ILLUMINATIONS

Implementation of an authentic learning exercise in a postgraduate physiology classroom setting

© M. Faadiel Essop
Centre for Cardio-Metabolic Research, Department of Physiological Sciences, Faculty of Science, Stellenbosch University, Stellenbosch, South Africa

Submitted 8 May 2020; accepted in final form 19 June 2020

authentic learning; cooperative learning; critical thinking abilities; postgraduate students; problem solving skills

INTRODUCTION

Physiology students are often required to engage with substantial amounts of subject content. Although it is essential for students to meaningfully engage with subject content, high loads can lead to the rote-type memorization of facts as their preferred mode of learning. Such behavioral patterns can be further embedded by lecturers that largely adopt passive teaching methods, often reducing students to mere spectators within the classroom setting (4). Of concern, this approach is unlikely to help realize the graduate attributes that are typically espoused and desired by contemporary tertiary institutions. For example, at Stellenbosch University (Stellenbosch, South Africa), graduates are expected to possess attributes that include the following: an enquiring mind, critical and creative thinking, leadership and collaboration, problem solving, and an innovative outlook. The current teaching and learning practices may also be frustrating for Generation Z students (born: 1995–1999, current university cohort) as they possess a relatively limited attention span during lengthy lectures and also display a strong need for social interactions. Moreover, they exhibit a preference for critical-thinking and problem-solving tasks, are reflective and independent learners, prefer group and collaborative work, and enjoy the ability to express opinions in groups and discussions (9). Hence, Generation Z students are more likely to be engaged by active teaching and learning methodologies that aim to promote and establish such abilities and skills (3, 4).

A major concern is, therefore, the resultant disconnection between the acquisition of decontextualized subject content and stipulated requirements for the development of critical/creative skills and problem-solving abilities. This disconnection may result in downstream effects, e.g., graduates are increasingly struggling to find employment as more employers are searching for individuals who display problem-solving and critical-thinking abilities to help address real-world problems (11). These employment requirements are expected to accelerate as such scarce skills will be in high demand during the Fourth Industrial Revolution (12). Active approaches, such as authentic learning, offer promise to address this disconnection as it focuses on the idea of learning in contexts that promote real-life applications (10). Resnick’s seminal work (8) on authentic learning highlights this notion, i.e., “When learning and context are separated, knowledge itself is seen by learners as the final product of education rather than a tool to be used dynamically to solve problems.” Thus students can be better engaged by customizing the subject content, and a constructivist approach can be adopted to derive meaning and to conceive appropriate solutions. Moreover, collaborative activities and the exploration of different perspectives also form a crucial part of the authentic learning methodology (5). In light of this, we introduced an authentic learning exercise to Physiology Bachelor of Science (Honors) [BSc (Hons)] students at Stellenbosch University (Stellenbosch, South Africa) to begin bridge this disconnection and to also assess the feasibility of its implementation. Here an effort was made to align the exercise to four previously identified criteria for authentic learning when investigating a realistic problem(s): 1) investigate the problem with a personal context; 2) devise an open-ended problem with no prescribed solutions; 3) aim to change actions and behavior with the identified solutions; and 4) focus the problem on a real group outside the classroom (7, 10).

Implementation

The authentic learning exercise was introduced to the BSc (Hons) class of 2019 in the Faculty of Science (n = 19 students) as part of their 3-wk cardiovascular physiology/pathophysiology theory module. Such students enter the Honors program at Stellenbosch University after completing a 3-yr BSc degree with Physiology as one of their majors (as part of the Human Life Sciences program). The third-year BSc physiology classes usually consist of ~250 students, of which ~80–90 apply for entry into the BSc (Hons) (Physiological Sciences) program in the Faculty of Science. The final BSc (Hons) class usually consists of ~20–25 of students. During their undergraduate years, the students complete all of the physiological systems of the human body. This foundation is further strengthened during their Honors year with the completion of several taught modules on physiological systems of the human body, each lasting 3 wk, and also by completion of a small laboratory-based research project.

