physiology, sport science (kinesiology) and neuroscience, with some students from other non-biomedical departments taking this course as an elective.

Allowing students to choose an area of anatomy or physiology that suits their own interests enhances engagement and means that students can develop knowledge and skills linked to their future career intentions. For example, students keen to follow a clinical career often study a pathophysiological topic and a military cadet explored injuries caused by improvised explosive devices. The novelty of the experience for everyone in the class encourages informal discussion and can help new students integrate more effectively.

When considering the feedback provided by students during the project and from class evaluation surveys/meetings, several comments seem to have consistently appeared over the past five years. Quotes were extracted from the anonymised university-administered course evaluation surveys conducted independently from the faculty involved; these are public documents and anonymised data/quotes may be published without ethics/IRB approval:

"This project has allowed me to be creative whilst still doing science."

"It's not the science bit that's hard, it's how you pitch it at the correct level that's the difficult thing!"

"I found this more enjoyable than doing a traditional science poster."

"I can remember what people's infographic posters were about weeks later, but I can't remember what anyone has done in a traditional scientific poster."

"It's easy to think this is simple, but it does take a bit of planning and work. I probably needed to manage my time a bit better and not leave producing the final infographic until the very end."

"I appreciated the freedom of choice in this project – I could combine something I was really interested in outside of my academic studies with physiology."

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"I have been using these new skills to help the societies and organizations I am involved with."

"Could teachers use this as a way to summarise the key points of a block of lectures or a practical class?"

"Since doing this project I realise that infographics are everywhere."

In response to some of the comments received over the past few years, we have provided students with a basic project plan at the start of their projects to help them manage their time and workload more effectively. This outlines the key milestones that they should have achieved by each week if they wish to stay on track and submit on time without a last-minute rush.

We have also added in a final feedback session where we ask students to reflect upon the skills they feel they have enhanced or learned, and how they might use this experience to improve their résumé. This discussion always provides examples of how students have enhanced their employability. For example, how they have used the skills outside of the classroom or how students have learned advanced IT/time management skills etc. Davidson and Hargis (2016) also reported improved awareness and development of transferable skills within their student population after undertaking an infographic-based assessment.

Other small changes that were introduced in light of feedback and experience was the format of citations within the infographics. Our school usually prefers the Harvard citation style for student assignments, but this can take up space and add too much text to an infographic. For this assignment, we allowed students to either use the numerical Vancouver citation format, or to provide a separate list of their citations if it was felt that the citations within the infographic might reduce its visual impact.

During the first trial of this assessment it also became clear that some students developed long infographics that were more suitable for scrollable webpages, whilst others were more appropriate as a poster or A4 brochure. We allowed such diversity but made it clear that students must have an appropriate rationale for their choice of format. Colleagues who have adapted this activity for their own purposes have chosen to specify formats appropriate for their class and the focus of their assignments. Examples of student-created infographics are shown in Figures 4 and 5, with other student-authored examples published by Blackburn (2019) and Davidson and Hargis (2016).

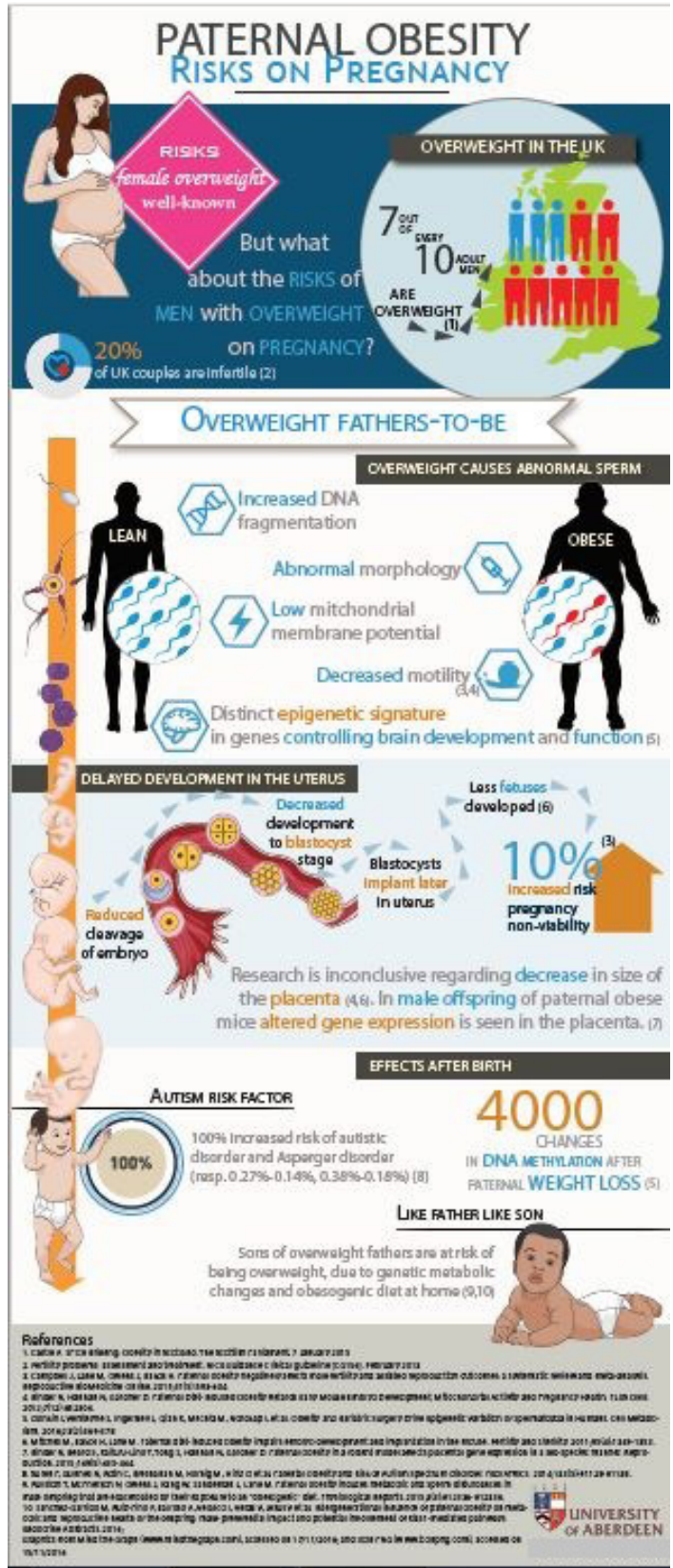


Figure 4. Example infographic created by a student during their project.

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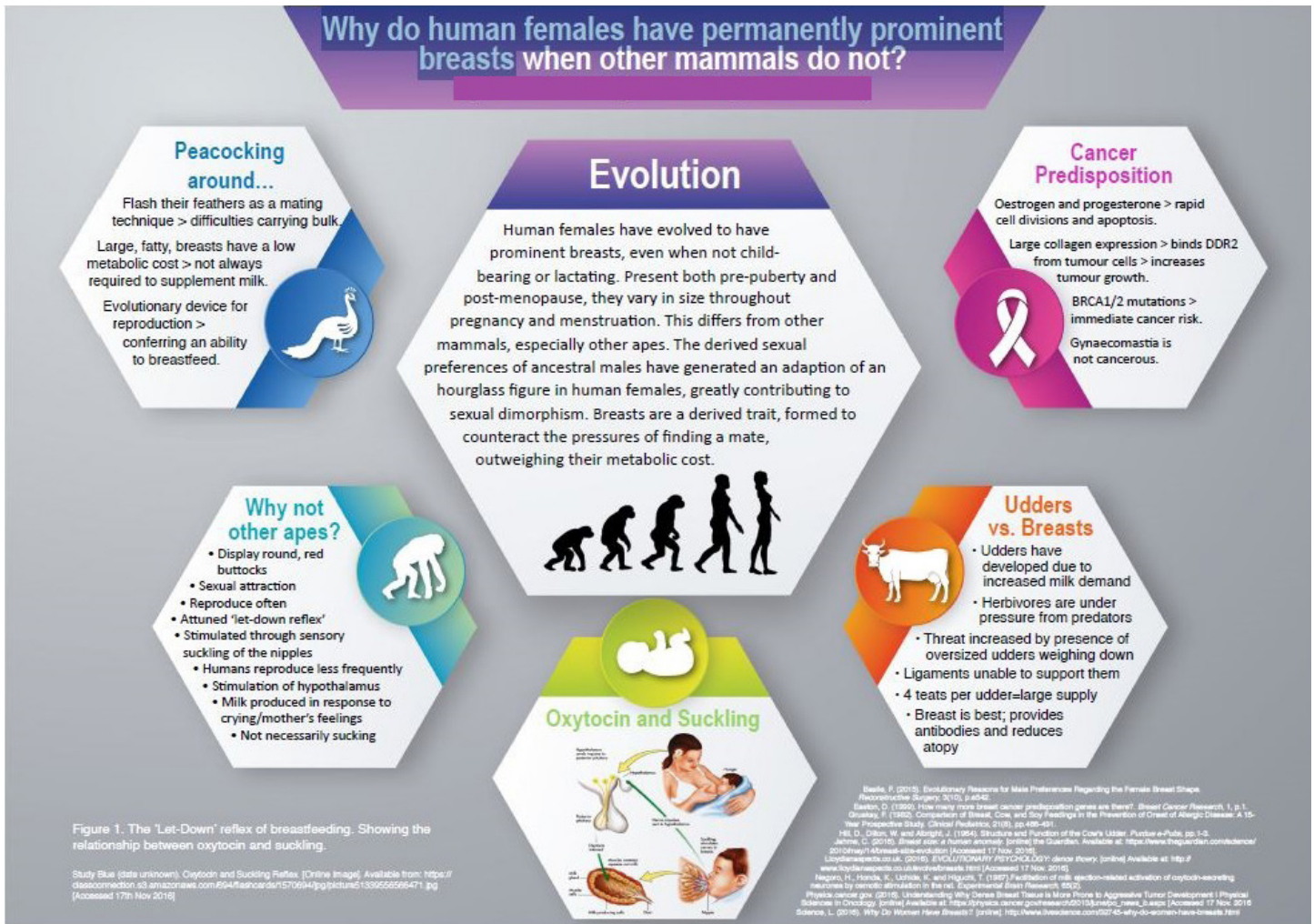


Figure 5. Example infographic created by a student during their project.

In terms of student attainment and satisfaction, when this assessment was introduced 42/44 students achieved a grade within the 70-100% range, with the average grade being 72.0 ± 4.8 % (error values represent standard deviation). During the previous traditional scientific poster assessment, the average grade was 63.0 ± 1.3 %, with only five students scoring within the 70-100% range (n=47). As a comparator, the average written course exam grade (four essays over three hours) was 58.1 ± 2.6 %, and the average overall course grade was 67.0 ± 6.0%.

Infographics were double marked to minimise any risk that we had lowered academic standards when grading this novel assessment. In terms of student satisfaction, 90% of students (n=44) rated the infographic assessment at either four or five on a five-point scale, where five indicated that it totally met their learning needs.

When considering why students were achieving higher grades, faculty suggested that students were better at communicating

the science in a clearer way than with the previous conference poster format. Another comment was that the students were no longer including excessive information and text and that the new format was forcing them to be more selective in the information they presented.

Instructor Feedback on Activity

Staff feedback has been focused on how creative and imaginative the students were, and the sheer range of topics that have been researched each year. With our previous traditional scientific poster session, it was common to have students researching very similar topics and there would be repetition every year. Since the introduction of the infographic format, none of the >250 projects have been identical. Examples of teacher feedback (derived from student-staff liaison committees and informal feedback at the poster symposium) include:

"I've learned something new again this year from these infographics."

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"Amazing topics that I would never have thought about. We used to regularly get students doing the same thing i.e. effect of caffeine on heart rate, but some of these topics are truly advanced."

"The students are so creative – you can see they are really passionate about their subjects and they have learned skills that they could use as part of their future careers."

"The students seem to worry less about the complexity of the science they are presenting but worry more about how effectively they are communicating it."

"This has made me wonder whether I should review how I present complex information in my lessons or at conferences. How many people actually remember what I present in its current form the next day?"

Permission was granted by staff to use anonymised quotes. Anonymised comments from staff-student liaison committees are published and can be reported without IRB/ethics approval.

The originality shown by the students in developing infographics and selecting appropriate information echoes similar results reported by Blackburn (2019). Due to the success of this activity and the positive feedback from instructors and students, similar assignments have been created by colleagues for classes with very diverse international graduate populations, such as our Master of Science programs. One of these class assignments related to drug discovery and clinical pharmacology. The students in this class were given a very specific brief that they must produce a one-page A4 infographic that should act as a drug company handout and social media post. Their task was to communicate why a specific drug being trialled should receive more investment. Their audience was specified as a business investor with no science background. Another class focused on diabetic physiology and the students in this class produced an infographic that educated a diabetic patient about some aspect of their care or monitoring. These graduate level classes completed their work over four weeks and similar positive feedback from staff and students have been received in relation to these assignments.

Limitations and Future Developments

Despite the success of these activities, there are some caveats that an instructor should be aware of. Firstly, some students can find too much choice overwhelming. Therefore, a feedback session with students within the first two weeks can be helpful for students in narrowing down a topic or focusing on a specific question. Some students will try to cover too large a topic as their project, whereas others may choose something so specialised that it can be difficult for them to

find a variety of peer-reviewed references to support their project work. Early informal feedback sessions can be useful to support those students who are new to an institution and are still dealing with the challenges of studying in a different environment.

It should be made clear from the very start that this is NOT an art assignment. The early publication of a detailed grading rubric can reinforce this and help students stay on track and assess for themselves whether they are achieving the learning outcomes associated with this activity. We also stress that students should try to use commonly available or free resources whenever possible, mainly to avoid any student feeling they cannot participate because of financial concerns, but also to highlight that these are useful skills and resources for when they leave the university environment.

In terms of the tools and software that students use, some will report that they find the free resources limiting in terms of templates, or that it may be harder to use if their primary device is a tablet. We provide reserved time on classroom PC's to avoid such problems and access to more advanced templates is becoming less of an issue now that a greater range of free infographic templates are becoming available for PowerPoint. There are instructional videos freely available online to help students make their own creations without a template.

One issue that may not be immediately obvious to some students is that their infographics should be designed to be read or understood by those with accessibility issues. We have altered our grading rubric and introductory materials to highlight that font, color, and format may pose issues for individuals with color blindness, visual impairment, or learning disabilities, which encourages greater awareness of these issues.

The participation of international exchange students often means that the class gets to learn about topics that are of major importance in parts of the world they may know little about. For example, previous international students have produced infographics about diseases that are more prevalent in their home country, or compared animal experimentation legislation between the UK and their country of origin. This diversity adds to the educational experience of the class and can mean that we cover far more specialist anatomy and physiology during the course than we normally would during scheduled classes and homework.

In terms of future improvements to our infographic assessments, our current work is focused on ensuring that such projects can still be undertaken effectively in blended or online mode should that be necessary due to future limitations posed by the impact of COVID-19. We propose to

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develop a series of short instructional videos hosted on our learning management system to help students start their projects even if they cannot attend classes in person.

We have also undertaken some limited work using infographics as part of various Honors research projects. These projects have involved creating large scale infographics to form a public exhibit that educates the public about key figures in biomedical research entitled 'Women in Physiology', and the creation of educational training posters for healthcare providers to improve their ability to diagnose delirium in older adults.

In addition, we are increasingly seeing infographics being included as part of the summary of the research work or as a mechanism to disseminate the outcomes to a wider audience. Further student-led work has developed a range of infographic information panels throughout our university botanic gardens to educate the public about the health and experimental uses of various molecules derived from plants. A separate project developed gamified revision resources that used infographics to help students remember the names and actions of drugs.

Conclusion

Our experiences have shown that infographic-based assessments can enhance student creativity, engagement, and communications skills when studying anatomy and physiology. Our initial use of them during a student literature research project has led to other applications throughout our curricula and provided a new way to assess student appreciation of biomedical concepts and evidence their wider graduate attributes.

About the Author

Derek Scott is Professor and Chair of Physiology & Pharmacology Education in the School of Medicine, Medical Sciences and Nutrition, University of Aberdeen. He teaches aspects of physiology, pharmacology and developmental biology at both the undergraduate and graduate levels and is actively involved in education development through the Physiology Society of Great Britain.

Alison Jenkinson is a Professor in the School of Medicine, Medical Sciences and Nutrition at the University of Aberdeen and Dean for Widening Access, articulation and Outreach. In addition to investigating practical examination assessments, Alison also explores the role of free radicals and antioxidants in disease.

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Poster Abstracts - *the clickable symbol* *indicates an accompanying infographic*



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A & P Concepts

Poster #101

How the Microbiome of the Human Gut Powerfully Impacts Anatomy and Physiology

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The microbiome is a bacterial ecosystem that resides in the human gut. Each human has a unique microbiome make-up. The specific species and amount of each residential bacteria heavily influences how effectively foods consumed are digested and utilized in the body. A good microbiome positively regulates bone maintenance, cellular metabolism, blood glucose, digestion, and mental health. However, an imbalanced microbiome, often due to poor diet, can negatively impact our biological systems which may lead to chronic disease. Our goal is to bring awareness of how vital the gut microbiome is to overall human health and propose ways to create and maintain a healthy gut.

Poster #102

How do Students Reason About Mass Balance Problems in Physiology?

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Mass balance is a powerful physiology reasoning tool that helps students determine how a substance accumulates in a compartment (e.g., cell). We examined how introductory and advanced students' use mass balance reasoning across a range of institutions and characterized their ideas in four reasoning levels (L): L4, explain that the accumulation of a substance depends on multiple influxes and effluxes; L3, explain how the magnitude of one flux influences accumulation; L2, conflate accumulation and fluxes; L1, use non-mass balance ideas. By understanding how students develop mass balance reasoning, instructors can address important challenges in learning physiology.

Poster #103

Where's the Intertubercular Groove?

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Optical illusions are all the rage with social media. Is the dress black/blue or white/gold? Do you see a rabbit or a bird? The authors didn't expect to encounter an optical illusion on a photo of the proximal humerus. Penefather-O'Brien and O'Loughlin found just that as they were working together to place labels on a photograph of a humerus. Both individuals have strong backgrounds in analysis of human skeletons, but couldn't agree on where to place the indicator for the intertubercular groove. Come see our poster and draw where you would label the groove.

Poster #104**Understanding the Relationship Between Dermatomes and Peripheral Nerve Sensation****MarkCook, University of Minnesota, cookx072@umn.edu**

Understanding the difference between dermatomes and peripheral nerve sensation is an important diagnostic tool for students working towards a career in healthcare. This is especially true for pre-medical and pre-physical therapy students, who must be able to determine if their patients' sensory deficit is consistent with a spinal nerve or peripheral nerve injury. However, the relationship between these two systems is often confusing for the undergraduate anatomy student. Discussions of the motor and sensory roles of peripheral nerves are usually well-received by students. However, the addition of the concept of dermatomes often lead to confusion, due to the "mental gymnastics" required to understand how the two are related. Having students overlay the peripheral nerve map with the dermatome map is a simple exercise that seems to help students quickly understand that not all spinal nerves that contribute to a peripheral nerve carry sensory information.

A & P Research**Poster #105****Using Student-Collected Data in Physiology Lab Course to Study Cardiovascular Changes in Human Diving Reflex****HeLiu, Gannon University, liu017@gannon.edu
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Humans adapt to the aquatic environment through physiological changes in the cardiovascular system. We are interested in the human diving reflex and the physiological factors that contribute to the changes. We examined the data collected from a physiology lab course where students measured changes in the heart rate and pulse amplitude over different time periods. Here we present the preliminary results in this ongoing research and future plans.

Poster #106**Salivary Melatonin Secretion of Rana Pipiens after Blue LED Photoperiod Acclimatization****AaronTerese, The University of Texas at San Antonio, hector.hernandez@utsa.edu
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Melatonin is the primary hormone secreted from the Pineal gland when the body enters the dark cycle of its circadian rhythm. However, chronic blue LED exposure during this cycle has been attributed to reduced melatonin secretion, thus disrupting natural circadian rhythms. To date, assessment of filtered blue light has yet to be addressed, as it is thought to reduce the amount of blue LED emitted from cell phone screens. In this investigation, salivary melatonin concentration levels in Rana pipiens were analyzed to determine if, and to what degree, exposure to blue LED might affect melatonin secretion. We hypothesize that exposure to blue LED, decreases salivary melatonin levels in Rana pipiens, therefore interfering with natural circadian rhythms.

