Relating human physiology content to COVID-19: a strategy to keep students in touch with physiology in times of social distance due to pandemic

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Abstract

In 2020 universities had to quickly implement remote education alternatives as a result of the social distancing due to the COVID-19 pandemic. To keep students engaged with the university, we implemented a teaching-learning model that relates physiology contents to the COVID-19 pandemic using online educational platforms. A 1-mo web course was proposed for health sciences students from the Federal University of Pampa. It included synchronous meetings twice a week and asynchronous activities using scientific articles, case studies, and interactive online tools. The students approved the methodology developed, assessing it as dynamic and innovative. They reported that the activity helped to better understand the relations between COVID-19 and physiological systems. The web course also contributed to the identification of reliable sources of news and stimulated the sharing of scientific content with their families. We concluded that the use of online platforms contextualizing the physiology content considering current events helps students in learning human physiology and improves their abilities to apply this information to their daily life, in this specific case, regarding the COVID-19 pandemic.

INTRODUCTION

On January 30, 2020, the World Health Organization (WHO) registered the disease COVID-19 as a public health disease of international importance. A couple of weeks later, on March 11, 2020, COVID-19 was characterized by the WHO as a pandemic (1). The impact of the COVID-19 on humans and society, most of them not yet clearly determined, required adaptations in the daily routine, and the effects of the disease increased the interest in understanding how COVID-19 affects the physiological systems.

The education also required adaptations due to the pandemic, and the need for a change in the approach to the classes was revealed to be a challenge. Despite the growing literature proposing new ideas and teaching methods, even in face-to-face teaching, the changes observed are still timid; traditional practices with a focus on expository classes and memorization of concepts still are persistent in academia (2). The teaching of biological sciences should promote the development of more complex skills than simple memorization of concepts (3). The students need to develop other skills, such as observation, interpretation, analysis, problem-solving, hypothesis survey, and synthesis, among others (2). The traditional teaching is often limited to expository practices when passive actions by the students prevail, and they stand as listeners to the teacher exposition (4).

Meaningful learning relies on relating new information acquired with relevant elements from an individual's previous knowledge and daily life (5). In this regard, traditional expository practices are not effective, especially in a context of social isolation, where the fear, anxiety, and uncertainty due to COVID-19 arise among the general public (6, 7). The contextualization of physiology with everyday life has been used as an integration strategy, mainly in the curricula of health courses (6). This practice improves the students' knowledge construction, resulting in meaningful learning (8). In this perspective, an approach relating physiology to the daily life experienced by students can make the teaching process more motivational and significant (6).

Currently, the overload of misinformation about the pandemic results in confusing news, uncertainties, and increases fear, anxiety, and panic among people (9, 10). Therefore, the health information provided during COVID-19 needs to be based on evidence, avoiding serious psychological outcomes (11). Updates on the mechanisms by which COVID-19 operates have been unveiled over the current period. In addition to affecting the respiratory system (12), the virus also acts on the nervous, cardiac, metabolic, and renal systems (3, 13–17), demonstrating its different interactions with the human body.

Recent evidence shows that infection by COVID-19 alters body homeostasis, affecting one of the most important
regulatory systems: the renin-angiotensin-aldosterone system (RAAS) (17). This is due to an interaction with the angiotensin-converting agent enzyme 2 (ACE2), which is abundant in our body, and ends up facilitating the entry of COVID-19 in host cells and, thereby, harming the homeostasis. Despite the need for further research on the mechanism of action by which COVID-19 works, immunomodulatory therapies are probably as effective as or more than targeting only the entry into the viral host cell, suggesting an appropriate immune response is fundamental to the recovery after infection (18). These are examples of how the elucidation of physiological mechanisms of the human body contributes to a better understanding and coping with the disease and its possible consequences (19). When teaching considering this perspective and exposing students to these concepts, they can be stimulated to critically evaluate the information available and limit their sources of information to official and reliable channels.

Understanding the importance of providing meaningful learning to students, we used an online teaching-learning model to review and contextualize physiology contents and relate contents to the COVID-19 pandemic. Here we describe the general idea of the web course and the students’ impressions about it.

● COURSE CONTEXTUALIZATION AND CHARACTERISTICS

Due to social isolation imposed by COVID-19 face-to-face classes were suspended in Brazilian universities. As the move from face-to-face to a remote environment of learning was not immediately established, it was important to find ways to keep students in contact with important content for their academic training. Professors and universities promoted online courses and activities to engage the students while remote classes did not start. In this context, we developed a web course entitled “Special Topics in Human Physiology,” which aimed to discuss relevant topics of human physiology with students who had already taken a physiology course in their undergraduate.