Here there were 3 × 2-h class sessions available for teaching and learning activities over the 3-wk period. For the previous year, the 3-wk module program included the following: 1) lecture on cardiovascular physiology (basics); 2) lecture/synopsis on different cardiovascular diseases (CVD); 3) ischemic heart disease discussions on research articles read beforehand by the students; 4) lecture on the regulation and control of the circulatory system; 5) two sessions in which students worked...
on case studies in small groups (n = 3; focusing on module content covered) and shared their respective answers with the rest of the class; 6) two sessions in which small groups (n = 3) delivered a formal PowerPoint presentation, i.e., a synopsis of research articles (on subject content covered in module) to the rest of the class; and 7) small groups (n = 3) designing posters (on subject content covered) and formally presenting these to the rest of the class. This module outline was largely followed during the preceding years, and students generally found it useful and also interesting to some extent. However, there remained a sense that 1) the module content did not connect well enough to real-life problems, 2) it lacked a “golden thread” running throughout the entire module, and 3) students were still not engaged enough to employ creative and problem-solving skills to devise appropriate solutions for real-life problems.

A modified approach was, therefore, adopted for the 2019 class by implementing an authentic teaching and learning intervention. In this instance, the first two slots of the module were employed to complete a general lecture on the basics of cardiovascular physiology. This was followed by a class discussion where students were invited to freely think of lifestyle-related CVD risk factors that would affect the ~30,000 students at Stellenbosch University. The lecturer acted as a facilitator, and care was taken to ensure there was a “bottom-up” generation of information by the students themselves. This session extended for quite some time until the lecturer noted down all of the identified risk factors on a whiteboard in the classroom. After further discussion and refinement, the students identified the following six lifestyle-related CVD risk factors (in no particular order) as the most applicable for the Stellenbosch University campus: substance abuse, sleep deprivation, alcohol consumption, stress, diet (sugar, fat, caffeine, energy drinks), and smoking/vaping.

The module thereafter proceeded as follows: 1) lecture on CVD; 2) three lectures on vascular dysfunction; 3) two case study sessions by groups and then sharing their findings with the rest of the class; 4) two formal PowerPoint presentation sessions by groups to the class; and 5) formal, group poster presentations to the rest of the class. Students were also provided with a module “roadmap” during the second lecture and were instructed that teaching and learning activities would focus on the identified CVD risk factors (Fig. 1). Thus lectures, presentations, and posters always included a strong reference to the identified risk factors. The only exception was the case study sessions, which were designed to strengthen basic cardiovascular physiology concepts and critical thinking. The students were requested to freely form small groups of three, except for one group that consisted of four individuals due to the uneven number of persons in the class. The groups remained together for the entire duration of the cardiovascular physiology/pathophysiology module. Of note, the number of lectures and time available for the 2019 module were exactly the same as for previous years. Students were informed that the breakdown of marks for assignments was as follows: case study presentations: 10%; vascular dysfunction essay: 15%; formal presentations: 10%; poster presentations: 15%; and integrative essay: 50% (Fig. 2). No ethical approval was required for this study, as only class-derived information was used to draw conclusions.

Vascular dysfunction essay. Students were instructed to write an essay focusing on a number of different cooking oils/fats (e.g., sunflower oil, olive oil, ghee) used to prepare meals and to discuss its impact on vascular function. Thus the essay emphasized links between dietary intake and CVD onset.

Case studies. For this exercise, 75 min were available to tackle three case studies per session (refer to examples below). There was an allocation of 25 min per case study, and each group was instructed to complete all three case studies within the allotted time. Here students could access the internet for the first 5 min, after which they were instructed to switch off and put away all cell phones and laptops. The focus of this exercise was on basic cardiovascular physiology, integration of interorgan signaling, and to enhance critical-thinking abilities. During the 25-min slot, each group then discussed the respective case study, while the lecturer and several postgraduate students rotated through the class to act as sounding boards and engage with the students in a Socratic manner. At the end of each 25-min slot, each group presented its findings to the class and were expected to respond to various questions posed by the lecturer and/or classmates.

CASE STUDY 1. The astronaut Mark Watney (the one stranded on Mars) has just returned to earth after spending 8 mo in the International Space Station. What problems, in terms of his

![Fig. 1. Roadmap for the 3-wk cardiovascular physiology/pathophysiology module with the six lifestyle-related risk factors for cardiovascular diseases (CVD) as identified by Bachelor of Science (Honors) students.](advan_89005_f1_1.png)
cardiovascular system, do you think he has acquired by being in a zero-gravity environment? How could these changes impact on his cardiovascular system when back home?