Poster #107**Examining Enamel Erosion After Chronic Exposure to Phosphoric Acid, Citric Acid, and Tannins on *Rana pipiens* Vomerine Teeth**

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Many commonly consumed beverages contain ingredients such as phosphoric acid, citric acid and tannins, all of which are known to soften dental enamel; this erosion can potentially lead to dental caries and gum disease. This investigation will examine enamel erosion on Vomerine dentition of *R. pipiens* after exposure to these chemicals, which has not been examined to date. *R. pipiens* dentition shares anatomical similarities to that of humans, making this animal model ideal for research. We hypothesize that chronic chemical exposure (citric acid, phosphoric acid and tannins) on Vomerine dentition of *R. pipiens* for fourteen days will cause enamel erosion.

Active Learning**Poster #108****Factors Influencing Quality of Team Discussion: Discourse Analysis in an Undergraduate Team-Based Learning Biology Course**

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Team activities in active learning classrooms are thought to be effective for learning in part because of the quality of discussion they engender. However, little is known about which instructional factors promote productive conversation; we explored this question in a team-based learning (TBL) physiology course. Using 12 transcribed team conversations, we analyzed three distinct discursive phenomena--conceptual explanations, re-evaluations, and co-construction--that occurred in productive conversations. These phenomena were more likely to occur in response to higher-order questions in Bloom's taxonomy. Pre-class preparation and student accountability as part of TBL may be important factors in this finding.

Poster #109**Guided Inquiry in the Physiology Classroom: Evaluating Concept Understanding and Retention**

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The difficult conceptual nature of Human Physiology and its successful completion to enter Healthcare Programs can lead to a high-stakes situation for students. Therefore using active learning techniques may help concept understanding and retention. Guided Inquiry has proven effective in laboratory settings but its effectiveness in the lecture classroom, especially in Community Colleges is not fully researched. This project compares two separate classes with a classic cross over design. Class 1 used Guided Inquiry to study Cardiac Output while Class 2 received a lecture. Next, Class 2 used Guided Inquiry to study Oxygen-Hemoglobin Disassociation while Class 1 received lecture. Evaluation with near term quizzes compared the two classes and Final exams assess material retention on the two topics. 2X2 ANOVA was used to evaluate class performance.

Poster #110**Keep Learning: From In-Person to Online Instruction****Steven Newman, Indiana University, stevnewm@iu.edu****Lauralyn Riggins, Indiana University, rigginsl@indiana.edu**

Introduction to Anatomy and Physiology at Indiana University historically has been a lecture based course which serves a diverse population of undergraduate students ranging from freshman to seniors, dance majors, health-centered majors and fills as a general education requirement. Given the interruption of face-to-face instruction due to Covid-19 we wanted to investigate student behavior and performance. Preliminary data we obtained can be used to help inform instructors when planning to switch a course from in-person to online with regards to student behavior of participation in course assignments and overall performance in times of crisis.

Poster #111**Anatomy and Physiology Education Research in Community Colleges: The CAPER Project****Kerry Hull, Bishop's University, kerryhull@me.com****Nancy Barrickman, Salt Lake Community College, nancy.barrickman@slcc.edu,****Kathy Bell, Salt Lake Community College, kathryn.bell@slcc.edu ,****Nancy Djerdjian, Anoka-Ramsey Community College, nancy.djerdjian@anokaramsey.edu,****Melaney Farr, Salt Lake Community College, melaney.farr@slcc.edu,****Ron Gerrits, Milwaukee School of Engineering, gerrits@msoe.edu,****Suzanne Hood, Bishop's University, shood@ubishops.ca,****Murray Jensen, University of Minnesota, msjensen@umn.edu,****Heather Lawford, Bishop's University, hlawford@ubishops.ca,****Shawn Magner, Anoka-Ramsey Community College, shawn.magner@anokaramsey.edu,****James McCaughern-Carucci, St. Johns River Community College, jamesmccaugherncarucci@sjrstate.edu,****Chasity O'Malley, Palm Beach State College, chasityomalley@gmail.com,****Betsy Ott, Tyler Junior College, bott@tjc.edu,****Olivia Page, Bishop's University, pageolivia@icloud.com,****Vicky Rands, Salt Lake Community College, vicky.rands@slcc.edu,****Kyla Ross, Georgia Tech, kross@hpsconnect.org,****Hiranya Roychowdhury, Dona Ana Community College, hroychow@gmail.com,****Dana Smith, St. Johns River Community College, danasmith@sjrstate.edu,****Skye Stowe, Bishop's University, sstowe15@ubishops.ca,****Kim Van Vliet, St. Johns River Community College, kimvanvliet@sjrstate.edu**

The NSF-funded Community College Anatomy and Physiology Education Research (CAPER) project helps instructors incorporate student-centered teaching strategies into their classrooms. Grant participants combine a professional development course with the design, implementation, and dissemination of a small-scale educational research project investigating the impact of their chosen strategy. In addition to their individual projects, instructors collaborate in a multi-institutional effort examining the hypothesis that these strategies could alleviate the negative impacts of anxiety on student performance and retention by improving learning and building community. This poster will summarize our preliminary results and outline our plans for a second project, CAPER 2.0.

Poster #112**Implementation of Evidence Based Instructional Practices in Anatomy and Physiology, and Their Effect on Student Success at St. Johns River State College**Kim Van Vliet, St. Johns River State College, kimvanvliet@sjrstate.eduDana Smith Jr., St. Johns River State College, danasmith@sjrstate.edu,James McCaughern-Carucci, St. Johns River State College, jamesmccaugherncarucci@sjrstate.edu,Suzanne Hood, Bishop's University, shood@ubishops.ca, Kyla Ross, Georgia Tech, kross@hapseconnect.org,Kerry Hull, Bishop's University, khull@hapseconnect.org, Murray Jensen, University of Minnesota,msjensen@umn.edu

The Community College Anatomy and Physiology Education Research (CAPER) project aims to answer research questions related to active learning, student success, and student anxiety in community college classrooms. This project investigates the impact of peer instruction and the use of clicker questions as an active learning strategy in A&P. Validated instruments were used to detect changes in student success measures such as self-efficacy, as a result of utilizing this evidence based instructional practice (EBIP) with community college students. The results of this work will help guide how we implement new practices in institutions with highly diverse student populations.

Poster #113**Comparison of the Effect of Clicker Questions on Academic Self-Efficacy and Metacognition between Dual Enrollment and Traditional Students in a Junior College Human Anatomy and Physiology Class**Dana Smith, St. Johns River State College, DanaSmith@sjrstate.eduBetsy Ott, Tyler Junior College, bott@tjc.edu,Murray Jensen, University of Minnesota, msjensen@umn.edu,Kerry Hull, Bishop's University, khull@hapseconnect.org,Suzanne Hood, Bishop's University, shood@ubishops.ca,Kim Van Vliet, St. Johns River State College, kimvanvliet@sjrstate.edu,James McCaughern-Carucci, St. Johns River State College, jamesmccaugherncarucci@sjrstate.edu

Students at the junior college level who are interested in pursuing careers in the health sciences often struggle taking the Human Anatomy and Physiology series of courses. Traditionally, lecture courses often include very little beyond the "sage on the stage" approach. Despite this common delivery method, active learning approaches, such as the use of clicker questions, have been shown to improve student performance in science courses. This study, a part of the NSF funded CAPER project, looks at the effect that clicker questions have on self-efficacy and metacognition for both Dual Enrollment and traditional college students.

Poster #114**Flipped Laboratory Activities in Human Anatomy and Physiology: Effects on Student Performance and Satisfaction**Ann Massey, The University of Georgia, ann.massey@uga.eduColleen Kuusinen, University of Massachusetts Amherst, ckuusinen@umass.edu

There is little in the literature about "flipped" approaches to learning (where lower level comprehension is moved out of the learning sessions) in the laboratory setting. We developed and implemented flipped content in the Human Anatomy and Physiology II laboratory course as an approach to reduce the amount of time spent reviewing / relearning foundational content during lab sessions and enhance higher-order learning of anatomy and physiology concepts. We describe the implementation of flipped content, student outcomes (measured as performance on individual assignments and overall grades), and student satisfaction with the approach in the lab.

Poster #115

Structure and Function of A&P at Quest University Canada

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Imagine if A&P was delivered “on the block” - an immersive experience with at least 3 hours of class every Mon-Fri for 3.5 weeks. What if classes were small (max 20 students) and classrooms could be reconfigured as needed to support larger-group discussion and smaller-group learning activities? Characteristic of all Quest courses, these unconventional structures lead to functional consequences for teaching and learning A&P. This poster overviews the challenges and opportunities that arise when an A&P is embedded in a radically interdisciplinary curriculum and delivered in an unusual format.

Poster #116

Use of Virtual Reality for Active learning, Student Engagement and Collaboration in the Health Sciences

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Virtual reality (VR) is an interactive technology that allows students to study anatomy and physiology in a novel, immersive 3-dimensional setting. Here we describe the use of three VR projects that enabled students to collaborate and innovate while getting a realistic, in depth understanding of the human body. Specifically, VR projects were implemented in lesson plans to study the structure and function of the cell, nervous and cardiovascular system, in addition to the anatomy and physiology associated with various pathologies. These projects enhanced student engagement, active learning and collaboration, in addition to exposing students to state of the art technologies.

Poster #117

Learning Communities Developed from Team-Based Learning in a Human Anatomy Course

Ann Caplea, Walsh University, acaplea@walsh.edu

Physical and Occupational Therapy students were assigned teams. Team work included group quizzes, classroom activities and cadaver dissection. Students were asked to list one positive thing about the course. Team work was noted by 50.8% as a positive thing. Students also made comments such as “I have formed friendships and learned new ways to study from my team.” and “They are great friends to bounce ideas off of and they help me to succeed in the course.” We conclude that team-based learning can also develop into beneficial learning communities.

Poster #118

Implementation and Assessment of Inquiry-Based Labs in Anatomy and Physiology

Heather Evans Anderson, Stetson University, hevansanderson@stetson.edu

Incorporating inquiry into labs is known to be an effective pedagogy. Here, 4 topic areas (Cardiovascular, Respiratory, Digestive, and Renal) were focused on to create inquiry-based labs that could be used in any A&P II lab. Specific learning objectives were targeted and separate lab sections were assessed for learning outcomes. One lab experienced an inquiry-based approach for Cardiovascular and Digestive, while the other lab went through traditional labs for those topics. This approach was flipped for respiratory and renal so that each lab section was exposed to at least 2 inquiry-based labs. Learning outcomes were measured via quizzes and exams.

Poster #119

Creating Anticipation in Summer A&P Curriculum to Improve Motivation and Learning

Marian Leal, Sacred Heart University, lealm@sacredheart.edu

To increase motivation in the classroom and to make A&P more enjoyable for summer students a series of interactive games/ activities were developed. Students worked in pairs or small groups and completed various activities which included card games, blind folded anatomical identification games, sequencing and yoga activities. Through these activities' students became more connected with each other and looked forward to more interaction in future classes. A comparison of quiz and practical grades were made from this summer class with classes from the three previous years. Participation in these activities resulted in greater student engagement and improved grades.

Poster #120

Enhancing Active Learning of Anatomy and Physiology with the Use of an Interactive Classroom Response System

Daniela Popescu, Kent State University, Geaugadpopescu@kent.edu

A challenging aspect of teaching anatomy and physiology is using teaching tools that enhance active learning. This poster will explore the use of an interactive classroom response system that is a reliable teaching tool, easy to use, cost-efficient, and re-usable for multiple anatomy and physiology classes each semester and across years. More specifically, the impact of clickers on students' performance will be investigated. The data will include exam scores collected from the clicker semesters and from the semesters before the clicker use. Student perception will also be examined, and the advantages associated with the use of clickers will be addressed.

Poster #121

Implementing a Competency-Based Approach to Anatomy Teaching

Alireza Jalali, University of Ottawa, ajalali@uottawa.ca

The shift in education from time-based to competency-based has encouraged the adoption of competency-based models in anatomy, such as flipped classrooms. This study aimed to assess the linkage between the flipped classroom model and academic performance. A sequential mixed-methods design was employed first to gather and analyze quantitative data, followed by a qualitative phase in which a series of eight anatomy laboratories were observed: four flipped Vs four traditional. The final exam scores showed little difference between the two groups. Observations revealed that students in the flipped model spent more time on task, practice more self-directed learning and employed more multimodal learning strategies than the traditional stream.

Applied Learning

Poster #122

Student Perceptions of Infographics for Poster Projects – A Cohort Comparison

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Infographics demonstrate key concepts in simple graphical form. This project assessed student responses to infographic assignments across cohorts. Students undertook a research project on a physiology topic of their choice and communicated it with an infographic poster. Students were invited to complete an anonymous questionnaire on delivery and outcomes. There were consistent positive findings on a range of aspects including that students gave more thought to information presentation and delivery to different audiences and became more critical of their own work. This approach has now been adopted by other courses to enhance student communication skills and increase graduate attributes.

Poster #123

Physiology Students Can Use a Quality Improvement Approach to Support a Safe and Efficient Medication Pathway in Geriatric Rehabilitation

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Quality improvement (QI) science enhances patient care and safety by using a structured experimental approach to learning and tests of change. We piloted the involvement of physiology honors students in such activities (in partnership with clinical staff) as part of their research project. We aimed to establish a comprehensive process map of medication pathways and identify areas for improvement in documentation standards. We also aimed to enhance the QI culture in a geriatric rehabilitation facility. We report how physiology students can apply QI principles to enhance medication usage and contribute to improving patient safety as part of a multidisciplinary team.

Poster #124

Using Simulations to Teach Electrocardiogram (ECG) in an Undergraduate Human Physiology Laboratory

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To augment the ECG lab experience with clinical aspects, we have designed a case study of myocardial infarction in 73 year old patient. Students role play the patient's family and health professionals interacting with a mannequin in a scenario. They interpret different outputs displayed in realistic emergency room settings and are prompted to consider relevant interventions to manage the case. Following this scenario, class meets to debrief and evaluate the experience. Learning assessment includes pre- and post-scenario quizzes. In this workshop, we present preliminary findings that suggests that clinical simulations are effective physiology education tools.

Assessment/Online Learning

Poster #125

Academic (Dis)Honesty in Online Anatomy Courses: A Comparison of Student Outcomes Before and After Instituting the Use of Online Proctoring Software

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Alyssa Kiesow, Northern State University, alyssa.kiesow@northern.edu

In an effort to assess the prevalence of academic dishonesty in our online anatomy courses, we compared student outcomes in courses that employed proctoring software and those that did not. Exam, quiz, practical and total scores were compared using two sample t-tests between students using proctoring software (n=59) and students that did not (n=62). In all categories, student scores were significantly higher (total scores: M=445.0, SD=45.7) when proctoring software was not used (total scores: M=316.9, SD=99; $t(87) = 1.99$, p

Cadaver

Poster #126

Softening up the Hard Science of Anatomy: Using Fabric Softener to Rehydrate Desiccated Cadaver Tissue

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Nicole Hackenbrack, Pennsylvania State University, nxh5166@psu.edu

Desiccation of human tissue is a common problem in gross anatomy laboratories. Damaged tissue looks and feels different, can completely change the structure of the anatomy, and hinders the educational experience. We hypothesized fabric softener could be repurposed for rehydrating cadaver tissue in this educational laboratory environment. This method proved successful when entire organs were submerged in fabric softener. However, it is not feasible to submerge an entire body. Instead, skin and muscle samples were soaked in varying concentrations of fabric softener and 2-phenoxyethanol. In this poster, we will present our methods, preliminary results, and future directions for this research.

Poster #127

Can Improving Anatomy Education begin in the Prep Room? An Evaluation of Two Embalming Solutions for Utilization in an Undergraduate Human Anatomy Course

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Laboratory practicals are a key component in assessing a student's comprehension in undergraduate human anatomy courses. However, certain structures or tissue types are consistently difficult for students to identify (i.e. artery v. vein v. nerve). This study aimed to assess whether or not students struggle with identifying these most missed structures as a result of the embalming solution being used. Two different embalming solutions were implemented into an undergraduate dissection course at the Ohio State University and were evaluated by student's performance on a laboratory practical.

Poster #128

The Use of Preserved Specimens to Study Human Pregnancy

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Preserved specimens are a valuable resource to study human anatomy and physiology when human cadavers are unavailable. However, various anatomical systems vary greatly when comparing different organisms. This work will examine the female reproductive system and other structures related to pregnancy. Here we compare and contrast different aspects of reproductive anatomy that relate to pregnancy such as uterine shape, placental shape, and placental structure. By viewing these characteristics in preserved pregnant specimens, such as pig, rat, and cat we can determine which aspects of each specimen would be most comparable to human reproductive anatomy.

Poster #129

Cadaver-based Instruction for Anatomy & Physiology at Harold Washington College

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A male cadaver purchased from the Illinois Anatomical Gift Association was prosected in 2019 by Dr. Ernest Telarico and Dr. Jose Mas from the Indiana University School of Medicine based on the plan provided by Harold Washington College. The cadaver is stored at 15 °C in cold storage, part of the state-of-the-art cadaver theater equipped with surgical lights, high-tech videotaping equipment, and smartboard screens to transmit cadaver-based activities to classrooms. Body muscles have been reflected and tagged using numbered metal tags. Photographs of the cadaver including student interactions will be displayed during the poster session at the HAPS conference.

Case Studies

Poster #201

Using a Case Study on SSRI Antidepressants and Neuron Puzzles to Teach Neuron Anatomy and Physiology

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In order to enhance student learning in the area of neurophysiology, I have developed a case study based lesson plan along with a neuron puzzle that students can use to learn the anatomy of a neuron and the locations of channels and pumps along the cell membrane. Students will consider how an SSRI (selective serotonin reuptake inhibitor) would affect stimulation of a post-synaptic neuron and, therefore, cause changes in brain activity to alleviate depression. The case study takes them from a friend exhibiting symptoms of depression, to a doctor's examination and prescription for anti-depressants, and finally alleviation of the symptoms as students discover how neurons function.

Poster #202

From Concept to Publication, The Success and Pitfalls of Writing Cases Studies

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To assist our students in understanding theoretical concepts in order to apply them, we have used case studies. While accessing established case studies are less time consuming, we found that many times we need to edit them to align with our course objects. As such we were motivated to write our own case studies. It allowed us to explore our creative process to examine problem in order to extrapolate key ideas and results that assist in predicting trends and outcomes, reveal hidden issues that have practical application and provide a means of understanding scientific concepts with greater clarity. Major stumbling blocks encountered were the time to conduct research and to formulate ideas.

Poster #203

The breathless heart: A case study to understand the anatomical and physiological implications of heart disease

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We developed a case study to aid students in understanding the cardiovascular system. The case relies on clinical notes of an infant who presented with anatomical and physiological abnormalities of the heart and blood. 2D Echo-cardiogram and Color Doppler Report, blood analysis and treatment were examined. A comparative analysis was developed between the normal versus patient's anatomy and physiology of the heart, blood composition and the corresponding impact on the respiratory system. This case is designed to be presented to an upper level anatomy and physiology undergraduate class.

Poster #204

Impact of Case Maps on Attitudes, Performance, and Critical Thinking in A&P

**Mawunyo Makebi, Tarrant County College, mawunyo.makebi@my.tccd.edu
Paul Luyster, Tarrant County College, paul.luyster@tccd.edu**

Case Maps are structured, take-home assignments that combine clinical case studies with concept mapping. Over the Fall 2019 and Spring 2020 Mawunyo Makebi, pre-nursing student and Supplemental Instructor, worked with professor Paul Luyster and his students in Anatomy and Physiology I and II. She administered a survey to compare grades, thought process, and confidence among students who were doing Case Maps with students who were not. Makebi's poster will provide data on how Case Maps have affected student performance and attitudes in A&P and how they seem to help health-care majors become better critical thinkers and problem solvers.

Poster #205

The Dead Guy of the Week: Using Case Studies and Collaborative Learning to Promote Self-Efficacy and Reduce Student Anxiety in the State College Anatomy and Physiology Classroom

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The case study approach to teaching is a widely-practiced methodology to promote the development of critical thinking skills and problem-based learning. Anatomy and Physiology is a discipline which lends itself well to the usage of case studies and problem-based learning strategies to apply previously learned material to clinical problem solving, collaboration and team-building. In addition, case studies are a methodology which can increase motivation, foster social skills and aid students in building community which will in turn hopefully increase student persistence and retention. In this study, we investigate the potential of using case studies in a collaborative learning format to foster student self-efficacy and reduce classroom anxiety in Anatomy and Physiology students.