The course invitation was disseminated through social networks (Facebook and Instagram), and 50 health students were selected. The course was conducted through asynchronous activities, which involved the preliminary study of a specific topic, and synchronous activities lasting 1h, which were conducted twice a week by Zoom meetings. In the synchronous meetings, interactions were stimulated by questions using the Mentimeter.

The course did not aim to review all the physiology content, but only a topic considered as a key concept in each body system and relate this topic to COVID-19 (Table 1). We used the following platforms and digital resources in the activities: Zoom, Lt/ADInstruments, Mentimeter, Facebook (group Physiology Unipampa: https://www.facebook.com/groups/140687446092701), and Instagram (@gpfisunipampa). This proposal was approved by the Institutional Education Committee (Institutional Review Board No. 10.069.20). At the end of the course, we conduct a questionnaire using GoogleDocs and including 11 multiple-choice questions to assess students’ perceptions about the proposal. We also evaluated, through Facebook’s group statistics, the engagement with posts made during the course.

From the 50 enrolled students, 40 of them finished the course and answered the evaluation questionnaire (80%). The participants were from different careers: 47.5% (n = 19) were from Physiotherapy, 25% (n = 10) from Nursing, 10% (n = 4) from Pharmacy, 5% (n = 2) from Medicine, 5% (n = 2) from Sports Sciences, 5% (n = 2) from Nutrition, and 2.5% (n = 1) from Biological Sciences. The results are presented as relative (%) and absolute frequency (n) and were analyzed by the chi-square test ($\chi^2$).

● RESULTS

When the students were asked if they ever had thought about the relationship of the different systems studied in the Human Physiology course with the COVID-19 previously, 75% said: “no” (Fig. 1A; $\chi^2 = 10.000; P = 0.002$). We found 92.5% of the students affirming that during/after the course they shared information related to COVID-19 with their social group (family, friends, coworkers, etc.) (Fig. 1B; $\chi^2 = 28.900; P < 0.001$). All students reported that the activities helped to better understand the so-called “risk groups” (Fig. 1C), and 95% said that the information discussed in the course helped to select better sources of news (Fig. 1D; $\chi^2 = 32.400; P < 0.001$). Additionally, 97.5% of the participants consider that establishing relationships between physiology contents and COVID-19 contributed and will impact on their academic formation (Fig. 1E; $\chi^2 = 36.100; P < 0.001$). Considering that the course promoted information about the COVID-19, 85% said that their concern about the gravity of the pandemic increased after the course (Fig. 1F; $\chi^2 = 19.600; P < 0.001$).

All students affirmed that studying the interactions of Sars-CoV-2 with the different body systems helped to understand better the COVID-19 (Table 2, question 1). Also, 70% of students considered that they learned a lot with this strategy of making relationships between physiology and COVID-19 (Table 2, question 2). We also asked if the web course contributed to making the participants able to identify fake news about COVID-19 easily; 92.5% said that the activities contributed a lot (Table 2, question 3). In addition, 92.5% of the participants said that studying the action mechanisms of interaction of soap and hand sanitizer with the virus membrane helped them to understand the importance of hygiene care (Table 2, question 4). Regarding the way in which the physiology topics were delivered, 57.5% (n = 23) considered it as excellent, 40% good (n = 16), and one student considered it regular (n = 2.5%) ($\chi^2 = 18.950; P < 0.001$).

The students interacted (by likes and shares) 405 times with the 14 publications made in the Facebook group during the course period (all were related to the course content). In addition, students commented 94 times, demonstrating an interest in the content shared.

● DISCUSSION

Our results demonstrate the importance of contextualizing the teaching-learning process of human physiology, in this specific case, with COVID-19. It provided students with a meaningful way of learning. This practice also contributed to the identification of fake news and stimulated the students to share scientific-based content with their relatives.

When students use the concepts of physiology to solve problems, the learning process is more effective (20). Therefore, in
addition to the teaching process being contextualized, the active involvement of students is fundamental. It can be achieved by stimulating them to go beyond the acquisition of content and interconnect and relate physiological content to personal experiences, especially when the clinical experiences when it comes to future health professionals (5, 8, 15). Therefore, facilitating the student's ability to mobilize cultural, scientific, and technological knowledge to understand reality and to address everyday situations and problems is essential (21).