CASE STUDY 2. Caster Semenya is recovering from her record-breaking 800-m run at the Olympic Games. Focusing on her cardiovascular system, describe the mechanisms involved in her body returning to a resting state after being in such a highly stressful and exerting situation.

CASE STUDY 3. Queen Daenerys Targaryen has lived in the Dothraki Kingdom most of her life. However, she suffers a midlife crisis and now he wants to be a deep sea diver, despite having had a heart attack last year. What do you think will happen to her cardiovascular system when she dives deeply into the cold waters of the Dothraki Sea? What potential side effects can she suffer as a result of his latest adventure (bearing in mind her history of CVD)?

Presentations. Each group focused on a single risk factor and completed a 9- to 12-min talk to the rest of the class that was followed by questions. Every group member was required to make a contribution of 3–4 min each. The briefing was to present their message in no more than five or six slides, and that was centered on the generation of a key, integrative master type of figure.

Posters. The class was initially briefed on how to make a successful poster, after which the exercise was tackled by the respective groups. As before, each group focused on one lifestyle-related CVD risk factor for its respective posters, but that was different from the risk factor discussed for their presentations. The posters were presented (10 min) in a “virtual” format (PowerPoint file) and projected onto a whiteboard screen. This was followed by 10 min of questions.

Integrative essay. This task was made available to the students at the start of the module to allow them to continuously work on it and to be able to access useful information, and gain insights, from the different teaching and learning activities tackled over the 3-wk period. The focus of the essay was as follows: the potential impact of major cardiovascular diseases risk factors on Stellenbosch University students in terms of their overall health and well-being. Students were informed to structure it as follows:

1. Background regarding the identification of lifestyle-related CVD risk factors at Stellenbosch University. They were instructed to talk to at least one fellow student regarding one (or more) of the identified risk factors. This was done to better sketch the background problem(s) within the local context and also with their recommendations.

2. Individually discuss the physiological/pathophysiological impact of chronic usage/exposure of every risk factor in terms of CVD onset.

3. Construct a unique diagram that integrates/synthesizes the impact of all six risk factors on CVD onset, showing common and distinct pathways. At the end of this section, they were required to make key, overall conclusions regarding the risk factors and its impact on Stellenbosch University students in terms of CVD onset in the short and long term.

4. Propose three practical and feasible recommendations to the Rector on how to help address such problems at Stellenbosch University.

5. Propose three practical and feasible recommendations to help Stellenbosch University students to begin to address such problems.

The lecturer also indicated early on during the module that the proposed solutions would be collated and refined and then

![Diagram]

Fig. 2. Synopsis of previous years’ Bachelor of Science (Honors) cardiovascular (CV) modules vs. the new approach adopted for the 2019 class. For the previous modules, the lecturer determined the course content and attempted to cover as much as possible by employing the various teaching and learning activities. Here, the students’ focus was on various assessments and a major class test that was tackled at the end of the module (refer to left-hand blocks). For the new approach, the students identified various CV disease (CVD) lifestyle-related factors, and, thereafter, all of the teaching and learning activities, assessments, and societal impact efforts were aligned with this focus (refer to right-hand blocks). The knowledge created by the students was thus shared with the Rectorate with the aim to result in changes on campus.
be formally submitted to the university’s Rectorate for consideration.

Assessment criteria. The major criteria employed for assessment included the following: 1) quality and accuracy of answers, 2) successful integration, 3) creative abilities, 4) depth of understanding, 5) critical-thinking and problem-solving strengths, and 6) the quality of their responses to questions posed. The students were strongly encouraged to pose critical and challenging questions to their class mates during the presentations, poster, and case study sessions. Students were also required to grade the various tasks (lower weighting than presentations, poster, and case study sessions. Students were also required to grade the various tasks (lower weighting than lecturer), but excluding the two required essays.