Curriculum Development

Poster #206

Development of a Curriculum Map to Assess Undergraduate Student Achievement of Departmental Program Goals

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To assist our department in making informed curricular decisions, we developed program goals identifying what a student should know and be able to do upon major completion. These were informed by overarching principles from disciplinary societies. We also created a curriculum map providing a visual representation of goals accomplished in each course and level (as reported by faculty). The process of curriculum mapping is a first step in ensuring program goals are met, courses combine into a cohesive whole with appropriate expectations of prerequisite knowledge and skills, and curricular changes are intentionally designed to build upon and improve student learning.

Poster #207

Revisions of an Integrated Human Physiology and Functional Anatomy Course to Enhance Student Engagement, Knowledge, and Retention

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The curriculum for a two-semester anatomy and physiology course was revised into an integrated two-semester physiology and functional anatomy course for students going into the health professions. The revised curriculum implemented the use of weekly critical thinking problems, active learning modules, cumulative exams, collaborative exams, and digital learning technology. The goals of these revisions were to provide students with opportunities to review difficult course concepts, allowing additional exposure to the content in a new format, and provide the students with the opportunity to apply course knowledge to a real-life physiological scenario. Summative assessment data were compared to previous course cohorts.

Poster #208

Faculty-Student Collaboration: Teaching Students to Develop Teaching Resources

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The Life Science Teaching Resource Community (www.lifescitrc.org) is an online resource for educators that allows access to peer-reviewed teaching resources. This project describes a faculty-student collaboration to develop a teaching resource in an upper level embryology course. Students led the development of a resource complete with directions, questions, key, and interactive activities. Resources were used to teach concepts in an introductory A&P course and submitted for peer review through the website. Embryology students reported a deeper understanding of their topic, a greater appreciation for the process of developing teaching materials, and excitement about submitting a resource for review.

Poster #209**Problem-Based Learning (PBL) Tutoring Program for Pre-Nursing Students****Caroline Hanson, Georgia Gwinnett College, chanson@ggc.edu****Victoria Bell, Georgia Gwinnett College, vbali@ggc.edu,****Wendy Dustman, Georgia Gwinnett College, wdustman@ggc.edu,****Becky Fiorillo, Georgia Gwinnett College, rfiorillo@ggc.edu,****Rebecca Kalman, Georgia Gwinnett College, rkalman@gcc.edu,****Xiaoping Li, Georgia Gwinnett College, xli@ggc.edu,****Karen Perell-Gerson, Georgia Gwinnett College, kperelig@ggc.edu,****Julie Shearer, Georgia Gwinnett College, jshearer@ggc.edu**

A faculty learning community (FLC) focused on the progression of learning throughout the five pre-nursing science courses. Following course content alignment, instructor recommendations were compiled. The FLC investigated the impact of course sequencing on student success and identified the need for students to have knowledge of problem-based learning (PBL) pedagogy. PBL is frequently used in healthcare professional programs because educators recognize that students separate “theoretical knowledge” (the ‘knowing that’) from “practical knowledge” (the ‘knowing how’) leading to a ‘theory-practice gap.’ The FLC then was able to design a PBL tutoring program for Anatomy & Physiology I which was used in the Spring Semester of 2020 at Georgia Gwinnett College.

Poster #210**Educational Lessons on Changes in Anatomy and Physiology, Risk Factors and Prevention Strategies of Cancers that can Affect High School and College Age Students****Lakshmi Atchison, Chestnut Hill College, latchiso@chc.edu**

Many pathological diseases affect the body’s normal anatomic and physiological functions. US statistics show that cancers of the blood (leukemia/lymphoma), skin, thyroid, brain, lung, cervix and testicles affect high school and college age students causing systemic changes. Lesson plans are developed to provide an instant education for this age group. Salient changes in anatomic structures and physiological functions of each disease is illustrated along with helpful tips for healthy lifestyles for disease prevention. These lesson plans emphasize young adults to be proactive, know their risk factors, and offers them a life-saving message to maintain the body’s normal anatomic structure and physiological function.

Diversity & Inclusion**Poster #211****Meeting Diverse Pre-Professional Needs in an Undergraduate Anatomy and Physiology Curriculum****Sarah Amugongo, St Olaf College, amugon1@stolaf.edu**

Our curriculum is mainly driven by the interests of our student population. We have a diverse group of students who are also diversely prepared to take our courses. These groups include students who major in Biology, Nursing, Exercise Science and Dance. They also include students who are preparing for graduate studies in healthcare professions like Medicine, Physical Therapy, Dentistry, Optometry, Pharmacy, Occupational Therapy, Clinical Chemistry, Physician Assistants and Master of Science in Nursing (MSN). This poster addresses the main challenges we face in serving these very diverse groups with our two-semester Human Anatomy and Physiology sequence and possible solutions.

Evaluation

Poster #212

Student Opinion Surveys: A Glance at In-Person versus Online Administration in Human Anatomy Courses

Alyssa Kiesow, Northern State University, amkiesow@northern.edu

Amy Dolan, Northern State University, amy.dolan@northern.edu

Student Opinions of Instruction (SOI) surveys changed to solely online at our institution, seemingly impacting faculty course evaluations. We examined the use of in-person (n=89) versus online (n=106) SOI surveys for Human Anatomy, using four sections of each type. We compared response rates and overall course ratings using a two-sample t-test. Data indicate no significant difference between in-person and online SOI surveys with regard to response rates (p=0.22) and overall course ratings (p=0.19). However, response rates trend downward and overall course ratings trend upward since using online surveys. Trend data may be useful when evaluating effective faculty evaluation tools.

Humanities

Poster #213

Anatomy in Art: Exploring the Connection between Science and Art

Rebecca Kruse, Elizabethtown College, kruser@etown.edu

Anya Goldina, Elizabethtown College, goldinaa@etown.edu

To unite the typically disconnected fields of art and science and inspire people to think across disciplines, we used artistic representations of anatomical structures created by students in the Human A&P course to develop an educational website. The website is a digital art gallery and a comprehensive resource for students and teachers. It provides lesson plans for educators of varying levels to encourage them to incorporate creative ways to teach anatomy in their classrooms. Using one platform to connect art and science, we hope to break down the barriers between art and science, allowing each field to inspire the other.

Mental Health

Poster #214

The Effect of Cooperative Quizzes on Performance and Anxiety in Community College Human Physiology Classes

Kathy Bell, Salt Lake Community College, kathryn.bell@slcc.edu

Ron Gerrits, Milwaukee School of Engineering, gerrits@msoe.edu

Community college students come from a variety of cultural backgrounds and have different levels of educational preparedness. Historically, retention rates of students in human physiology courses, especially among minority and first-generation college students, have been low. This study, which was part of the NSF-funded CAPER project, introduced cooperative quizzes into community college human physiology classes to determine if they improved student performance on exams and whether they decreased student anxiety, in particular among minority and first-generation students.

Poster #215**The Emotional Effects of Cadaver Dissection on Undergraduate Students & Their Coping Mechanisms**

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Cadaver Dissection is an integral educational tool for Anatomy and Physiology. The object of this research is to identify the initial emotional effects it has on students and their coping mechanisms. It also examines students' perspective on the importance of cadaver-based Anatomy education. The original study was conducted in 2019 by a questionnaire taken by students of various majors. The sample consisted of 106 Nursing majors and 24 other majors (n=130). The striking result was that 89% of the students identified a need for incorporating cadaver dissection into Anatomy, in spite of the emotional factors displayed initially. This is an ongoing study.

Online Learning**Poster #216****The Launch and Evaluation of an Undergraduate Fully-Online Anatomy Laboratory Section**

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To meet demand for anatomy at the University of Missouri, an interdisciplinary team developed and implemented a fully online laboratory section to complement established hybrid laboratory sections. In this study, we analyze student performance and satisfaction in this course. The study sample included students enrolled in the fully online lab section (n=10) and the established hybrid lab section (n=405). Data include pre-course assessments, post-course assessments, and course exams. Other data also collected during the semester included demographic data, mid-semester evaluations, and end-of-semester evaluations. Results from this pilot course can be used to inform future course organizational decisions.

Poster #217**The Impact of Course Format and Section on Performance in 1st Year University Human Physiology**

Sarah West, Trent University, sarahwest@trentu.ca
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We examined the performance and knowledge retention in online (N=285) vs. two in-person sections (N=339) of a first-year university human physiology course. Students in the online format performed 23% better on the midterm exam but finished with a 3% lower final grade and performed 7.5% lower on a knowledge retention test administered ~4 months after course completion. We now examine whether demographic variables affected course performance in online vs. in-person formats and between in-person sections. Specifically, we will determine whether year or program of study, and/or lecture day/time predicts course performance, to better understand why performance/retention differs by class.

Poster #218**The Impact of Midterm Format on Course Performance in 1st Year Human Physiology**

**Holly Bates, Trent University, hollybates@trentu.ca
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We previously examined the performance and knowledge retention in online (N=285) vs. in-person (N=339) first year university human physiology courses. Students in the online format performed 23% better on the midterm exam which was identical except for delivery (online vs. in person). We now examine whether performance on individual questions and question types account for the difference in midterm success between the two formats. Midterm questions will be assessed according to Bloom's Taxonomy and/or question difficulty. We will determine if the students that write an online midterm perform better on certain types of questions when compared to in person testing.

Poster #219**"True or False? Prove it!" Making Virtual Physiology and Pathophysiology Labs More Meaningful and Attractive to Students**

**Michel Desilets, University of Ottawa, mdesilet@uottawa.ca
Laurent Legault, University of Ottawa, llega103@uottawa.ca**

To complement didactic lectures, we incorporate virtual labs constructed from freely available simulation programs in first- and second-year physiology and pathophysiology courses (cardio/resp/renal topics). These labs were originally designed to simulate wet labs with data collection and interpretation. While students recognized their added value, the overall appreciation remained relatively mitigated. With this study, we undertook a new approach whereby students are presented with a list of statements, have to identify the false ones, and prove experimentally why they are wrong. This new strategy significantly elevated students' appreciation of the labs.

Poster #220**Evaluating the Use of an Online Tool to Increase Retention of Material in the Community College Classroom**

Kerry Fahnstock, Butler Community College, khale1@butlercc.edu

The community college environment is often populated by students with multiple life distractors that make learning outside of the classroom difficult. Though students are strongly encouraged to spend an extra 8-12 hours, weekly, preparing for Anatomy & Physiology, the average student finds this time commitment difficult. Efficient use of study time is also an issue. There are many online tools that claim to bridge this gap, offering engaging materials to maximize out-of-class practice. Here, I evaluate the use of this approach to determine its effectiveness in helping students retain what they have learned in the Anatomy and Physiology classroom.

Outreach

Poster #221

Cadaver Dissection, Engaged Learning, and Outreach at Northern Illinois University

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Mary McGinn, Northern Illinois University, ka3emw@gmail.com

At Northern Illinois University (NIU), cadaver dissection, engaged learning, and outreach are the cornerstones of our Human Anatomical Sciences (HAS) graduate program and our undergraduate curriculum. Northern Illinois University administers a long-established donor body program that supports our cadaver-based undergraduate and graduate anatomy courses. Prosection opportunities are available each semester, as are engaged learning opportunities through programs such as Research Rookies and University Honors. Anatomical outreach efforts at NIU are extensive, ranging from hosting local Kiwanis Club meetings to hosting area high schools on Fridays each Spring semester. Our poster documents all of our efforts.

Poster #222

Primary School Children can Take the Lead in Teaching Anatomy and Physiology to their Peers

Derek Scott, University of Aberdeen, d.scott@abdn.ac.uk

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The Scottish Government published a strategy that recommended increasing science education at primary school level. Our institution had previously developed activities to help older pupils learn about anatomy and physiology, but we had little experience with younger students. We aimed to develop a series of activities for primary school pupils and teachers, with children encouraged to take the lead in presenting what they had learned. This pilot study demonstrated that involving primary school students in biomedical learning activities can foster leadership, improve presentation skills, encourage pupil-led research and stimulate interest in anatomy and physiology at a very young age.

Professional Development

Poster #223

Impact of Service-Learning Participation on Volunteers' Academic and Personal Development

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Service-learning is an immersive experience that provides academic and personal development for volunteer participants. For example, Mentors of Anatomy Academy, who reflected on their teaching experiences in an active learning environment, noted significant improvement in qualities of constructivism and significant learning. Through the process of teaching, Mentors learned skills that allowed a deeper connection with their mentees and realized that their resulting increase in knowledge applied directly to understanding real world issues. The simultaneous learning of skills and knowledge facilitated a journey toward life-long learning that is difficult to teach in conventional classroom environments.

Steering Committees

Poster #224

HAPS Cadaver Use Committee Update Poster: Mentor/Mentee Initiative

Cindy Wingert, Ohio State University cindy.wingert@osumc.edu
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The HAPS Cadaver Use Committee will present the mentor/mentee survey results as well as the number of mentor/mentee's in each HAPS region.

Poster #225

Laboratory Safety and Animal Use Committee

Richard Simons, SUNY Schenectady County Community College, rrsimons60@gmail.com

Updates to Animal Use Policy and the Safety Cases will be highlighted.

Poster #226

The HAPS Educator: Where to Publish Everything A & P

Kerry Hull, HAPS, khull@hpsconnect.org

The HAPS Educator is the peer-reviewed journal of HAPS, publishing educational research articles, topic updates, and class-tested teaching techniques and activities. Our articles are indexed in the Life Science Teaching Resource Community (LifeSciTRC) database and in the Education Resources Information Center (ERIC) database. Come by the poster to see some of our latest articles and to learn about authorship and reviewing opportunities.

Student Success

Poster #301

Implementation of a Metacognitive Learning Strategies Session to Improve Students' Metacognitive Skills and Course Performance in Human Anatomy and Physiology

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Student success in Human Anatomy and Physiology is exceptionally important for students who desire to enter any health profession as a career. This study took an approach to giving students tools for success by introducing them to metacognition. Students were given a metacognitive learning strategies session that discussed methods for changing their studying habits to be more efficient and to retain a deeper level of understanding of the material. Specific techniques for studying will be presented, along with the study design. Available data may include students' levels of metacognition and evidence of success of the sessions.

Poster #302

Biology Bootcamp for Incoming A&P Students

**Shari Litch Gray, Regis Collegeshari.gray@regiscollege.edu
 Jeannine Foley, Regis College, jeannine.foley@regiscollege.edu**

Biological foundations prior to studying human A&P is assumed yet many undergraduate programs don't require biology as a pre-requisite. Incoming A&P students often have no biology since high school. Weeks of teaching these topics takes away from necessary system materials covered in A&P I. An online "Biology Bootcamp" was piloted in summer 2019 to review the biological chemistry and cellular structure/function required in A&P. Students were required to score at least 80% on assessments but could take each quiz multiple times. Greater than 50% of survey respondents found the preparation helpful and there was significant improvement in lab practical scores.

Poster #303

When can Closed Captioning Enhance Student Learning from Educational Videos?

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 Magdalena Vuletic, University of Ottawa, mvule070@uottawa.ca**

As a bilingual university, we provide educational materials in French and English. Closed captioning of A&P-related videos may offer benefits, not only by making a film available in another language, but also by helping international students grasp film dialogue more completely and allowing students working in their first language to become more familiar with new terminology. Survey feedback was solicited from Anglophone and francophone students regarding prior experiences with closed captioning and their utility for educational videos. Focus groups were conducted in which students watched a documentary, with or without closed captioning, and were then tested for recall and understanding of film content.

Poster #304

The Impact of Content Reinforcement on Physiological Knowledge Retention in Nursing Students

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Numerous studies have demonstrated the difficulty to retain and apply anatomical and physiological knowledge experienced by students in medical, allied health disciplines, although few studies focus on nursing students (Narnaware and Neumeier, 2019 a,b). As an intervention strategy, and an attempt to improve long-term knowledge retention, the present study reveals that repeated evaluation of physiological knowledge over eight weeks period can significantly increase knowledge retention regarding vascular physiology and body defenses compared to the evaluation of these organ systems in the first week. Our results show that content reinforcement can be used as an effective interventional strategy to improve long-term knowledge retention of physiology in nursing students.

Poster #305

A comparison of student performance in anatomy and physiology courses using an open resource textbook versus a common publisher textbook.

**Robert Humphrey, Cayuga Community College, robert.humphrey@cayuga-cc.edu
Joel Humphrey, Cayuga Community College, humphrey@cayuga-cc.edu**

This study compared student performance in anatomy and physiology courses that used a low-cost open resource textbook versus a common publisher textbook. Student performance on a standardized twenty question pre and post-test was compared, as well as average scores on quizzes and the final exam.

Poster #306

Extracurricular modifiers to success in a large human anatomy classroom

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Students in undergraduate classrooms experience a wide variety of extracurricular barriers that may hinder success, such as concurrent exams in other classes, student employment, primary language, lack of exposure to human anatomy in high school, and more. This poster aims to correlate these factors to exam scores, homework scores, class attendance, and overall class success. Over 300 students participated in data collection spread across four major academic units in a large undergraduate lecture setting. This research will address these extracurricular barriers to success and provide examples of students who may be at the highest risk for poor classroom assessment scores.

Poster #307

How beneficial is optional lab time for undergraduate anatomy students?

Danielle Hanson, Indiana University, dchanson@alumni.iu.edu

Stacey Dunham, Indiana University, dunhams@indiana.edu

Undergraduate human anatomy students have access to lab materials for study 3.5 hours per week during their registered lab section. In the two weeks before exams they are given two types of optional opportunities for studying in the lab with instructors present for assistance. The first is 50 minutes of unstructured study time, and the second is a two-hour block with a self-administered practice exam and unstructured study time. Attendance at these optional lab times was tracked and linked to exam and course grades to explore the potential effects of taking advantage of this extra lab time.

Poster #308

What nutrients are our students not getting enough of and what are the possible physiological implications?

Alannah Maurer, Medicine Hat College, amaurer@mhc.ab.ca

Sujin Whang, Medicine Hat College, sujin.whang@mymhc.ca

The eating habits of college students are often concerning as many live away from home and money is limited. We looked at a 3-day, self-reported diet analysis for 227 students. The analysis calculated the amount of essential nutrients consumed in diet. Most students reported consuming less than 50% of the required amount for several nutrients, including ones which play important roles in the immune system. The diet of our students may be linked to depressed immune system function and could impact class performance. This research hopes to eventually examine additional dietary links to the immune system and potential academic repercussions.

Poster #309

How is student preparation for exams reflected in their scores?

Ethel Gordon, Salem State University, egordon@salemstate.edu

Instructors are always looking for ways to encourage student success. After reviewing the scores from a second course exam, I wondered how students were preparing for tests. Did they expect their grades to improve based on current study habits? Are they joining or forming study groups? Are they taking advantage of freely available peer tutors? Did they use office hours or appointments to seek help from Instructors? Did they use other resources, including electronic supports provided by their text book and laboratory manual publishers? This study reviews various tools available to students and their active access to these resources.

Poster #310

Student Engagement and Critical Thinking in A&P Course using Active and Adaptive Learning Strategies

Manju Bhat, Winston-Salem State University, bhatmb@wssu.edu

Anatomy & Physiology course is a content-rich course and most undergraduate students find it to be a challenging course. Student engagement as well as critical thinking are keys to student success. We will present a variety of strategies and tools that are being used in a large class format undergraduate anatomy & physiology course to improve student learning and success. These include adaptive reading assignments that students complete before coming to class and in-class case-based discussions combined with clicker-based active learning activity. Post-class quizzes and learning assistant-facilitated sessions are used to engage students outside of the classroom.

Poster #311

High Impact Lab Activities to Enhance Student Performance

Tejendra Gill, University of Houston, tgill@uh.edu

In recent years, new learning environments and resources available to the students, have changed the strategies students use to achieve their goals. More cost effective and customizable approaches are now available to the prospective authors. Course management systems and virtual lab manuals are slowly replacing the traditional hard copies. In order to maintain high academic standards, students need to be challenged and motivated enough to come up to or exceed well defined expectations to ensure mastering of learning objectives. Engaging the students in activities on measuring and recording physiological variables, dissections, virtual anatomy visualization and labeling tools, worksheets, concept maps, and self-assessments is likely to yield good results.

Poster #312

Promoting Student Success: Splitting Laboratory Sessions and Using Tablets in the Lab

Sheri Chisholm, WVU - Potomac State College, sheri.chisholm@mail.wvu.edu

The difficult challenge for the student has been learning the large amount of information required to obtain mastery of the content area. One strategy that was initiated was to take the traditional 3-hour lab per week and split it into two 1.5 hour labs per week. The second strategy employed was the introduction of tablets into the lab that utilize an interactive visualization software. This software utilizes an interactive platform that facilitates the three-dimensional structures of anatomy, vocabulary that is spoken, various animations of physiological processes and quizzes to test mastery of the subject content areas. The tablets and software purchase were made possible through a generous grant, the Technology and Integration Grant, provided by WVU-Teaching and Learning Commons. The past 4 semesters utilized the tablets with the software for assessment purposes and the data will be presented.