Most of the participants had the perception that they could relate the physiology content with COVID-19 after the web course. Importantly, all of them affirmed that the topics studied during the course contributed and had an impact on their academic formation. We consider this result extremely relevant as it demonstrates the importance of this strategy, which can be used in other courses, such as biochemistry, immunology, pharmacology, among others, to involve the students and give applicability to the content.

Among the tools that we have used in our web course, there are social media. The incorporation of modern technology into the educational system has broadened the spectrum of teaching and learning and has enhanced the skills of independent and collaborative learning (22, 23). By using Facebook, for example, we verified that all participants reacted to at least one of the activities proposed. Previous research already suggests that the relationships between teachers and students mediated by Facebook have provided “an open communication channel, resulting in richer learning environments and greater involvement of students in schooling processes” (24). We consider that although we have used Facebook, other media may elicit similar outcomes.

The use of technological resources should be supported by a learning philosophy that supports the teacher's technological choices to provide moments that value sharing, debate, the collective construction of knowledge, and respect for difference (25). We consider that our course can be adapted for future offers, perhaps with mixed learning to serve as a

Table 1. Physiology topics, its interaction with Sars-CoV-2 virus, and how topics were worked during the web course

| Topics                  | COVID-19 Relationship                                                                 | Methods and Platforms Used                                                                                                                                 |
|-------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cellular physiology     | Interaction of the Sars-CoV-2 virus with human cells and their receptors and the importance of protective agents, such as soap and alcohol | We posted an infographic to Facebook and explained the interaction of the coronavirus with receptors in human cells and the membrane transport used by the same, in addition to the mechanisms of interaction and destruction of the Sars-CoV-2 membrane through the use of protective agents (soap and alcohol 70%); We also published and suggested that students watch a video on YouTube (https://www.youtube.com/watch?v=eYY1hDY1JJc). Students were expected to be prepared for interactive questions on these topics through the Mentimeter at the synchronous meeting held by Zoom. |
| Nervous system          | Neurological manifestations related to patients infected with Sars-CoV-2. Effects of the pandemic and social distance in our brain | We created a web flyer with information on how the invasion of the central nervous system occurs through the ECA2 receptors. The flyer was posted to the Facebook group, and students were asked to send their questions through the synchronous meeting held by Zoom. We invited participants to watch a lecture about how our brain reacts to a pandemic on YouTube. The talk approached questions related to anxiety, stress, and fear. In addition, the video talked about the effects of social isolation and ways to avoid its negative impacts (https://www.youtube.com/watch?v=UHBs1SUBzGo). The material will be posted on Facebook and/or Instagram for dissemination. |
| Cardiovascular          | Impact of the Sars-CoV-2 virus on the renin-angiotensin-aldosterone system | The students were instructed to watch a video about the impacts of COVID-19 on the renin-angiotensin-aldosterone system (https://www.youtube.com/watch?v=UHBs1SUBzGo). The video was made available on the Lt/ADInstruments teaching platform. After watching the video, the students were asked to prepare some material summarizing information about it. The material will be posted on Facebook and/or Instagram for dissemination. |
| Respiratory             | Main respiratory changes caused by COVID-19                                           | The students received a video through the Lt/ADInstruments platform in which some of the symptoms caused by the COVID-19 were described, for instance breath difficulty, stops in the walk, short talk phrases due to poor oxygen inhalation, and a pulmonary radiograph elucidating differences between normal and COVID-19-affected lungs. The students were requested to identify the symptoms. |
| Endocrine               | Possible outcomes of a patient with diabetes infected by Sars-CoV-2                   | We provided a series of articles and leaflets with information from the Brazilian Diabetes Society on the disease and its relationship with COVID-19 (https://www.diabetes.org.br/COVID-19/notas-de-esclarecimentos-da-sociedade-brasileira-de-diabetes-sobre-o-coronavirus-COVID-19/?fbclid=IwAR1BtaAq1J-KmbEmf5k7ikE8k445-kE). In addition, we shared an article discussing COVID-19 as a systemic disease. The students were asked to read and interpret the results for further discussion during the synchronous meeting by Zoom. |
| Digestive               | Possible interactions of COVID-19 with the gastrointestinal tract                      | We shared two YouTube videos as a reference (https://www.youtube.com/watch?v=x5yKfd29Mg&feature=youtu.be; https://youtu.be/1aQRJQRHHyQ). The first video was about the relationship between coronavirus and the gastrointestinal tract and the second about fake news involving coronavirus. We suggested that after watching the videos, the students should comment on the videos in our Facebook group, as a form of interaction. |
| Renal                   | Kidney function problems and COVID-19; interactions of coronaviruses with angiotensin conversion enzyme 2 (ACE2), angiotensin II, and renin-angiotensin system (RAS) inhibitors | Students were provided with two scientific papers on the interaction of COVID-19 with the kidneys and its relationship with ACE2, angiotensin II, and RAS inhibitors (https://www.nature.com/articles/s41585-020-0319-7; https://www.nature.com/articles/s41440-020-0455-8). In this scenario, students were asked to use their creativity to create a flyer for publication in our social networks (Facebook and/or Instagram) and contribute to the dissemination of scientific information about the COVID-19. |