DISCUSSION

The authentic learning exercise was relatively easy to implement within a small class setting. The initial discussion involved some risks, as it was not clear which lifestyle-related factors the students would identify and whether some would be too outlandish in terms of the module’s stated outcomes. However, this was not a major concern, as the students not only embraced the exercise, but also came up with a highly relevant and appropriate list of CVD risk factors. During this session, several students also shared, in a general sense, anecdotes (anonymously) of alcohol consumption and substance abuse by others at Stellenbosch University. Here it emerged that relatively high workloads, demands, and expectations placed on students resulted in increased stress, and that this was likely a significant underlying reason for several of the risk factors identified. In terms of the lecturer’s workload, this increased to some extent as the shift in focus required the course content to be reoriented to link it to the identified risk factors. However, this was manageable and did not at any stage become a major burden in terms of time and effort required. DiCarlo (2) also stressed that lecturers should not worry about “wasting” or “losing” lecturing time when replacing it with class discussions and problem-solving-type exercises. Thus the operational framework employed meant that: 1) students were provided with the necessary tools to access information, 2) the lecturer always tried to excite them to critically engage with the authentic learning exercise, and 3) the students were continuously encouraged to expand their critical thinking abilities to solve the questions posed (2, 6).

The students enjoyed the nature of the exercise and especially its relevance and applicability. For example, during the first session, they were quite enthusiastic about the idea and vigorously debated which risk factors actually applied to the Stellenbosch University context. This attitude was consistent throughout the module as students increasingly expected their class mates to adequately respond to their critical viewpoints and questions. The students were also excited at the possibility that their solutions would be shared with the university’s Rectorate. This is in agreement with Cunliffe’s position (1) that “from this perspective, teaching focuses on enabling students to think more critically about themselves, their assumptions, actions, and situations they encounter.” Moreover, the approach adopted subscribed to the idea that teaching is about fostering learning that is transformative and that can eventually lead to social change (1).

Informal discussions with the students at the end of the module revealed that they valued the following aspects: interactive classes, integrative aspects, relevance of the work, practicality and applicability of knowledge, degree of engagement, and the excellent and regular feedback provided. They also indicated that higher order skills, such as critical-thinking and problem-solving abilities were strengthened by the authentic learning exercise. In terms of criticisms, the students indicated that the workload was in the medium-high range, and some suggested that the integrative essay should only cover four instead of all six risk factors. Others indicated that they would appreciate clearer instructions regarding the depth of information required for the integrative essay. Both of these suggestions can be relatively easily implemented in future authentic learning exercises of the same nature.

After the completion of the module, the various recommendations made by the students were collated and refined by the lecturer, who subsequently drafted a summary to be submitted to the Rectorate. This draft was thereafter sent to the students for feedback and approval before it was submitted (by the lecturer) to the university’s Rectorate, which included the Rector and Vice-Chancellor; Vice-Rector: Learning and Teaching; Vice-Rector: Research, Innovation, and Postgraduate Studies; Vice-Rector: Social Impact, Transformation, and Personnel; and Vice-Rector: Strategy and Internationalization. An extract of some of the solutions submitted included:

1. Launch a student survey. Stellenbosch University should launch a detailed survey to better identify the scale and prevalence of the six identified risk factors on campus. This can be followed up at regular intervals to assess progress made following the various interventions suggested below.

2. Student stress is a major problem that should be immediately tackled. The student problems regarding excessive alcohol consumption, drug abuse, and smoking often stem from stress as the root problem. Stress and time management courses/workshops could be offered free of charge at residences and in the Neelsie Student Center. In addition, the university should consider establishing a facility on campus called BeWell@Stellies that will serve as a mental health and wellness center. The center would feature audio and video instruction on a variety of topics, including relaxation, sleep issues, and healthy lifestyle behaviors. Professionals would also provide individual services, such as stress management and time management courses.

3. Increased availability of cost-effective healthier foods on campus. The university should create an app for healthy living for students and include, e.g., information regarding dining choices on campus, nutritional information listed for each food vendor’s menu, tips for healthy living and well-being, and also ways how best to achieve this.

4. Create a smoke-free campus. This involves creating a university policy that prohibits smoking on campus grounds and areas where individuals congregate. This policy should also be strictly enforced on campus and within the various residences. There may initially be designated smoking areas that limit the risk of second-hand smoke exposure to others and facilitate the transition from a smoking to a nonsmoking campus.