Poster #313**Implementation of Collaborative Active Learning to Assess Pre- and Post-Semester Knowledge in Human Anatomy****Kjerstin Owens, Bemidji State University, kjerstin.owens@bemidjistate.edu**

In lieu of the traditional pre- and post-semester test to assess student knowledge, an active-learning group activity was created for a 3000-level Human Anatomy lecture. On the first day of class, students were divided into small groups and discussed three questions regarding an organ of their choice. On the last day of lecture, the students were put back into their original groups and asked to apply what they learned in the semester to the same set of questions. Average scores over three semesters improved from 3.3 on the first day to 7.1 out of 10 on the last day.

Poster #314**Increasing the Retention Rate in Human Anatomy and Anatomy and Physiology I: A Return to Old School Methods****Howard Motoike, La Guardia Community College, hmotoike@lagcc.cuny.edu**

The first semester of Human Anatomy and Physiology is a high risk course for our students at La Guardia Community College. In the Fall I 2019 semester more than half of the students withdrew or failed the course. In this study, I introduced weekly homework assignments into the lecture portion of the course to increase student retention. As a result from these homework assignments the retention rate increased to more than seventy percent without significantly elevating course grades. Student surveys support that the homework assignments were a major factor in their success and retention in the course.

Poster #315**Repeating an Anatomy Course: A Qualitative Analysis of the Need to Repeat for Pre-Nursing Students****Amberly Reynolds, Indiana University Bloomington, ammreyno@iu.edu**

Basic Human Anatomy (ANAT-A215) is a prerequisite for admission to Indiana University Bloomington's (IUB) nursing program. Student conversations suggest that an "A" is needed for admission, thus students repeat the course. To investigate, interviews with pre-nursing students, nursing students and two advisors at garnered perspective. Analysis provided: 1) acknowledgement that nursing school admission should not be solely based on grades and 2) differing perspectives on repeating ANAT-A215. Advisors see the benefit of repeating the course with reservation, whereas students often get information on repeating from peers. It is important to recognize the need for a clear statement on repeating courses in conjunction with likelihood for admission.

Poster #316**Medical Students' Perception of Anatomy and Faculty Orientation Program in Usmanu Danfodiyo University, Sokoto, Nigeria****Auwal Ahmed Musa, Usmanu Danfodiyo University, auwal.ahmedmusa@udusok.edu.ng**

Orientation programs have been reported to assist students by clearing misconceptions and misinformation. They are reported to allay students' anxieties. This study was aimed at eliciting students' perceptions of anatomy courses when an orientation was included. Validated self-administered questionnaires were used to collect student feedback. The majority of students (71%) agreed that the orientation has changed their perception. The overwhelming majority also agreed that orientation boosted their confidence (97%) and gave them more insight into what the course entails (89%). It is concluded that orientation programs boost students' confidence and allay their anxiety.

Teaching Ideas

Poster #317

Using Analogies to Help First Year A&P Students Visualize and Better Comprehend Challenging Concepts

Joanne Savory, University of Ottawa, Joanne.Savory@uottawa.ca

Jacqueline Carnegie, University of Ottawa, jacqueline.carnegie@uottawa.ca

Understanding abstract concepts is an important part of learning human anatomy and physiology and for students new to this discipline, this can often prove to be challenging. Analogies are frequently used to help students better understand difficult concepts by relating them to their known experiences. For example, comparing the chordae tendineae to bungee cords or the slowing of an impulse at the AV node to the merging of lanes on a highway immediately creates mental pictures with which students are familiar. Here we present some analogies we use to engage students and reinforce their understanding of body structure and function.

Poster #318

An Interactive Approach to Teaching the Brachial Plexus

Mary McGinn, Northern Illinois University, mmcginn3@niu.edu

Daniel Olson, Northern Illinois University, drolson@niu.edu

The brachial plexus is often an area of difficulty for students to visualize. Learning the nerve branches in lecture does not always transfer to being able to identify the same structures on the cadaver. Here at Northern Illinois University, I have developed an interactive tutorial for drawing the brachial plexus. The goal of this project was to help students gain a deeper understanding of the network of nerves that goes beyond the basic memorization by having them trace the plexus from its roots to its terminal branches.

Poster #319

Using the “Four Rules of 4” to Teach Clinical Anatomy of the Brainstem

Jonathan Bending, Indiana University, jbending@iu.edu

For many medical students, learning the complex anatomy of the brainstem can be overwhelming, especially when it comes to clinical implications of the associated nuclei, pathways, and vascular supply. The “Four Rules of 4” mnemonic is a simplified way of consolidating brainstem anatomy into more manageable schema and linking it to vascular syndromes. Resources using the “Four Rules of 4” were provided to preclinical medical students at Indiana University School of Medicine. A subsequent survey of these students demonstrated that this approach was highly valued as a resource for learning foundational brainstem anatomy and its clinical correlations.

Poster #320**Got a heart? Make a Heart! Inexpensive, Versatile, 3D Models of The Human Heart for Medical Education****David Resuehr, University of Alabama at Birmingham, resuehr@uab.edu**

The human heart is an incredibly complex organ. In addition to understanding the general anatomy and physiology of the heart, it is important to understand the three dimensional (3D) position and relationships of the heart as it plays a central role in many aspects of medical training across various healthcare-related disciplines. Preclinical ultrasound education has been shown to enhance the teaching of gross anatomy, which makes it a very useful tool, yet, many learners struggle with understanding the 3D structure of the human heart, and often have difficulty interpreting views of the heart in ultrasound. Our goal was to create a physical model of the heart (in various stages of assembly), that the learner could hold and inspect from any angle, to facilitate learning by providing an approach not available through ultrasound or didactics (both 2D) alone.

Technology**Poster #321****Integrating Body Donor Imaging into Anatomical Dissection using Augmented Reality**

**Geoffroy Noel, McGill University, geoffroy.noel@mcgill.ca
 Kimberly McBain, McGill University, kimberly.mcbain@mail.mcgill.ca ,
 Liang Chen, McGill University, liang.chen2@mail.mcgill.ca,
 Angela Lee, McGill University, angela.lee2@mail.mcgill.ca,
 Jeremy Obrien, McGill University, obrien.jeremy@gmail.com,
 Nicole Ventura, McGill University, nicole.ventura@mcgill.ca**

Augmented reality has recently been utilized as an additional teaching tool in medical curricula given its ability to view a virtual world while interacting with the real-world environment. The purpose of this study was to evaluate the implementation of overlaying donor-specific diagnostic imaging onto associated cadaveric body donors in a fourth-year, dissection-based, elective medical course. Students were separated into two groups; one received images displayed on a Microsoft HoloLens, and the second group received images on an iPad . Results suggested that the HoloLens had improved the students' understanding of, and their spatial orientation of, anatomical relationships.

Poster #322**Using Cell Phone Digital Technology to Improve Student Engagement and Comprehension of Histology in Anatomy and Physiology****Jennifer Adjodha-Evans, Herkimer County Community College, adjodhaje@herkimer.edu**

Histology is typically considered one of the most difficult topics in Anatomy and Physiology courses. Many students have very little experience using microscopes, so a significant amount of time is spent in demonstrating proper microscope use. New digital technologies have started to replace traditional mechanisms for teaching science education, and current students who have been exposed to technology most of their lives, feel more comfortable utilizing those resources. To observe if a multiple resource-based approach would be more beneficial on student learning of histology, we had students use their cell phone technology in combination with traditional examination of microscope slides. The overall result was a significant improvement in student engagement and comprehension of histology.

Poster #323

Using Video Response Systems in Human Anatomy Laboratory Classes

Melanie Schroer, Stockton Universitymelanie.schroer@stockton.edu

In human anatomy laboratory classes, students must interact with anatomical models in order to learn the relevant structures. However, maintaining student engagement with this task is a challenge, and subsequent performance on practical examinations suffers. In this study, students were required to use one of several video response systems (VRS) to introduce models in the laboratory. Student-generated videos were accessible to all members of the class as a study tool. Data will show how the VRS impacted student interest, engagement, and efficiency in studying anatomy, as well as student performance and self-efficacy.



Poster Infographics



THE MICROBIOME AFFECTS ALL BODY SYSTEMS



Lena Farah and Bridgit Goldman, Ph.D.
Contact bgoldman@siena.edu for full references.

The microbiome consists of roughly 100 trillion bacteria that live in the human digestive tract. A healthy microbiome is diverse in species and positively regulates all body systems.

An imbalanced microbiome can negatively impact health.

Teaching the importance of the gut microbiome throughout A&P can enlighten students and may positively impact their health.

DIGESTIVE

Irritable bowel syndrome (IBS) and inflammatory bowel disease (IBD) have been associated with variations in the gut microbiota that could be responsible for the intestinal inflammation associated with these syndromes (Bull et al., 2014).

MUSCULOSKELETAL

Exercise promotes beneficial changes in gut microbial health that result in the reduction of circulating inflammatory agents and supports the maintenance of muscle and bone function (Grosicki et al., 2018).

NERVOUS

Certain bacterial flora enhance production of 5HTP (the precursor to serotonin) and can alleviate anxiety and depression (Tian et al., 2019). A mother's microbiome plays a significant role in the neurodevelopment of the fetus (Sampson et al., 2016).

ENDOCRINE

Bacterial components of the microbiome act as endocrine factors that can control host metabolic processes such as appetite, fat storage, glucose tolerance, and insulin sensitivity (Martin et al., 2019).

CARDIOVASCULAR

Atherosclerotic plaques contain bacterial DNA, and those bacterial taxa are also present in the gut of the same individual, thereby indicating a potential relationship where the gut microbes may be harboring and producing proinflammatory molecules (Tang et al., 2017).

RESPIRATORY

Both a poor microbiome and antibiotic use increase the chances of asthma in early life. Additionally, the gut microbiota has the potential to contribute to changes in antitumor immunity in lung cancer patients (Sivan et al., 2015).

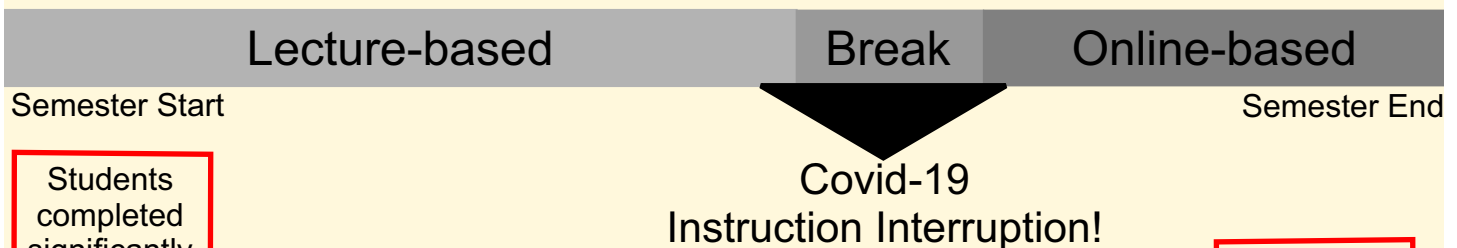
Keep Learning: from in-person to online instruction

Steven Newman and Dr. Lauralyn Riggins Indiana University

The Course: M115: Introduction to Anatomy and Physiology historically is a lecture based course that met 3 times per week. This course served a diverse population of undergraduates ranging from freshman to seniors and from dance and health-centered majors. For online-only instruction, once a week instructor lecture videos were recorded for students to watch in preparation for assignments and their last exam.

The Situation: Given that this course, like so many others, had in-person instruction interrupted by the novel Covid-19 virus, we as instructors were curious what academic effects this abrupt transition from in-person to online-only would have on our students participation and learning. As shown below, our course had to transition and be ready for online instruction after an extended two week spring break ended.

Course Timeline



Students completed significantly more assignments when online.

What Resulted?

Table 1. Course Descriptive Statistics Compared Using t-tests

| | Lecture-based | | | Online-based | | | t-test |
|----------------------------------|---------------|------|------|--------------|------|------|---------|
| | N | M | SD | N | M | SD | |
| Course Assignments Completed (%) | 22 | 89.9 | 14.5 | 17 | 96.9 | 10.8 | -3.79** |
| Online Quiz Scores (%) | 5 | 83.1 | 13.2 | 5 | 86.1 | 12.4 | NS |
| Missed Points (%) | | 14.9 | 13.6 | | 10.2 | 11.5 | 2.58* |
| Exam scores (%) | 3 | 79.7 | 11.4 | 1 | 82.8 | 11.3 | NS |

Note: N = number of assignments, M = mean, and SD = standard deviation. NS = not significant.
The first three lecture exams were pooled together to obtain an average lecture-based exam score percentage.

** $p < 0.001$. * $p < 0.05$

Students missed significantly less assignment points when online.

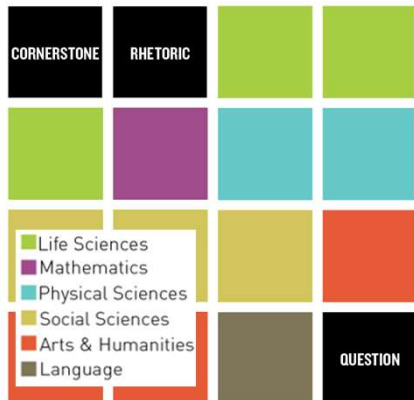
Final Thoughts: The Covid-19 crisis abruptly interrupted and caused a quick turn-over from 3x a week in-person lectures to 1 weekly posted instructor video lecture. Given this extreme circumstance our students stayed on task with course participation as evidenced by the higher assignment completion and lower assignment points missed when online. We should note these were constant throughout the semester. Further the lack of a decrease in exam grades between lecture-based and online is encouraging. This course case-study helps sheds light on how students responded positively when asked to maintain participation and keep learning during these times of extreme stress and uncertainty.

Structure and function of A&P at **QUEST UNIVERSITY CANADA**

Meaghan MacNutt and Molly Welsh

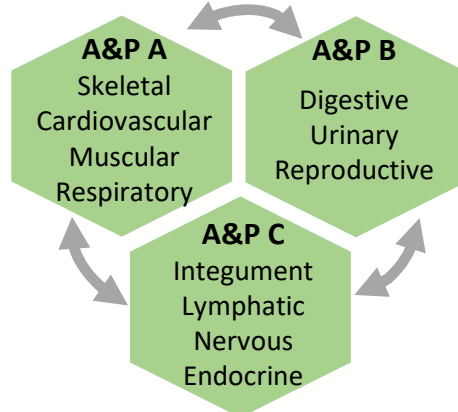
Quest's interdisciplinary academic program motivates our **A&P curricular goals.**

After a 2-yr core Foundation...
(16 consecutive courses)



Challenge: Students who are trained to think broadly and critically ask very tough questions!
Opportunity: Interdisciplinary thinking → intellectual growth for teachers and learners.

Students can take up to 3 upper division A&P courses... in any order!



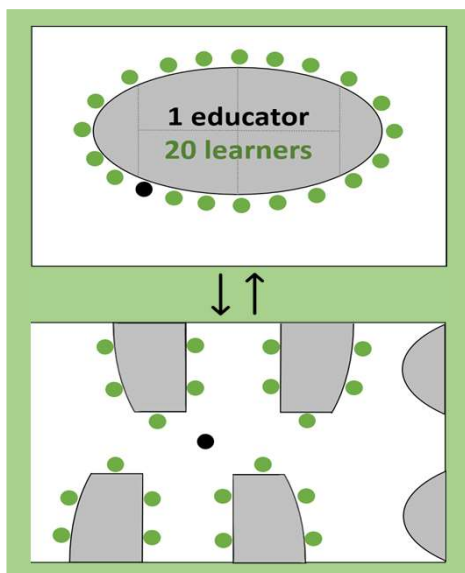
Courses incl intro → intermediate content/skills. Students have mixed levels of prior knowledge. Some repetition needed across courses. Opportunities for peer teaching and effective redundancy.

Quest A&P courses:

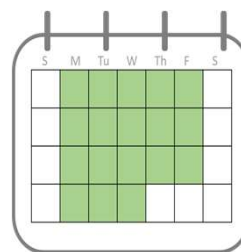
- ✓ Meet HAPS learning outcomes
- ✓ Are recognized across North America
- +
- ✓ Support Quest's mission of liberal education
- ✓ Focus on transferable skills/social responsibility

Ambitious meta-goals for content-heavy courses. Stimulates reflection on what/why/how we should be teaching and learning about the body.

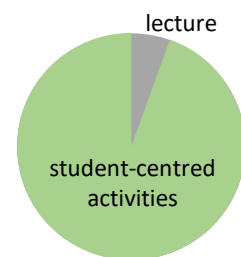
Quest's unique format facilitates **unconventional approaches to A&P teaching/learning.**



Easy classroom transitions facilitate large/small group activities. Students expect a variety of challenging, engaging learning activities. Intimate, interactive learning environment. Supports creative course design.



Compressed course format: 3.5 weeks, 3-6 hr/day. **INTENSE. Fast-moving. Immersive. Community-building.**



Fully flipped classroom with integrated labs. **Requires student buy-in. High student engagement. Active learning. FUN to teach!**

Think about structure and function in your program/curriculum/course format/learning environment. What challenges and opportunities do you encounter?



Learning Communities Developed from Team-based Learning in a Human Anatomy Course

Course Design

In their first semester, Physical and Occupational Therapy students were assigned teams of 3 or 4 students within their program. For lecture, students were assigned textbook reading as out of class preparation. At the beginning of each lecture students took a multiple-choice IRAT (Individual Readiness Assurance Test) over the assigned reading material. This was followed by a TRAT (Team Readiness Assurance Test) in which the students on a team retook the quiz. The remainder of the lecture involved mini lectures and team activities. For the lab component of the course, the team worked together on their cadaver dissection.

Conclusion

We conclude that team-based learning can also develop into beneficial learning communities.

“I found that I did all the readings because I knew I was going to be quizzed on them and because I did not want to let my team down.”

“I have formed friendships and learned new ways to study from my team.”

“They help me to stay focused and disciplined, and support me when I am having rough days. They are great friends to bounce ideas off of and they help me to succeed in the course.”

Course Evaluation

At the completion of the course a standard IDEA evaluation was completed by each student with an additional question asking to list one positive thing about the course that was worth keeping and/or valuable.

Of the 61 students that responded to this question, 31 students (50.8%) mentioned the team work as a positive thing about the course

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Implementation and assessment of inquiry-based labs in Anatomy and Physiology

Heather Evans Anderson

Targeted Learning Objectives



Identify components of an ECG recording and relate to cardiac depolarization patterns and resulting muscle contraction. Be able to discuss cardiac arrhythmias and what structural features result in abnormal ECG patterns.



Detail the structural changes to the lungs that occur with smoking and the related functional changes.



Compare and contrast the renal processes of filtration, reabsorption, and secretion.



Describe chemical digestion of macromolecules in the GI tract. Focus on carbohydrates, proteins and lipids and the importance of brush border enzymes for absorption

Inquiry –based labs

- ECGs were measured on an invertebrate model system (crayfish) that were treated with different ionic solutions
- Porcine lungs (normal and simulated smokers lungs) were demonstrated along with bell jar alveolar model
- Nephron models were constructed to simulate filtration, reabsorption and secretion of different substrates
- Digestive enzyme activity was assessed by measuring osmotic rate

Traditional* labs **at our institution*

- Students went through virtual simulations of ECGs and sketched out ECG components following tutorial
- Models of lungs and torsos were described in lab in conjunction with simulation activity for smokers lungs
- Worksheets and interactive simulation of renal filtration, reabsorption and secretion were used in lab
- Enzyme activity was modeled using worksheets

Initial assessment from cardiovascular and respiratory labs indicate that inquiry-based labs resulted in improved student performance on quizzes and exams but students did not like the time it took to complete labs. Renal and Digestive labs were not conducted due to COVID 19 disruption to semester.

Implementing a Competency-Based Approach to Anatomy Teaching



Alireza Jalali¹, Dahn Jeong², Stephanie Sutherland³

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³Department of Critical Care, The Ottawa Hospital, Ottawa, ON, Canada.