Advances in Physiology Education • doi:10.1152/advan.00214.2020 • http://advan.physiology.org 131
complement to the content addressed in face-to-face classes. This type of blended learning strategy enhances student involvement, since technological support is a trend, and there is a potential to offer digital online learning experiences that can be individualized, flexible, and specialized (26).

Although social networks can be used for educational purposes, fake news and misinformation about COVID-19 proliferated widely on media (27). In this sense, the students must have a critical look at the information that surrounds them and the ability to discern fake news from a true report. We found that the associations between the physiology contents and the COVID-19 helped participants to identify fake news and seek better sources of information. These data highlight the importance of evidence-based teaching (12) and its positive impact on student learning (11).

The course proposed here was beyond a topic of great importance in the current scenario. The COVID-19 pandemic was related to physiology topics and it facilitated the learning through contextualization that attracted the attention of the students. Considering that the contextualization of the contents is nothing more than to root the knowledge to the original text from which it was extracted to any other context that gives it meaning (28), the approach to physiology topics that are pertinent to the students’ daily life enhances learning. In this sense, we believe that new relevant themes of the common daily life or specific to certain time can arise and

### Table 2. Responses to the questions with multiple alternatives in the questionnaire

| Question                                                                 | A Lot (%) | Regular/Medium (%) | Little (%) | Nothing (%) | Chi-Square Test ($\chi^2$) | P Value |
|--------------------------------------------------------------------------|-----------|--------------------|-----------|-------------|---------------------------|---------|
| 1) Do you believe that studying the interactions of SARS-CoV-2 with the different physiological systems helped to better understand the COVID-19? | 90% (36)  | 7.5% (3)           | 2.5% (1)  | 0           | 57.950                    | <0.001  |
| 2) How much do you think you have learned about the relationship between the physiological systems studied and COVID-19? | 70% (28)  | 27.5% (11)         | 2.5% (1)  | 0           | 27.950                    | <0.001  |
| 3) Did the concepts about COVID-19 worked in the course help you to identify fake news about the disease? | 92.5% (37) | 5.0% (2)          | 2.5% (1)  | 0           | 63.050                    | <0.001  |
| 4) How much do you think that studying the mechanisms of action of protective agents, such as soap and 70% alcohol, helped you to understand the importance of washing your hands frequently? | 92.5% (37) | 7.5% (3)          | 0         | 0           | 28.900                    | <0.001  |

Numbers in parenthesis denote number of student responses ($n = 40$).
they can be adapted and used to teach physiology in a similar way by which we did in our course.

We also believe that the pandemic, despite the great challenges imposed by the disease, can bring us some lessons in the sense of new adaptations in the social and cultural scope, as well as coping strategies, in the perspective of a future new pandemic.

## FINAL CONSIDERATIONS

The contextualization of physiological contents with daily life situations, such as COVID-19, has a significant impact on the students’ learning, and this approach can be adopted in web teaching, using online platforms, or in other contexts. Additionally, this practice has an impact on the daily life of students, influencing their decisions and practices.

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## DISCLOSURES

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

## AUTHOR CONTRIBUTIONS

N.A., G.S.C., C.B.S., A.C.d.R., N.M.S., and P.B.M.-C. conceived and designed research; N.A., G.S.C., A.C.d.R., N.M.S., and P.B.M.-C. performed experiments; N.A. and G.S.C. prepared figures; N.A., G.S.C., C.B.S., A.C.d.R., N.M.S., and P.B.M.-C. drafted manuscript; N.A., G.S.C., C.B.S., A.C.d.R., N.M.S., and P.B.M.-C. edited and revised manuscript; students, in web teaching, using online platforms, or in other contexts.

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