5. Address the drinking problem. Attempt to reach an agreement to close nightclubs and local drinking pubs at an earlier time. As alcohol consumption is primarily a social
activity, students may be persuaded to drink less if the clubs close earlier (e.g., midnight) and the social events do not end very late at night. This would require an initiative where the university and clubs/pubs work eventually together to achieve this goal. The university should launch a program aimed at decreasing high-risk drinking behaviors and regulating drinking culture among the students. This could include fun challenges and activities, such as an “Alcohol-free April” or “Alcohol-free August” months where students can participate and hold each other accountable as they try to wean themselves off regular drinking.

The Vice-Rector: Learning and Teaching responded by email to the lecturer by stating: “Thank you for sharing this study of your students with us. We shall explore the many practical suggestions within Student Affairs. I will have a discussion with our senior director tomorrow, whom I copy on your document.” In addition, the Vice-Rector: Research, Innovation and Postgraduate Studies responded a few days later and commented that the students’ responses were “insightful.”

The implementation of the authentic learning into a relatively small postgraduate Physiology class is, therefore, feasible and was adopted with enthusiasm by the students. The final marks for the module were roughly similar compared with the previous year, but the class of 2019 strongly indicated that they felt their higher order learning skills were substantially enhanced. However, there was no quantitative assessment as to whether the creative-thinking and problem-solving abilities of the students actually improved, and this should certainly be evaluated in the future. Of note, Stellenbosch University earlier this year instituted a temporary alcohol ban in student residences, and hopefully the solutions provided by the BSc (Hons) class played some part in this decision.

ACKNOWLEDGMENTS
Thanks to Dr. J. P. Bosman (Stellenbosch University) for providing useful suggestions regarding the completion of this manuscript.

DISCLOSURES
No conflicts of interest, financial or otherwise, are declared by the author.

AUTHOR CONTRIBUTIONS
M.F.E. conceived and designed research; prepared figures; drafted manuscript; edited and revised manuscript; approved final version of manuscript.

REFERENCES
1. Cunliffe AL. On becoming a critically reflexive practitioner. J Manage Educ 28: 407–426, 2004. doi:10.1177/1052562904264440.
2. DiCarlo SE. Too much content, not enough thinking, and too little fun! Adv Physiol Educ 33: 257–264, 2009. doi:10.1152/advan.00075.2009.
3. Essop MF, Beselaar L. Student response to a cooperative learning element within a large physiology class setting: lessons learned. Adv Physiol Educ 44: 269–275, 2020. doi:10.1152/advan.00165.2019.
4. Goodman BE, Barker MK, Cooke JE. Best practices in active and student-centered learning in physiology classes. Adv Physiol Educ 42: 417–423, 2018. doi:10.1152/advan.00064.2018.
5. Herrington J, Reeves TC, Oliver R. A Guide to Authentic eLearning. New York: Routledge, 2010.
6. Lujan HL, DiCarlo SE. Humor promotes learning! Adv Physiol Educ 40: 433–434, 2016. doi:10.1152/advan.00123.2016.
7. Renzulli JS, Gentry M, Reis SM. A time and a place for authentic high-end learning. Educ Leadersh 62: 73–77, 2004.
8. Resnick LB. Learning in school and out. Educ Res 16: 13–20, 1987.
9. Rothman D. A Tsunami of Learners Called Generation Z (Online). https://mule.net/Journal/A_Tsunami_of_Learners_Called_Generation_Z.pdf [5 May 2020].
10. Rule AC. Editorial: The components of authentic learning. J Authentic Learn 3: 1–10, 2006.
11. Trudeau S, Omu K. Are graduates prepared for the job market? Rethinking Africa’s university model. The Conversation, September, 2017. https://theconversation.com.Are-graduates-prepared-for-the-job-market-rethinking-africas-university-model-83108 [5 May 2020].
12. Xu M, David JM, Kim SH. The fourth industrial revolution: opportunities and challenges. Int J Fin Res 9: 90–95, 2018. doi:10.5430/ijfr.v9n2p90.