Introduction



In transitioning from a time-based to a competency-based medical education system, the focus of curriculum (and curriculum delivery) is now a learner-centred approach that emphasizes achieving specific outcomes called milestones. Among the basic sciences, anatomy is often a logical starting point for implementing competency-based education because the "old" course already included experiential laboratories as well as didactic classrooms. In keeping with the CanMEDS 2015 Physician Competency Framework, this study sought to map the milestones for anatomy teaching according to the CanMEDS roles of the medical expert, communicator and collaborator. Another goal of this research was to test the hypothesis further that a modified team-based learning (TBL) approach promotes increased student engagement and learning.

Methods



At the University of Ottawa, we began utilizing a modified team-based Learning approach (Figure 1), herein called Anatomy Based Learning (ABL). This pilot study employed a mixed-method approach. Quantitative data included final student scores. Qualitative data was employed via participant observation. A series of eight anatomy labs were observed using a pre-designed interview protocol (four using a modified team-based approach and four traditional labs).

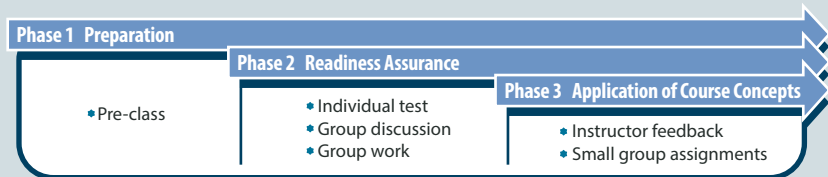


Fig.1

Results



Through a series of direct observations comparing the ABL approach to pedagogy versus a more traditional approach, we were able to demonstrate the students were more engaged (communicative and collaborative) in their learning through the ABL approach. Notably, we found students to spend more time on task (i.e., devoted more time engaging with the cadaver), as well as less reliance on the facilitator to "tell students the answers."

Conclusion



Traditional basic science courses can be effectively restructured as integrated student-centered sessions using specific competencies as templates. Based on our findings, we have developed a matrix outlining appropriate milestones for the CanMEDS roles of **Communicator**, **Collaborator**, **Medical Expert**, **Scholar** and **Professional** (Figure 2). It is anticipated that such milestones will enable students to better understand the progression and significance of their anatomy learning.

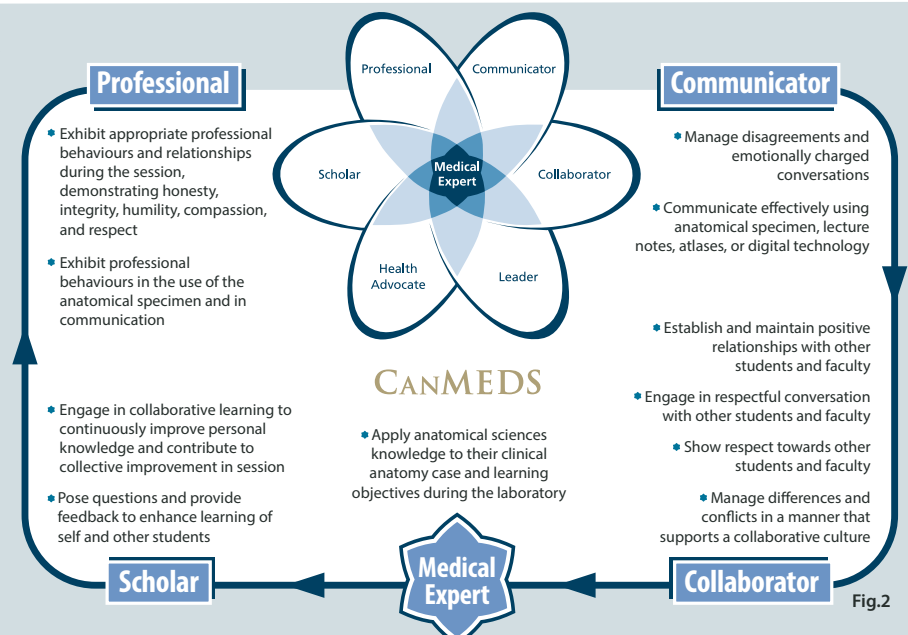


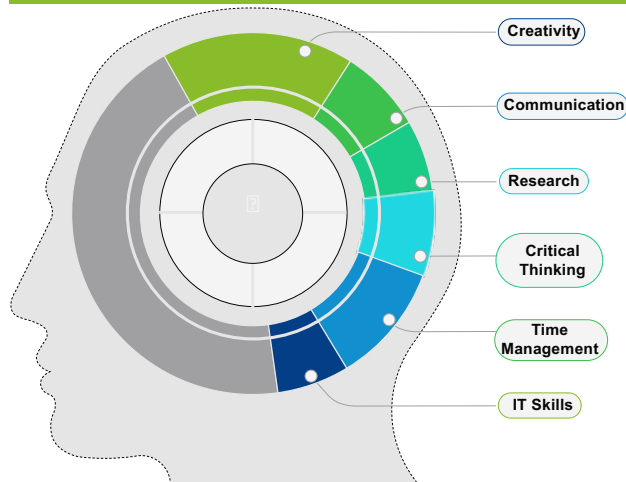
Fig.2

CanMEDS Diagram Copyright © 2015 The Royal College of Physicians and Surgeons of Canada. Reproduced with permission.

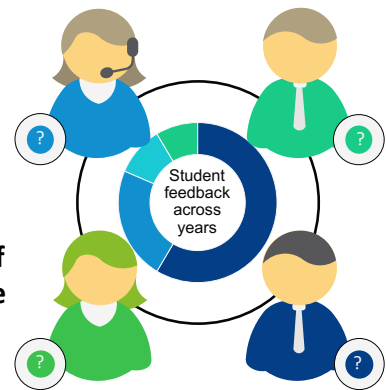
Student perceptions of infographics for poster projects – a cohort comparison

Derek Scott, Frances Coombey, Alison Jenkinson

School of Medicine, Medical Science & Nutrition, University of Aberdeen, Scotland, UK

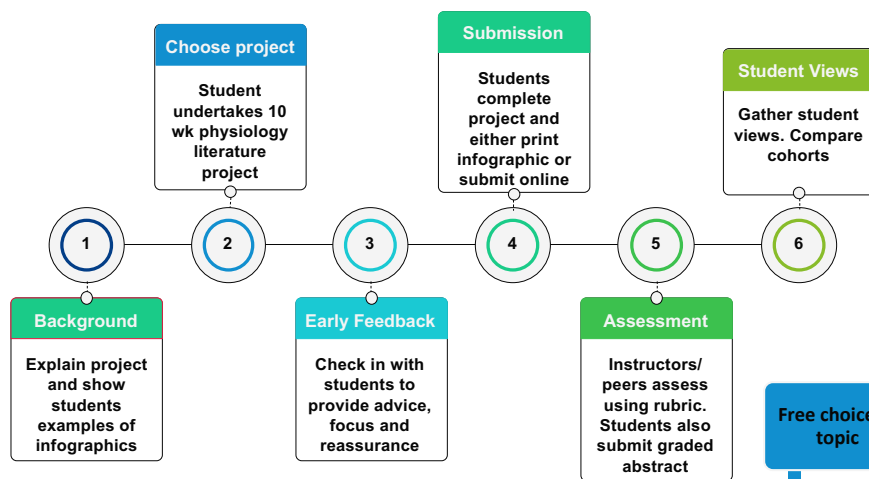


Creating infographics to communicate science can develop a variety of skills in students. Our students create infographics as part of a physiology literature research project.

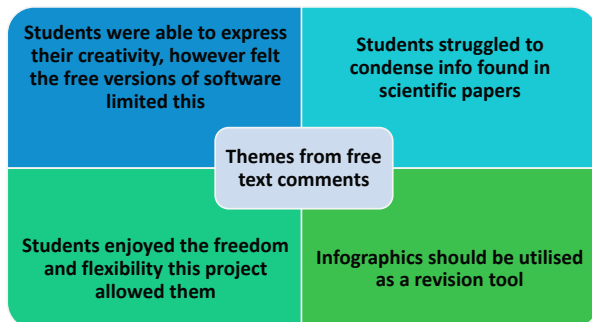
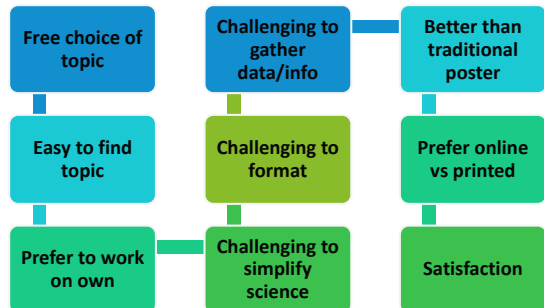


This approach was received very positively in its first year, but we wanted to know if this response was sustained across cohorts.

Infographic Project Outline



No change across cohorts regarding:



Where next?



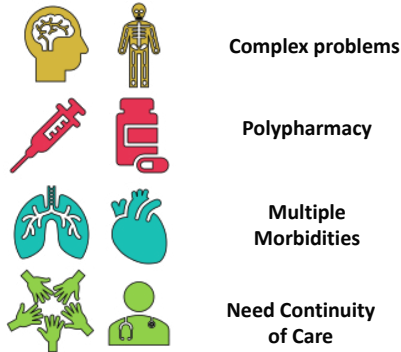
- Popularity has taken off!
- Students working on infographics to help healthcare partners and to educate public about COVID-19

Physiology students can use a quality improvement approach to support a safe and efficient medication pathway in geriatric rehabilitation

Isabel Chung, Louise Brodie, Lindsay Cameron, Iain Rowe, Derek Scott

University of Aberdeen, NHS Grampian, Robert Gordon University, Aberdeen, Scotland, UK

Geriatric rehabilitation poses challenges since multifactorial.....

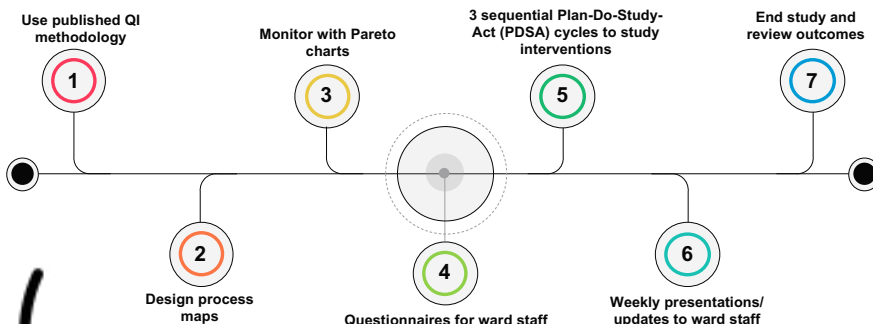


Could we use a Quality Improvement (QI) approach to address this?

This Project

- 1 **Problem**
Medication errors can occur in geriatric rehabilitation ward – major safety issue.
- 2 **What might be the cause?**
Documents may not be completed accurately and multiple people making entries.
- 3 **What can we do?**
Study how medicines prescribed and documented in a geriatric rehab ward to identify strengths/weakness – will allow us to identify any useful interventions.

Project Methodology



Mapped medication pathways for the ward

Established new table of contents page in patient notes with standardized organizational system to simplify medicines reconciliation (Med Rec) form completion for all staff.

Completion of 'Medication history taken' section of Med Rec form

Completion already rose from 46% to 80% during initial project – monitoring was to continue to July 31 2020 but COVID-19 has disrupted due to reconfiguration of geriatric facilities during NHS emergency status.

Staff perceptions of new Med Rec file system

Significant increases in favorable staff perceptions for:

- Ease of use
- Efficiency
- Overall experience when using with medical files



- #### Conclusions
- Intervention positively affected Med Rec completion.
 - Positive staff experiences.
 - Work continues to hit 95% target.



Using simulations to teach electrocardiogram (ECG) in an undergraduate human physiology laboratory

Burhan Gharaibeh¹, Laurel Roberts¹, Suzanna Gribble¹ and Deborah Farkas²

1. Department of Biological Sciences, University of Pittsburgh and 2. Winter Institute for Simulation Education Research (WISER), University of Pittsburgh and University of Pittsburgh Medical Center



Background

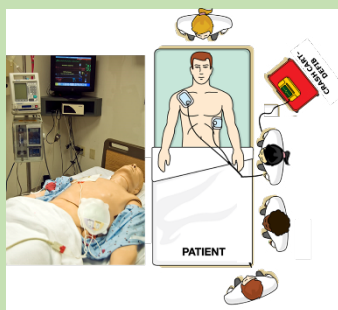


- The literature lists use of problem-based courses that incorporate role-play, standardized patients (actors) and mannequins.
- These are intended for clinicians to practice and improve their clinical skills.
- We found one report that investigated the efficacy of using simulations in teaching a basic ECG lab.
- We developed a scenario enactment or mannequin protocol to augment teaching a traditional ECG physiology lab.
- We present preliminary results that show that simulation sessions intended to teach clinical skills, can be tailored to deliver basic science content and improve students' learning.

Methods and Materials



- Participants are undergraduate students registered in the human physiology lab at the Department of Biological Sciences, University of Pittsburgh.
- ALL students were given two ECG labs covering the topics of ECG and heart sounds; and the effects of exercise on cardiovascular output.
- Nine students are divided into two groups: Team A: includes the patient, her daughter, a shopkeeper and a bystander. Team 2 is the medical team and includes
- Pre- scenario quiz and post-scenario quiz are given on tablets in the room where the scenario was conducted. The quizzes are proctored to post instructional survey regarding the learning experiences is conducted using the university online survey system.



Challenges



- The same quiz was given twice. The students doing the same questions twice may have inflated post-quiz scores.
- Students were too apprehensive about making the wrong diagnosis or decision.
- The logistics of organizing the visit, reserving the rooms and meeting students at WISER for a whole week is difficult.
- All of those will be addressed next time we teach this lab.

Conclusions



- Overall, the simulation experience was positive for students.
- We have seen statistically significant improvement of knowledge of ECG in a clinical application setting based on quiz scores.
- Probably the experience provided an improvement of confidence level during critical care crisis situations that will be useful for senior undergrads applying to the medical and other health sciences schools.
- Students discover a connection between basic science and clinical medicine that is often ignored in traditional physiology labs.
- In the future, to teach ECG using this simulation session, we need to refine the case scenario structure and programming of the simulator. Furthermore, we need to expand our qualitative assessment of the student perceptions after the simulation session.

Academic (dis)honesty in online anatomy courses:

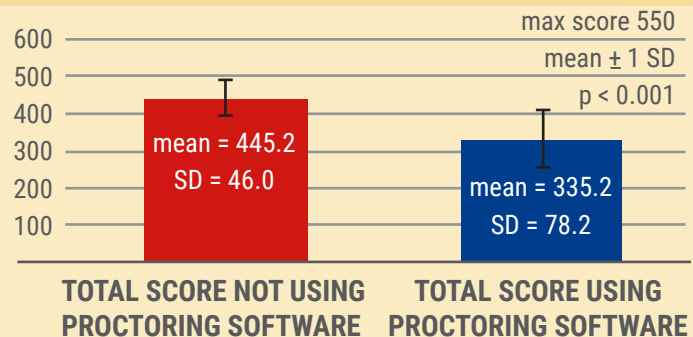


northern *State* university

A comparison of student outcomes before and after instituting the use of online proctoring software

Authors:
Dr. Amy Dolan
Dr. Alyssa Kiesow

Student assessments decreased by 20% when proctoring software was instituted, suggesting cheating had been common.



Why do students cheat?

- Opportunity or lack of deterrents*
- Peer behaviors*
- Perception of lack of consequences*
- Memorization heavy exams**

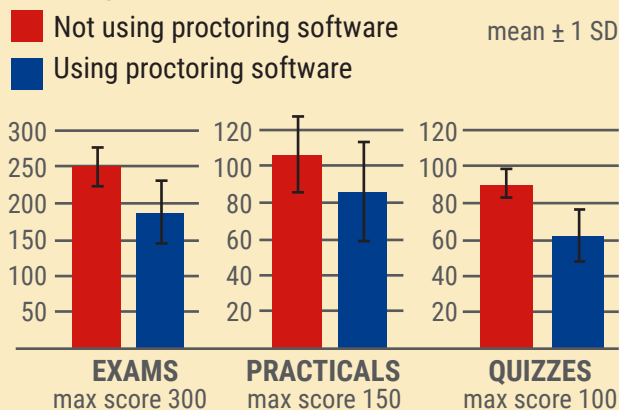
*Chase, A. E. (2010). Academic Dishonesty in online courses: the influence of students' characteristics, perception of contentedness and deterrents. (Doctoral dissertation). ProQuest Dissertations Publishing. (UMI# 3405540)

**Küçüktepe, S.E. (2014). College students' cheating behaviors. Retrieved May 31, 2020, from <https://www.sbp-journal.com/index.php/sbp/article/view/3778>

Proctoring software limits online cheating methods

- Prevents use of other applications or windows
- Records test environment (e.g. presence of books or phones, people speaking, other people in room)
- Uses facial detection to monitor student behavior (e.g. student leaves frame, looking off screen, different student takes exam)
- Reinforces expectations and consequences

Change in student scores



In all categories, student scores significantly lower when proctoring software was used. ($p < 0.001$)

| | Exams | | Practicals | | Quizzes | |
|---------|----------|-------|------------|-------|----------|------|
| | 2019 | 2018 | 2019 | 2018 | 2019 | 2018 |
| avg pts | 187.3 | 248.6 | 86.1 | 106.6 | 61.8 | 90 |
| SD | 43.9 | 26.3 | 21.2 | 27.2 | 14.54 | 8.11 |
| t(df) | 1.99(93) | | 1.98(106) | | 1.99(87) | |

Methods: Exam, quiz, practical and total scores were compared using two sample t-tests between students in 2019 using proctoring software (n=58) and students in 2018 that did not (n=57). Assessments were identical between the two treatments.

This study was conducted in accordance with Northern State University's Institutional Review Board guidelines and policies. IRB PROTOCOL#: 2020-01-28A

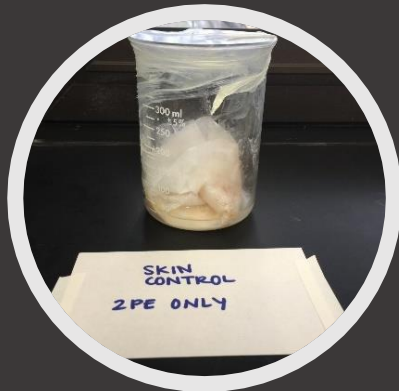
SOFTENING UP THE HARD SCIENCE OF ANATOMY:

Using fabric softener to re-hydrate desiccated cadaver tissue

Danielle Waters M.S. & Nicole Hackenbrack M.S.

DESICCATION OF HUMAN TISSUE

Damaged tissue looks and feels different, can completely change the structure of the anatomy and hinders the educational experience. We hypothesized that fabric softener could be repurposed for rehydrating cadaver tissue.



PRELIMINARY FINDINGS

The control (100% 2PE), 100% FS, and 50% (2PE/FS) showed *no reversal of desiccation*.

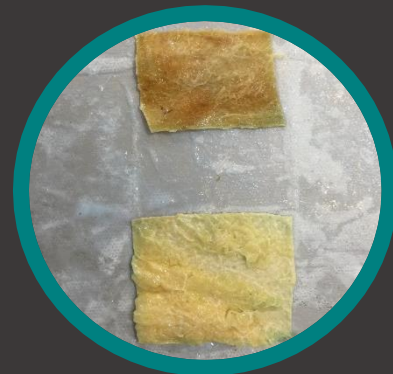
Some samples soaked in a 50% solution of FS and 2PE were dyed blue, and a film developed over the tissues.

From these findings, dryer sheets were used to wrap the tissue samples and soak in the same concentrations of 2PE/FS. The dryer sheets showed minimal improvements to the texture of the skin samples over 15 days. In conclusion, there were no deleterious effects to the FS treatment on the tissues.



EXPERIMENTAL DESIGN & SETUP

Sections of severely desiccated and hydrated skin and muscle tissue were removed from one cadaver. The tissues were soaked in different concentrations of 2-phenoxyethanol (2PE) and name brand fabric softener (FS). The samples were observed weekly.



FUTURE DIRECTIONS

Prevention of desiccation of cadaver tissue is key. There are areas of the body prone to desiccation because of their use in the anatomy courses. The next phase of our experiment is to wrap these sections with dryer sheets, to see if this will slow the rate of desiccation.

Using a case study on SSRI antidepressants and neuron puzzles to teach neuron anatomy and physiology

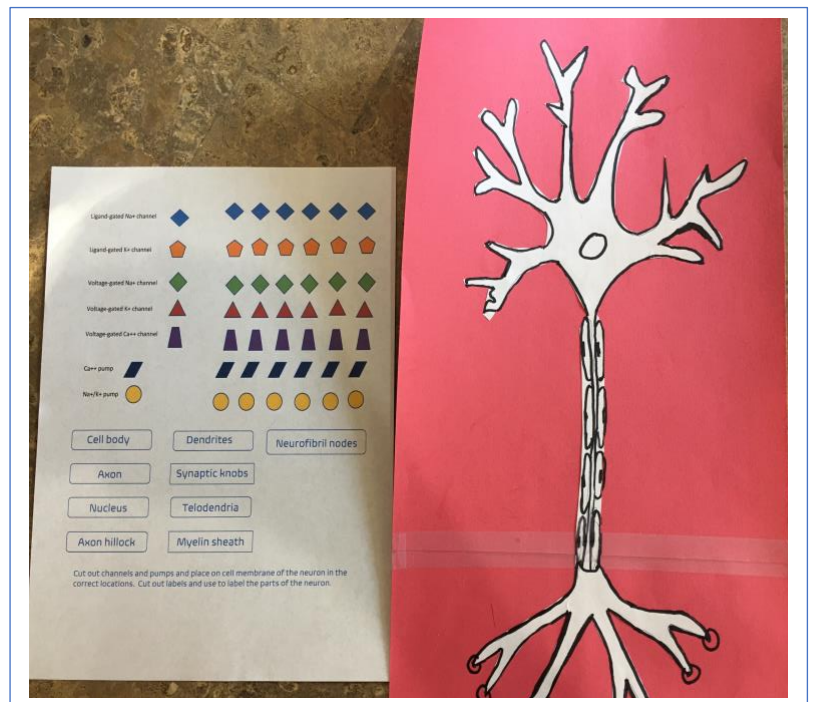
Jamie Dalton, Senior Instructor of Biological Sciences, Arkansas Tech University, Russellville, Arkansas

Pre-tests and post tests were given to eight Anatomy and Physiology classes at Arkansas Tech over a two year period

Results of post tests showed that 40% of students missed questions related to neurophysiology

We have received positive feedback from students on the use of case studies, and previous research has shown active learning as being effective

We developed a case study on SSRI antidepressants and a neuron puzzle to facilitate student learning in the area of neurophysiology



Students can cut out the channels and pumps and place them along the cell membrane in the correct locations. They can cut out the labels and use them to identify the parts of the neuron. Student can also color the different parts of the neuron.

Pre-tests and post tests results from fall and spring 2020-2021 will tell us if our changes are effective.

From Concept to Publication, The Success and Pitfalls of Writing Cases Studies.



Nalini V. Broadbelt, Michelle A. Young and Nevila Jana



Background

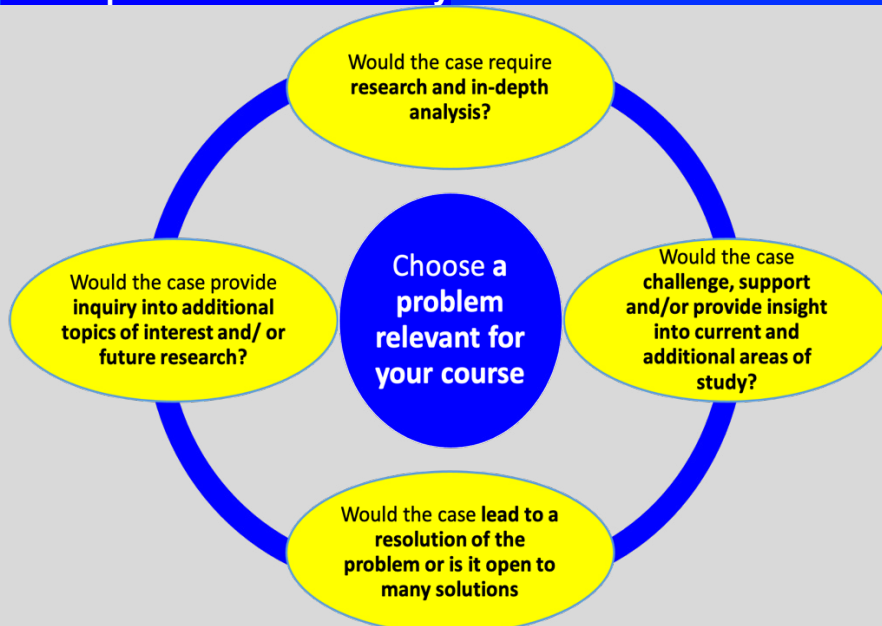
Writing a successful case study rests on the analysis of a situation where existing problem/s need to be solved. A connection should be made between the theory to practical application.

Before beginning ask yourself:

- ① Why write a case?
- ② What is the purpose of the case?
- ③ How will it address the proposed problem?
- ④ Who is the target audience?



Development of a Case Study



Pitfalls

- Time management for research and writing
- Identify alternative solutions to the problem/s and conclusions
- Have limitations – keep to objectives you have set out
- Always have credible sources for all material used
- Receiving timely feedback from peers and students



Success

- Topic Identification and Relevance:**
 - ① What is being studied?
 - ② What makes this topic important to be investigated?
 - ③ What prior knowledge do you have about this topic?
 - ④ How will this case contribute to new knowledge and understanding?
- Key Points When Writing the Case**
 - ① Use real-life examples to make the story believable
 - ② Have clearly defined objectives
 - ③ Ensure that each part have a solution and/or points of discussion
 - ④ Have credible supporting data and evidence on topic
 - ⑤ Identify the resources you will need and know if they are accessible
- Publication Selection**
 - ① National Center for Case Study Teaching in Science (NCCSTS)
 - ② International Journal of Teaching and Case Studies



The Breathless Heart: A Case Study to understand the Anatomical and Physiological Implications of Heart Disease

Amitoj S. Sawhney, Nalini V. Broadbelt, Michelle A. Young

Background Information

This study provides an insight to a real-life case of a newborn with multiple Congenital Heart Defects, resulting in the mixing of blood in the heart, thus causing an increased workload on the Circulatory System. The objective here is to help understand and analyze the effects of a combination of such heart conditions and their potential treatments.

Diagnostic Tests

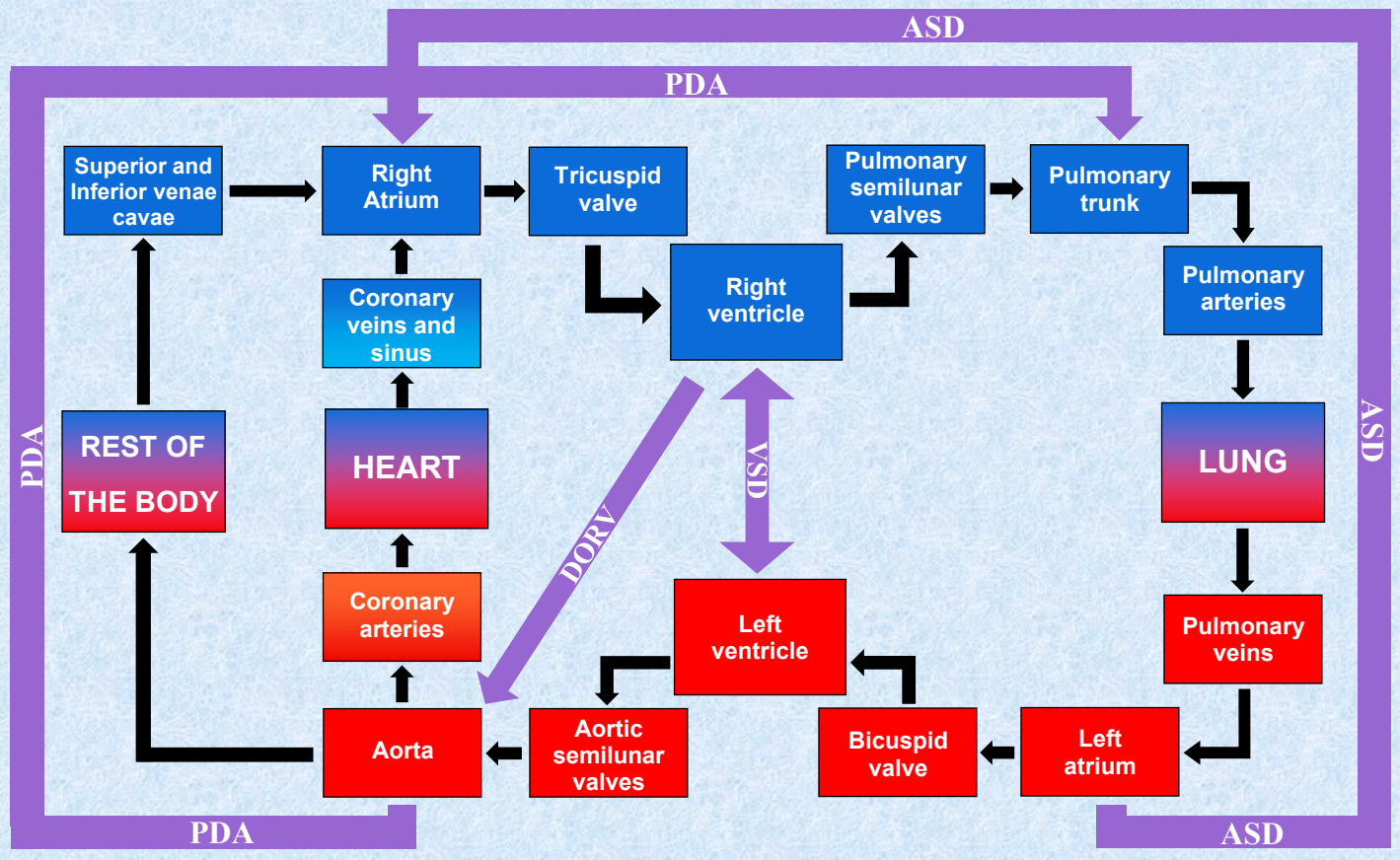
- 2D-Echo Doppler Study
- Complete Blood Count (CBC)
- C-Reactive Protein (CRP) Test

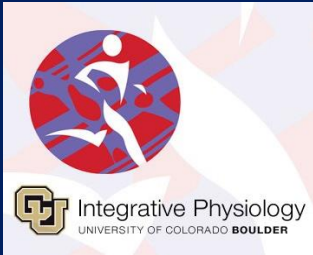
Impact on Cardiovascular and Respiratory Systems

- Increased precordial activity
- Breathlessness
- Pulmonary embolism
- Cyanosis

Significant Cardiac Conditions

- ① Patent Ductus Arteriosus
- ② Atrial Septal Defect
- ③ Double Outlet Right Ventricle
- ④ Ventricular Septal Defect





Development of a curriculum map to assess undergraduate student achievement of departmental program goals

Janet Casagrand & Teresa Foley



PROGRAM GOALS – WHY & HOW?

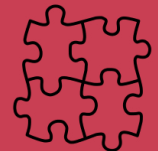
To assist our department in making informed curricular decisions, we developed **program goals** identifying what a student should know and be able to do upon major completion. These were informed by overarching principles from disciplinary societies. Faculty input was solicited and used to refine 27 goals which centered on 5 themes: scientific method, critical thinking, professional skills, metacognition, and disciplinary knowledge.



IDENTIFYING GOALS ACCOMPLISHED IN COURSES

We next created a **curriculum map** providing a visual representation of goals accomplished in each course and level (as reported by faculty). This process involved collecting course artifacts and surveying faculty about the level of exposure students had to each goal in a course. Follow-up interviews are planned along with a review of individual course goals.

EVALUATING THE OVERALL CURRICULUM



The process of curriculum mapping is a first step in ensuring program goals are met, courses combine into a cohesive whole with appropriate expectations of prerequisite knowledge and skills, and curricular changes are intentionally designed to build upon and improve student learning.



HOW IS THIS HELPFUL FOR STUDENTS?

A summary of the curriculum map will be posted on the departmental website for students to make informed decisions about their course schedules, and to understand the relationship between the courses so they are set up for success, not failure. It can also inform prospective students, post-bac programs, and future employers of the specific knowledge and skills gained by our undergraduate students through the curriculum.

Problem-Based Learning (PBL) Tutoring Program for Pre-Nursing Students



Hanson C., Bali V., Dustman W., Fiorillo R., Kalman R., Li X., Perell-Gerson K., Shearer, J.
Georgia Gwinnett College

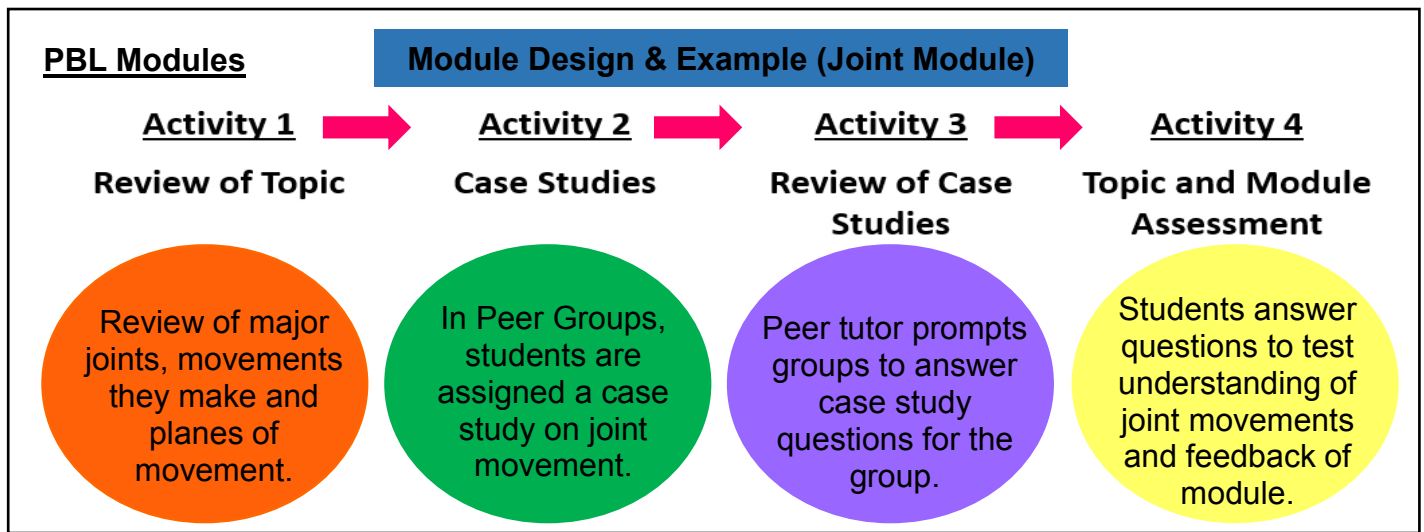


Background

PBL is a pedagogy developed as an approach to medical education and described as learning that results from the process of working toward the understanding or resolution of a problem (1). PBL has been adapted to nursing programs at many institutions and is thought to encourage critical thinking and active learning skills (2).

How to Design a PBL Tutoring Program?

At GGC in the Spring 2020 Semester, faculty designed modules that focused on difficult concepts in A&P I and included activities such as case studies. During peer tutor led sessions, students worked together in problem solving activities.

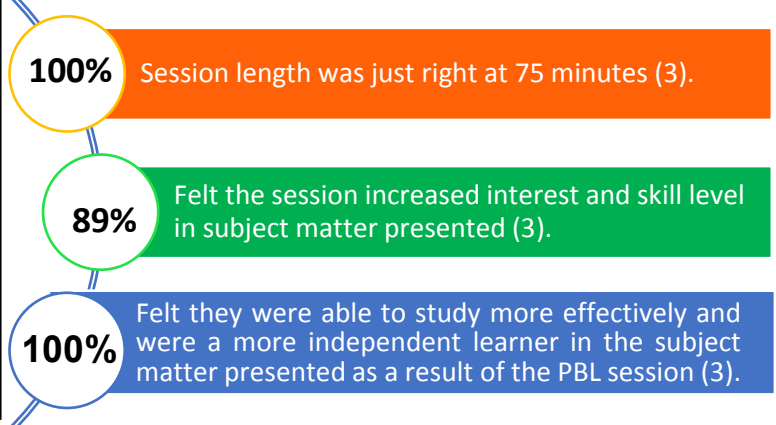


PBL Tutoring Program Details

- Two former A&P I students hired as peer tutors.
- Modules designed by faculty corresponding to the A&P I schedule.
- 3 modules led by peer tutors during the Spring 2020 semester.

Module Topics-Skeletal System, Joints and Muscular System

- 51 students attended three sessions.



References

1. Barrows, H. S., & Tamblyn, R. M. (1980). Problem-Based Learning: An Approach to Medical Education. New York, NY: Springer
2. Li J., Jayasekara R., & Zang Y. (2019) The effectiveness of problem-based learning in undergraduate nursing programs: A scoping review of the literature. Journal of Nursing Healthcare 4(1), 1-5.
3. Perell-Gerson K, Kalman R, Bali V, Shearer J, Li X, Fiorillo R, Hanson C, Dustman W. Problem Based Learning Tutoring Program for Pre-Nursing Students. USG & G2C Case Study Publication. John N. Gardner Institute for Excellence in Undergraduate Education. (paper submitted for peer review by 5/15/2020)

Cancers That Affect High School and College Age Students Proactive Measures For Cancer Prevention

Lakshmi Atchison, Ph.D. Professor of Biology, Chestnut Hill College, PA



OVERVIEW

- Many cancers affect young adults.
- The need to educate all young adults.
- Changes in anatomic structures and physiological functions.
- Risk factors and early warning signs.
- Being proactive, following a healthy diet, and avoiding obesity.
- Critical thinking questions. The time to act is now!

- Potential positive outcomes by remote learning.

Education is the Key! Prevention, Remain Cancer Free, Lead a Healthy Life.

[ACS 2019 US Cancer Statistics, Incidence: 1,762,456; Mortality: 606,880¹]

Examples of Cancer Changes in Young Adults

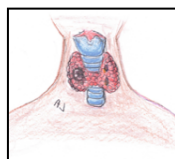


Cancers That Can Affect Young Adults

- Leukemia
- Lymphoma
- Melanoma/Skin
- Thyroid
- Brain/Nervous
- Lung/Bronchus
- Uterine/cervix
- Testicular cancers

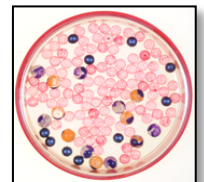


Lymphoma: Swollen lymph nodes, frequent infections, enlargement of spleen or liver, skin discoloration, and multiple organ failure.



Leukemia: White blood cells increase in number and shape, clogging blood vessels, and impairing the physiology of circulation.

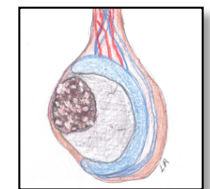
Thyroid tumors: Enlarged thyroid nodules, lump in front of the neck, hoarseness, swollen glands, difficulty swallowing, persistent cough, altered thyroid structure, impaired function of the endocrine system.



Testicular cancer: Lump or swelling in the testicle, sudden build-up of fluid in the scrotum, or dull ache in the groin. Testicular cancers can produce hormones resulting in breast tenderness, and the possibility of sterility.

[All cancer diagrams are the author's original illustrations].

Know the **do's** and **don'ts** for cancer prevention.



LEARN REMOTELY ON CANCER PREVENTION AND TEN PROACTIVE MEASURES²



References: 1. Cancer Facts and Figures American Cancer Society Inc., Surveillance Research 2019
2. Lakshmi Atchison, Ph.D. and Michael Atchison, Ph.D. Cancers That Affect High School & College Age Students. Prevention is Now! An Instant Education Guide, MaLa Scientific.com, 2020.

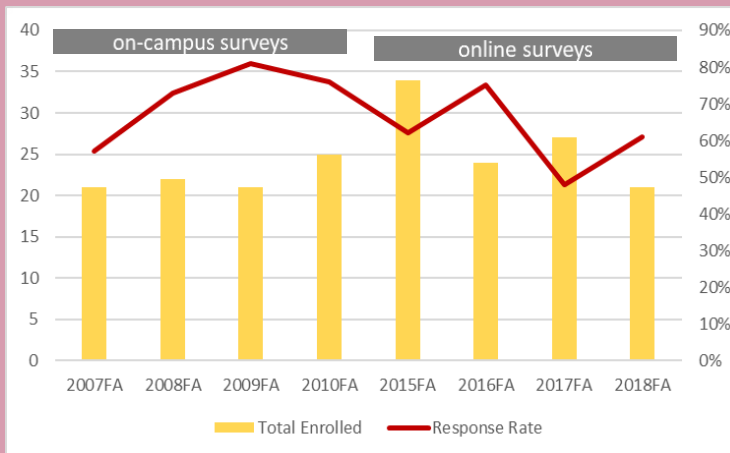


Student opinion surveys: A glance at in-person versus online administration in Human Anatomy courses

Drs. Alyssa Kiesow and Amy Dolan

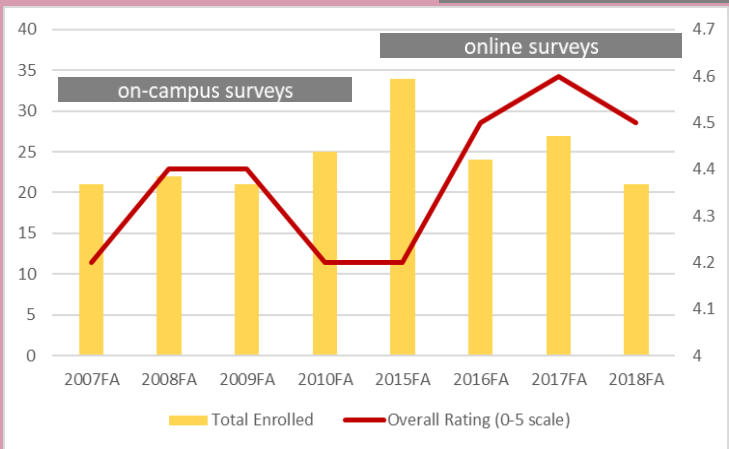
The need...

- Student response rates have seemingly decreased with the shift to online opinion surveys¹
- Qualitative and quantitative data from student surveys is helpful to adapt courses
- Less information from students means less reliability and usefulness of input



Response rate dropped to its lowest at 42% but regained participation from students after one year (p=0.22)

Overall faculty ratings increased from 4.2 to 4.5 (on a scale of 5) with more qualitative



What we did...

- Compared **in-person (n=89)** and **online (n=106)** student surveys from four sections each of **Human Anatomy**
- Used a two-sample t-test to examine differences

What we found...

- Movement to online student opinion surveys originally impacted student response rates but over time increased
- As students continue to use online resources it is expected student response rates will increase in online surveys
- Online surveys do not seem to impact faculty evaluations rather as students acclimate to the use input and suggestions to faculty become more meaningful and positive

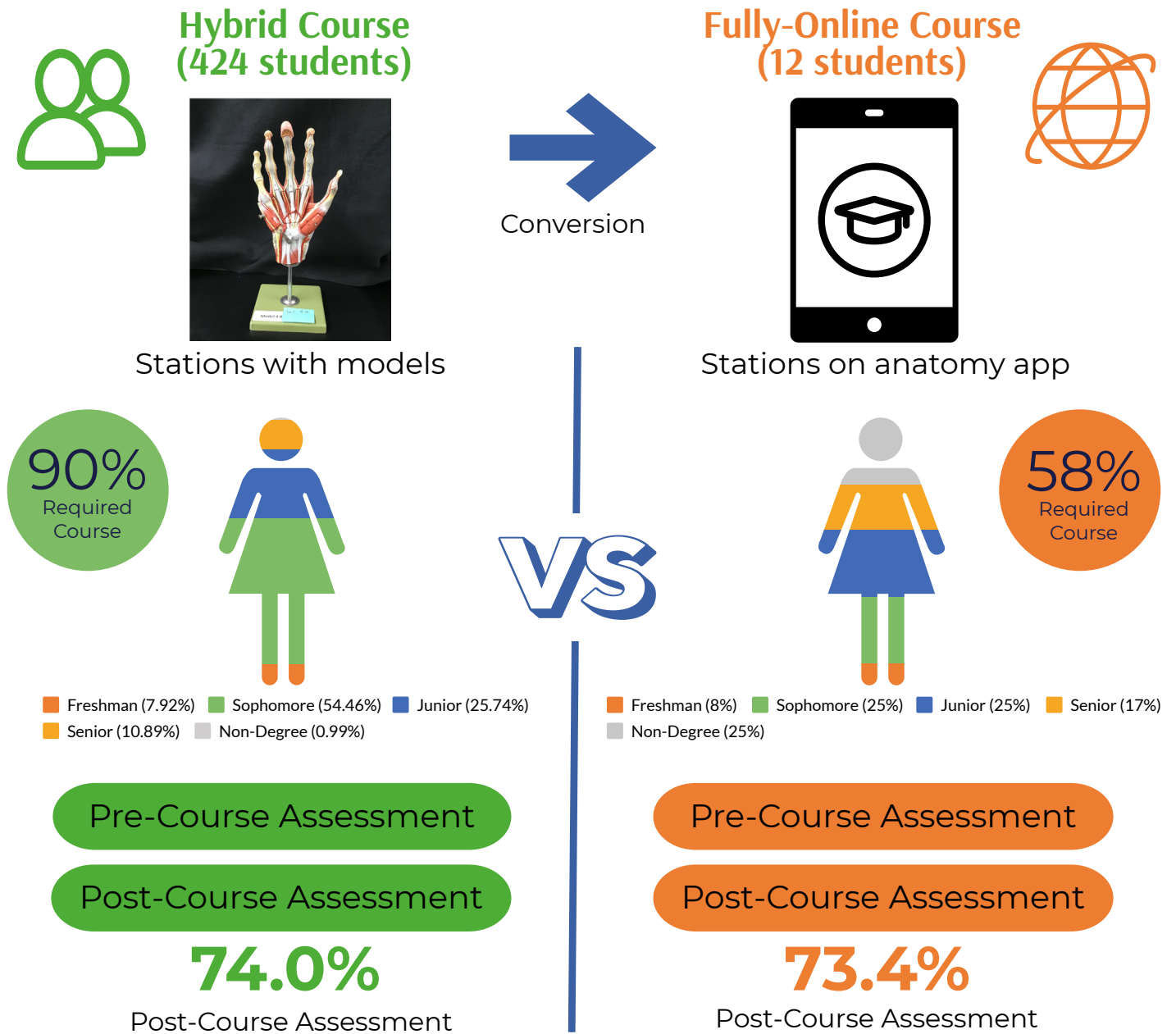
¹Dommeyer, C., P. Baum, R. Hanna, and K. Chapman. 2009. Gathering faculty teaching evaluations by in-class and online surveys: their effects on response rates and evaluations. *Assessment and Evaluation in Higher education* 29: 611-623.



The launch and evaluation of an undergraduate fully-online anatomy laboratory section

Cheryl Hill, Sean Greer, James Proffitt, Amanda Stafford

To meet demand for anatomy at the University of Missouri, an interdisciplinary team developed and implemented a fully online laboratory section to complement established hybrid laboratory sections. In this study, we analyze student performance and satisfaction in this course.



Results indicate similar outcomes in the hybrid and fully-online sections of anatomy lab at the University of Missouri. Further analyses will be completed after Fall 2020 with a large sample of fully-online students.

“True or False? Prove it!” Making Virtual Physiology and Pathophysiology Labs More Meaningful and Attractive to Students.

Laurent Legault and Michel Désilets, Faculty of Medicine, University of Ottawa
(mdesilet@uottawa.ca)

To complement didactic lectures, we incorporate virtual labs in 1st and 2nd year physiology and pathophysiology courses (blood/cardio/resp/renal topics). These labs were initially designed to simulate wet labs with data collection and interpretation. Although students recognized their added value, the overall appreciation was mitigated.

We undertook a new approach whereby students are presented with a list of statements, have to identify the false ones, and prove experimentally why they are wrong. Based on surveys given at the end of the session, this strategy significantly elevated students' appreciation of the labs ($p < 0.01$).

TIMELINE

Pre-assignment with tutorial

Download the program, play with it:
QCP: <http://hummod.org/>



First assignment :

To ascertain students' understanding of the tool while stimulating their interest.

Data collections from experiments reproducing the concepts seen in class.

Ex.: Give the values of body T° , MAP, PO_2 , pH, etc., at various time points before and during an exercise.



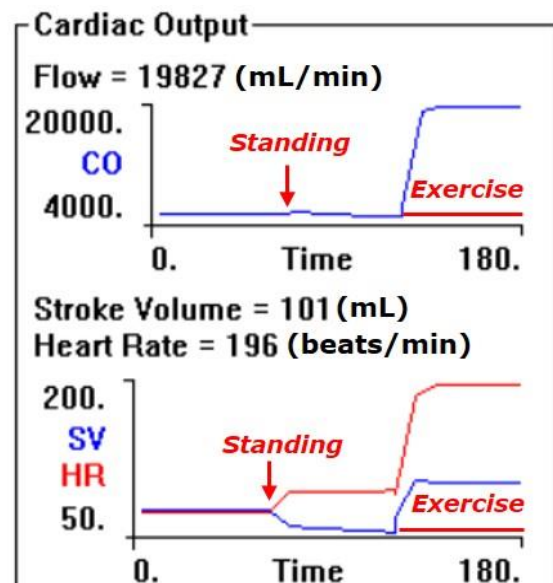
Self evaluation from the correct answers



**Subsequent assignments:
Experiment-based learning.
True or false? Prove it.**



Self evaluation from the correct answers



Examples of questions:

“Identify the following statements that are wrong, explain why, and perform the appropriate measurements that support your explanations.”

Conditions: 1h standing followed by 1h running on a treadmill at 12 km/h.

The exercise caused:

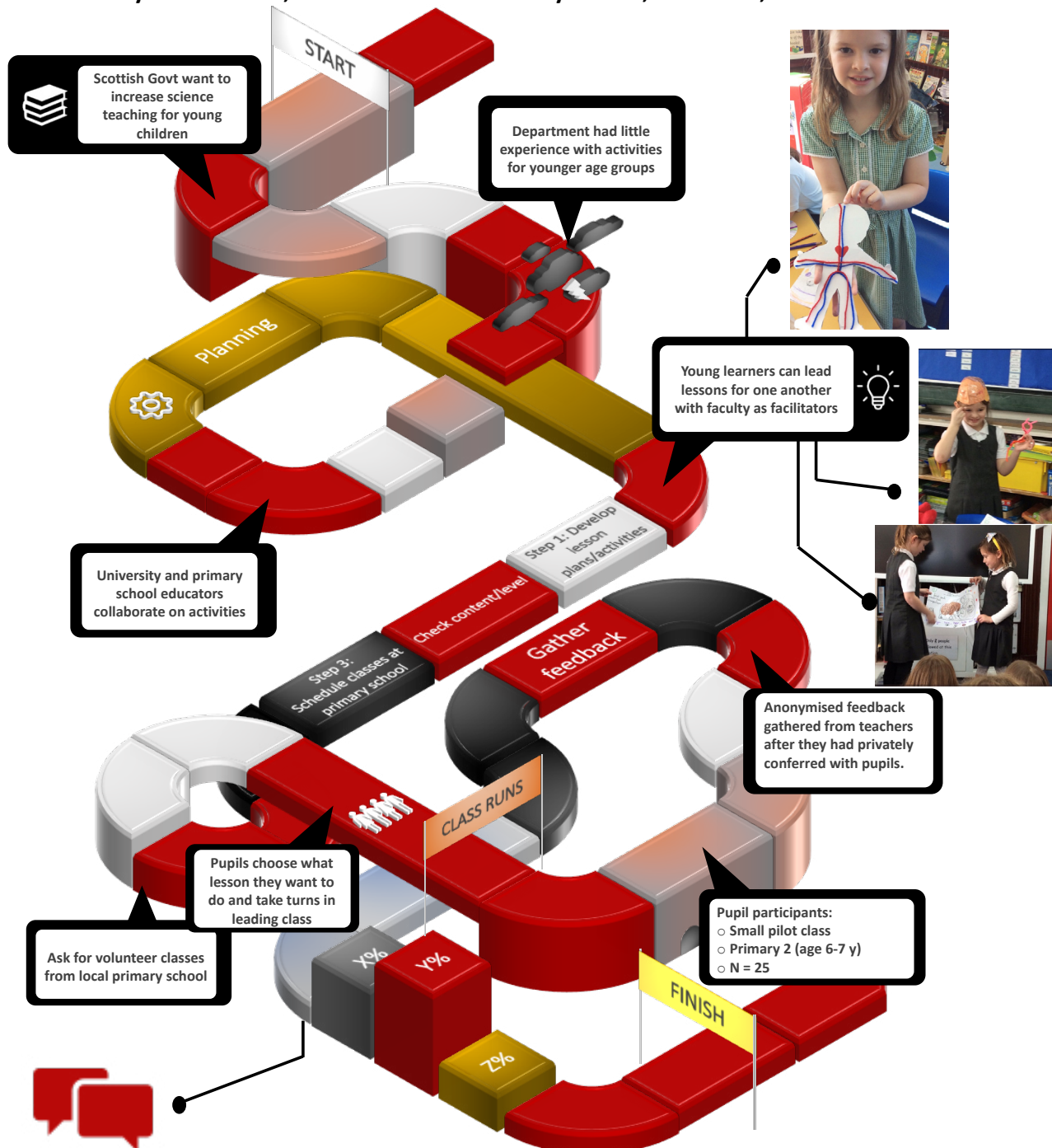
- 1: ... an increase in mean arterial pressure because of an increase in peripheral resistance.*
- 2: ... an increase in stroke volume because of an increase in cardiac contractility and an increase in cardiac preload.*
- 3: ... vasodilatation in muscles because of an increase in sympathetic activity.*
- 4: ... an increase in alveolar ventilation because of an increase in respiratory rate and an increase in tidal volume.*
- 5: ... a stimulation of the chemoreceptors because of a decrease in arterial PO_2 .*

(Answers: 1, 3 and 5 are false statements that the students had to identify, explain why and prove experimentally their hypothesis.)

Primary school children can take the lead in teaching anatomy and physiology to their peers

Fiona Murray, Claire Aitken* & Derek Scott

University of Aberdeen, UK & *Broomhill Primary School, Aberdeen, UK



“ after one student led the lesson others wanted to do similar activities”.

“very successful lessons”

“all of room 9 were very, very engaged during the pupil-led lesson about the brain”

“the pupil told the class about the brain and organised the other children into groups to complete activities”

“another fantastic pupil-led lesson about the heart, enjoyed by the whole class”

CONCLUSIONS & FUTURE WORK

Involving primary school students in biomedical learning activities can foster leadership, improve presentation skills, encourage pupil-led research and stimulate interest in anatomy and physiology at a very young age.

* permission granted from parents for images



Translational Anatomy of Degenerative Diseases & Developmental Disorders



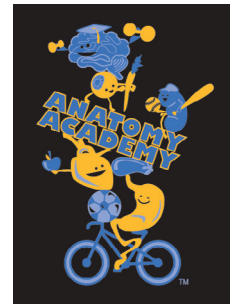
Impact of Service-learning Participation on Volunteers' Academic and Personal Development

Kevin S. Steed, Ph.D.¹, Chloe J.C. Read, M.S.², Jonathan J. Wisco, Ph.D.³



¹California Health Sciences University, College of Osteopathic Medicine, Clovis, CA 93611; ²Spectrum Academy, Pleasant Grove, UT 84062; ³Department of Anatomy and Neurobiology, Boston University School of Medicine, Boston, MA 02118

Service-learning is an immersive experience that provides academic and personal development for volunteer participants. For example, Mentors of Anatomy Academy, who reflected on their teaching experiences in an active learning environment, noted significant improvement in qualities of constructivism and the following significant learning cognitive frameworks: Learning how to learn, Caring, Human Dimension (Fink, 2003, 2013)

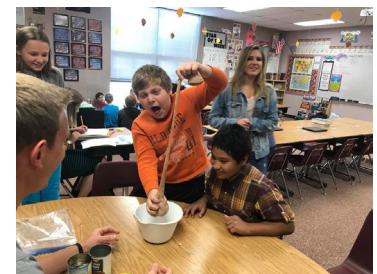


Learning How to Learn

"I have always liked to learn, but as I have continually gone through school my love for it has diminished with the stress of exams, projects, and just keeping up with everything. Working with the kids helped me remember how much I really do love to learn!"



"I feel a larger responsibility to be able to discern accurate information...because I know that I will need to respond truthfully to questions that my students may have. This motivates me to look at all sides of an argument when information is presented to me, so that I can discern the truth."



Caring

"My understanding [of anatomy] has changed because it's less about learning the material and more about applying it and sharing the knowledge with others so that they can apply these things in their lives, too."

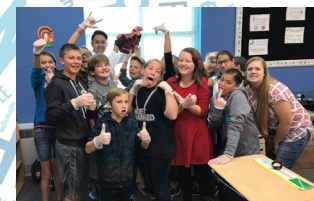
"I engaged [my students] by asking questions that were meaningful, and then found ways to apply the lesson to their lives through those questions."



Human Dimension

"Through teaching kids it helps you see the real life application of anatomy instead of just seeing it in terms that will help you do well on a test."

"Giving my students facts to remember is less helpful than teaching them to formulate questions and analyze data for credibility. This applies to me as well: I need to stay curious, and focus on the larger picture, because specific data can be easily looked up."



Through the process of teaching, Mentors learned skills that allowed a deeper connection with their mentees and realized that their resulting increase in knowledge applied directly to understanding real world issues. The simultaneous learning of skills and knowledge facilitated a journey toward life-long learning that is difficult to teach in conventional classroom environments.

Implementation of a Metacognitive Learning Strategies Session to Improve Students' Metacognitive Skills and Course Performance in Human Anatomy and Physiology

Chasity B. O'Malley, Kyla Ross, Kerry Hull, Olivia Page, Suzanne Hood, and Murray Jensen

Metacognition

AN UNDERSTANDING OF METACOGNITION AIDS IN DEVELOPING MORE EFFICIENT STUDY HABITS. WHEN STUDENTS TAKE AN INTEREST IN HOW THEY LEARN, THEY CAN IMPROVE ON THIS SKILL OVER TIME.



Students need a plan for success

WITH A PLAN, TIME SPENT STUDYING IS FOCUSED AND MORE EFFICIENT. THROUGH TEACHING METACOGNITION, STUDENTS GAIN THE APPROPRIATE TOOLS TO MAKE AND FOLLOW A STUDY PLAN.



Give specific examples

TO HELP STUDENTS WITH METACOGNITIVE LEARNING STRATEGIES, PROVIDE SPECIFIC EXAMPLES OF WHAT THEY SHOULD DO. FOR EXAMPLE, DEMONSTRATE HOW TO USE ACTIVE READING TO READ AN EXCERPT FROM THE CHAPTER.



Help your students help themselves

TO HELP STUDENTS IMPROVE THEIR STUDY STRATEGIES, THEY NEED GUIDANCE AND PATIENCE. STUDENTS WHO ARE STRUGGLING WILL BE RECEPTIVE TO WAYS TO IMPROVE THEIR PERFORMANCE IF THEY ARE PROVIDED WITH THE APPROPRIATE TOOLS. TIMING FOR DELIVERY IS IMPORTANT, AS WELL AS HOW MUCH YOU EMPHASIZE THE POWER OF METACOGNITION.



REGIS COLLEGE

BIOLOGY BOOTCAMP FOR INCOMING A&P STUDENTS

SHARI LITCH GRAY AND JEANNINE FOLEY



BACKGROUND

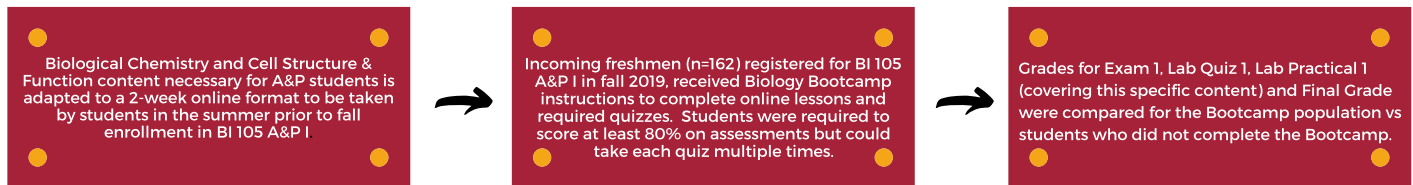
Biological foundations prior to studying human A&P is assumed yet many undergraduate programs do not require biology as a pre-requisite. Incoming A&P students often have no biology since early in high school making them less prepared to be successful in the content covered in A&P I.

PURPOSE

An online "Biology Bootcamp" was piloted in summer 2019 to review the Biological Chemistry and Cellular Structure/Function required in A&P.



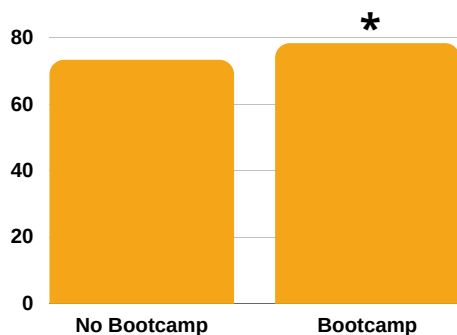
DESIGN



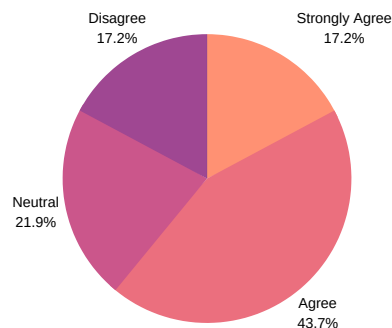
RESULTS

- Greater than 60% of survey respondents found the preparation helpful
- There was significant improvement in Lab Practical 1 scores ($P < 0.05$).
- While other graded assessments generally were higher in the Bootcamp group, the results were not statistically significant indicating a need to increase sample size.

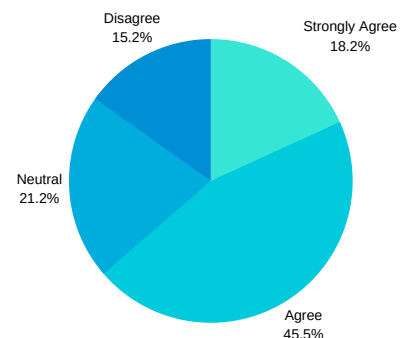
Lab Practical 1 Grades



Biological Chemistry Bootcamp was Helpful



Cell Structure/Function Bootcamp was Helpful



NEXT STEPS



Bootcamp study will be a regular component for all students in fall 2020 enrolling in BI 105 A&P I. Satisfaction Surveys and comparison of grade assessments will continue with the increased population group to further assess the effectiveness of providing Biological Chemistry and Cell Structure/Function content in a summer Bootcamp prior to beginning A&P I.



Regis College

When can Closed Captioning Enhance Student Learning from Educational Videos?

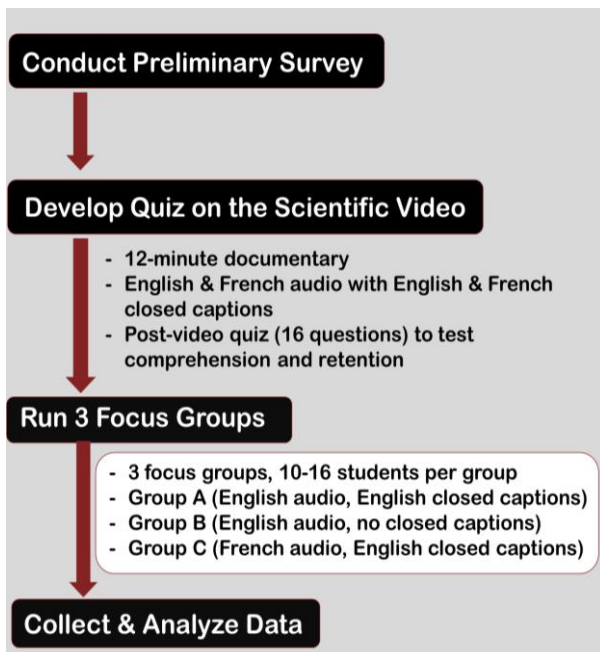
Jacqueline Carnegie, Catherine He & Magdalena Vuletic, University of Ottawa

Potential Advantages of Closed Captioning

- Allows a quality film to be available in another language
- Helpful for international students working in their second language
- Good for disciplines like anatomy that have complex terminology



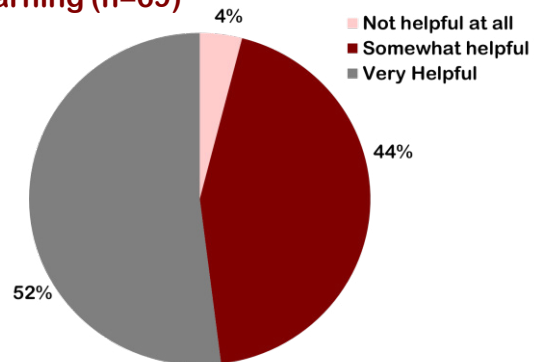
METHODS



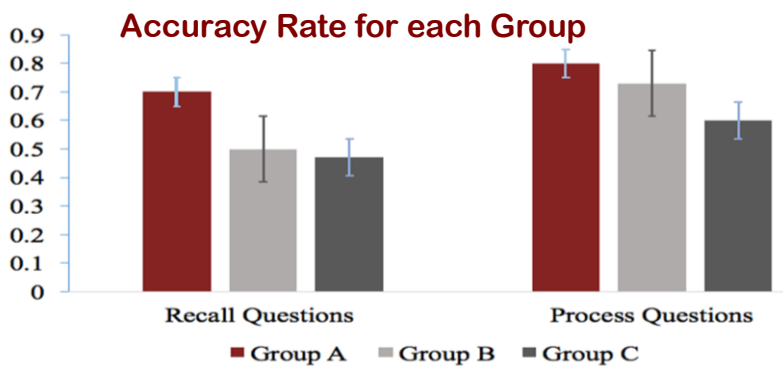
Results of online survey answered by 117 Anglophone undergraduate students

- 85% students were willing to watch videos with closed captions in their primary language.
- 83% students used videos with closed captions in an academic setting.
- 29% students indicated English as their second language.

Francophone students' assessment of ability of closed captioning to support their learning (n=69)



Anglophone focus groups were shown a 12-minute documentary video followed by a 14-question quiz with questions of two types: **Recall** (asking for a name, location, number, etc.) and **Process** (understanding).



Conclusions

- ❖ Survey data indicates that students (Anglophone and francophone) use closed captioning and find it helpful
- ❖ Focus groups suggest that closed captioning may help students capture and retain factual information

The Impact of Content Reinforcement on Physiological Knowledge Retention in Nursing Students.

**Raj Narnaware, Melanie Neumeier,
J. Claudio Gutierrez, Paul Chahal**



Background

There is growing concern over the loss of anatomical and physiological knowledge in medical, allied-health & nursing students over time. Numerous studies have demonstrated the difficulty of the students in these disciplines to retain and apply anatomical knowledge as they progress through their programs of study (Narnaware and Neumeier, 2019). However, physiological knowledge retention has not been studied as extensively as anatomical knowledge retention in health care disciplines, with very few studies focusing on nursing students (Aari et al., 2004). Of those studies, most are carried out after graduation (Aari et al., 2004), or are focused on a single or limited number of organ systems (Pourshanazari et al., 2013). We have previously shown that physiology students retained approximately 86.6% of their first-year physiological knowledge over four months (Narnaware et al., 2020).

Objectives

To improve the acquisition and retention of physiological knowledge, the present study aims to develop an interventional strategy that includes the repeated assessment of vascular physiology knowledge over an eight-week period.

Methods

Nursing students were quizzed on vascular physiology using the on-line quizzing system Kahoot. Each Kahoot quiz included 9-11 knowledge and comprehension level multiple-choice questions, and new sets of questions were used for each week's Kahoot quiz. Data were statistically analyzed using SPSS II, and means were compared using 2-sample t-tests. The scores are described as the mean and standard deviation (SD). Statistical significance was set at $P \leq 0.05$ for all tests.

Results

Compared to week 1, repeating knowledge of the vascular physiology yielded a significantly higher ($P < 0.05$) knowledge retention at week 2 (8.3%). However, this retention was highest at weeks 3 (16.0%) and weeks 4 (21.6%), $P < 0.001$, with less significant improvement ($P < 0.05$) at week 6 (13.3%) and week 8 (13.6%).

Discussion and Conclusion

The present study shows that repeated knowledge assessment can significantly improve knowledge retention of vascular physiology in nursing students, and agrees with previously reported studies in medical students (Pourshanazari et al., 2013). Therefore, content reinforcement should be used as one of the interventional strategies to improve knowledge retention in nursing students, and further research should be conducted to explore effective ways to maintain increased retention over longer periods of time.

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Modifiers to Success in a Large Human Anatomy Classroom

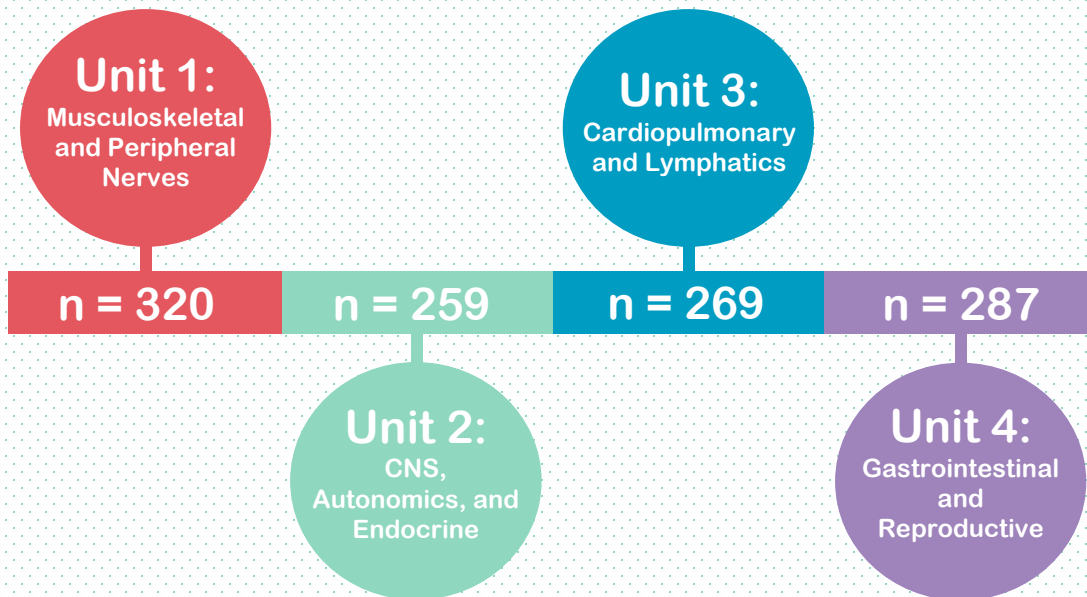
Ryley Mancine OMS-III, Nicole Geske PhD, Lindsey Jenny PhD

This project was completed at Michigan State University in the Fall of 2019.

On the survey, students were asked about study methods, hours of sleep, help-seeking behavior, degree of confidence on each exam, and if they had been exposed to the subject in the past.

A total of 1,135 responses to a survey were collected in a large, lecture-style Human Anatomy classroom. Questions remained constant on each survey, and students took a survey just after the exam for each unit.

Surveys responses were compared with unit exam scores and overall class grades.



Four main factors were strongly correlated to classroom success:

Sleep

In two of four units, sleep was significantly correlated with increased exam performance ($p < 0.05$).

Confidence

In all four units, confidence was significantly correlated with increased exam performance ($p < 0.05$).

Participation

In all four units, in-class participation was significantly correlated with increased exam performance ($p < 0.05$).

Homework

Homework performance was significantly correlated to whole-class final grade ($p < 0.05$).

Promoting Student Success: Splitting Laboratory Sessions and Employing Tablets in the Lab

Sheri C. Chisholm, Ph.D.



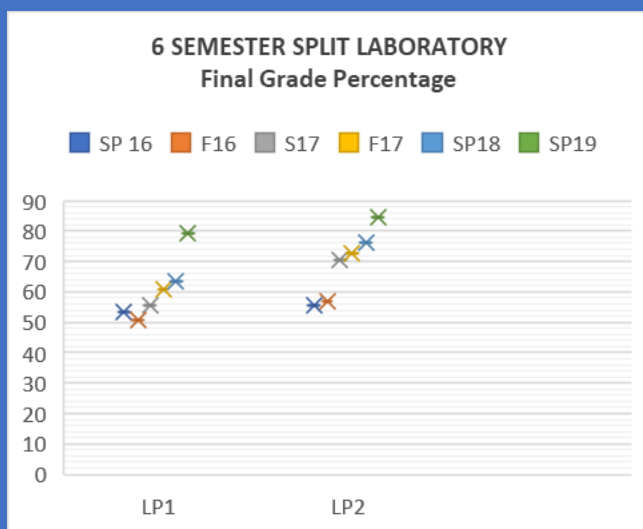
The Challenge

The difficult challenge for the student has been learning the large amount of information required to obtain mastery of the content area.

Strategy 1: split the traditional three-hour lab per week into two 1.5 hour labs per week.

Strategy 2: the introduction of tablets into the lab that utilize an interactive visualization software utilizing the split lab in Strategy 1. These were purchased through grant funding.

STRATEGY 1



Course Assessment Student Evaluation Comments:

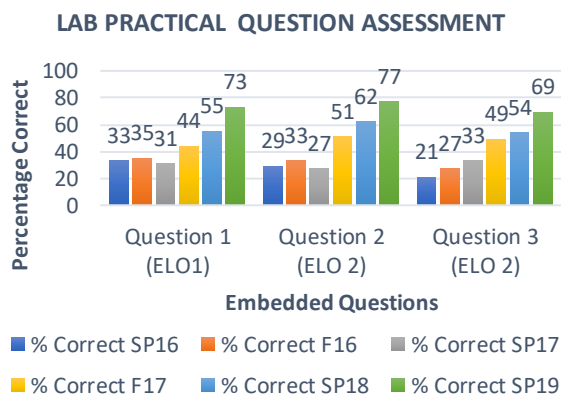
- *It is much easier for me to concentrate having the lab split in half.
- *I don't get tired and seem to retain the information better.
- *I really like it and feel more successful.
- *I think I learned more.
- *I didn't think I would like coming to lab twice a week, but I have really enjoyed it and feel like I learned a lot.



NEXT STEPS

The use of both strategies has provided very positive outcomes for the students. The strategies will be continued and expanded upon to include the identification of further funding to purchase a tablet for each student in the lab and continued course level and program level assessment measures.

STRATEGY 2



ELO – Expected Learning Outcomes (HAPS)

- Question 1:** Identify the individual bones and their location within the body.
- Question 2:** Explain the sliding filament theory of muscle contraction.
- Question 3:** Explain how an electrical signal from the nervous system arrives at the neuromuscular junction.

Course Assessment Student Evaluation Comments:

- *The tablets are awesome!
- *They made the lab lots more fun and gave us another way to learn the material.
- *I liked using it because if you (instructor) were busy with someone else, I was able to figure it out on my own easier.
- *It is a really great resource. Thank you for getting them for us.
- *I wish there were more of them so we didn't have to share 4 students to one tablet, but they were great!

“Increasing the Retention Rate in Human Anatomy and Physiology I: A Return to Old School Methods”

Howard K. Motoike, Ph.D.

Department of Natural Sciences, La Guardia Community College (CUNY)
31-10 Thomson Avenue, Long Island City, NY 11101

Human Anatomy and Physiology I at LAGCC has consistently shown a low retention rate (47%) finishing with very low student numbers (11) of sections that started with twenty-four students. Interestingly, students that complete all the lecture and lab exams have a respectable lecture average of 78% (Fig. 1). I report here the effect of going back to old school methods of assigning lecture homework to increase student retention. A total of 13 homework assignments was given during the 12-week semester. The homework consisted of one page of short answer questions comprehensively covering each lecture. The average of the 12 highest homework assignments replaced the second lowest quiz score worth 6% of the course grade. The homework assignments was used in 4 sections of SCB-203 during the Fall I 2018 and 2019 semesters. All lectures were taught by Professor Motoike. The incorporation of homework assignments into the curriculum increased the retention rate from 47% to 66% demonstrating the impressive role of a simple homework activity (Fig. 2).

Fig.1 Fall I 2019 SCB-203 Lecture Course Average (N = 36 ± SE)

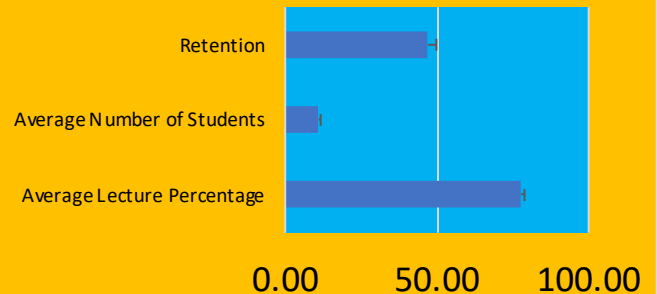


Fig.2 Homework Assignments Increased Student Retention Compared to Fall I 2019 Sections

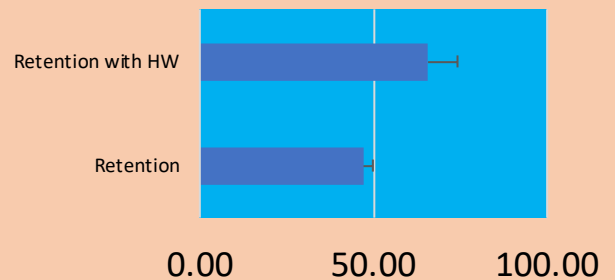
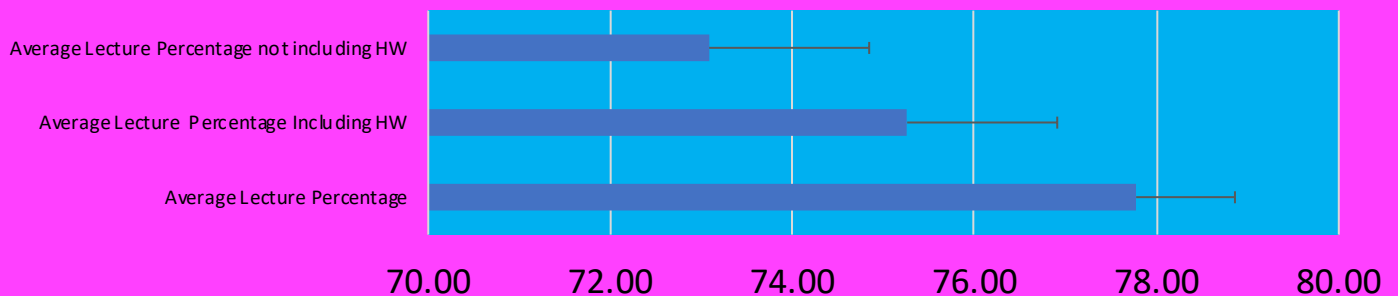


Fig.3 Homework Assignments Did Not Inflate Grades Compared to Fall I 2019 Sections



These results demonstrate that the use of short, relatively easy assignments was sufficient to encourage students to study more on a routine basis well in advance of the quizzes and exams. The incentive to do the homework was minimal and only increased lecture grades by 2% (Fig. 3). The top bar and middle bar represents the average lecture grade without and with the inclusion of the homework scores in place of the second lowest quiz. Thus, I was able to increase retention in a very rigorous course without the inflation of course grades and expensive digital platforms.

Using analogies to help first year A&P students visualize and better comprehend challenging concepts

Joanne Savory & Jacqueline Carnegie
 Department of Cellular and Molecular Medicine
 University of Ottawa, Ottawa, ON



- Understanding abstract concepts is important to learning human anatomy and physiology
- Students learn by moving from the known to the unknown
- Analogies help students grasp abstract concepts by relating them to their known experiences



- Saves time
- Speeds up understanding
- Reduces student frustration
- Helps students visualize concepts

PHYSIOLOGICAL CONCEPT ATP as the body's energy currency



- A ten-dollar bill as paper money is useless in a coin-operated washing machine.
- Converting the ten-dollar bill into coins does not change its value, rather it simply transforms the paper money into a form the machine was designed to recognize.
- In the same way, cells cannot directly use nutrients as energy sources but must first convert the nutrients into ATP –the form of energy used by the cells.

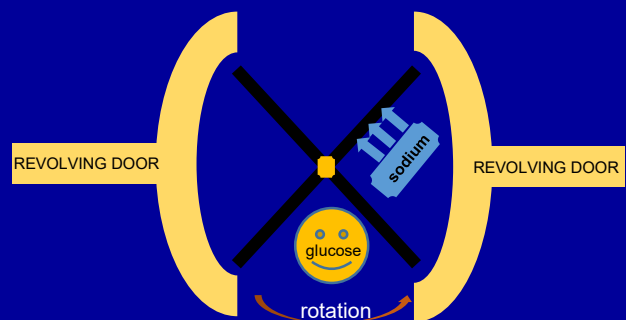
'One good analogy is worth three hours discussion'

-Dudley Field Malone

PHYSIOLOGICAL CONCEPT

- Secondary Active transport

Analogy: Revolving door



- The movement of sodium ions down their concentration gradient is likened to pushing the door.
- Glucose uses the rotation of the door created by sodium to piggyback into the cell

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