SCIREA Journal of Education

http://www.scirea.org/journal/Education

January 31, 2021

Volume 6, Issue 1, February 2021

Teaching physiology to medical students in the COVID-19 era with synchronous formative assessments utilising simultaneous, combined Zoom and Socrative platforms

Mohammed H. Abdulla[1], Elizabeth Brint[2], Mark G. Rae[3]

[1]Department of Physiology, School of Medicine, University College Cork, Cork, Ireland.

[2]Department of Pathology, Cork University Hospital, University College Cork, Cork, Ireland.

[3]Department of Physiology, School of Medicine, University College Cork, Cork, Ireland.

Abstract

Background: The continuing COVID-19 crisis of 2020 demanded a sudden and massive shift within academia from face-to-face learning to online and remote learning for both teaching and assessment.

Methods: Herein, we describe our own experience of this transition and, more specifically, of using the web-based Zoom video conferencing platform in conjunction with the cloud-based student response system, Socrative, to deliver synchronous physiology formative assessments/tutorials to first-year medical students.

Results: Of the 65% (n=55) of students in the class that responded to an end of module survey on the assessments, 96% (53 students) indicated that they had joined at least one of the four Zoom/Socrative quiz sessions, with 65% attending all four. The vast majority of respondents (82%) indicated that the sessions were effective in facilitating their learning.

Based upon comments submitted for the survey, students liked the Zoom/Socrative assessments primarily because they provided an efficient and uncomplicated way of both communicating remotely, but still 'face-to-face', with their instructors, and allowed them to assess their knowledge of asynchronously-delivered, pre-recorded physiology material.

Conclusions: In summary, this study presents a feasible means of delivering real-time, synchronous physiology teaching and assessment in this era of enforced social distancing and remote learning.

Keywords: formative assessment; Socrative; Zoom; remote learning; pre-recorded lectures

Introduction

The temporary closure of education centres worldwide that took place in 2020 in order to stem the progress of the COVID-19 pandemic has heralded the most significant shift in the way that most academic courses are taught and assessed than has ever been previously seen. Specifically, the delivery of previously synchronous, in-person activities such as lectures, tutorials and assessments have been moved online *en masse,* utilising virtual learning environments such as Canvas and Blackboard and/or online communication platforms such as Zoom (Zoom, San Jose, California, USA), Microsoft teams (Microsoft, Washington, USA), Slack (Slack Technologies, San Francisco, CA, USA), *etc.* [1].

Prior to the outbreak of COVID-19, knowledge of, and experience using, such video/audio conferencing tools in conventional education settings was relatively limited (although they have been deployed previously to guide distance learners in some disciplines such as medicine [2], nursing [3] engineering [4] and law [5]). However, the coronavirus pandemic precipitated a surge of interest in video/audio conferencing tools that could be utilised to facilitate remote student learning [6], due primarily to their versatility in fostering both real-time collaborative learning and feedback opportunities [7], as well as the provision of affective support for students irrespective of instructors' or students' geographical locations. Furthermore, these platforms also permit the sharing of one's screen with others in meetings which allows the rapid transmission of information between users without the requirement to send and/or download files. Anecdotally, the Zoom video conferencing platform is currently the most popular of such platforms in higher education settings. For example, a recent report

showed that 80% of academics in Norwegian universities had used it for teaching during the COVID-19 crisis in spite of the fact that 30% of those had no previous experience with online teaching [6].

While reports on the use of web-based platforms for virtual learning continue to emerge [1, 7, 8], studies of their use for the teaching and assessment of physiology on early year medical programmes are currently absent from the literature.

In contrast to the use of video conferencing for remote teaching, the cloud-based student response system, Socrative, is now used relatively extensively for both summative and formative assessment across a wide range of disciplines, such as computer science [9], sport management [10] and medicine [11]. These and other studies have demonstrated that using Socrative as an in-class assessment and feedback tool appears to enhance students' exam performance [12] and, indeed, is positively received by both students and teachers alike [13, 14]. Specifically with regard to the teaching of physiology, several previous studies have clearly demonstrated that Socrative enhances students' overall learning experience by fostering greater engagement, interaction and peer collaboration within the classroom [15-17]. However, to the best of our knowledge, to date there is an absence of literature investigating its use in a real-time virtual classroom setting, or how students perceive such a format for remote learning. Similarly, although very recent work has explored the use of teleconferencing platforms for various academic needs in medicine such as teaching, training and assessment [7, 18], these were mainly utilised for clinical-based learning. Therefore, it remains unclear as to the utility of such an approach for basic science teaching in the pre-clinical years of a medical programme.

Although the provision of pre-recorded lectures and recordings of live lectures on universities' virtual learning environments is becoming increasingly common [19], in our experience this type of resource is primarily used as a revision aid by students [20]. However, during the current pandemic, online live and pre-recorded lectures have become the main forms of teaching delivery rather than simple teaching supplements to face-to-face teaching interactions. As such, we were also interested in determining how graduate entry to medicine (GEM) students viewed and used such pre-recorded lectures, in addition to other electronic resources such as videos, self-assessment quizzes, *etc.* that were posted to their virtual learning environment (VLE) as part of the physiology teaching material.

Therefore, the aims of the current study were two-fold; firstly, to investigate the use of online physiology tutorials/formative assessments provided to first year GEM students using Zoom integrated with the Socrative online response system. Students' attitudes towards, and perceptions of, this approach, utilised over four synchronous, approximately one hour live teaching sessions, were gathered using a survey questionnaire at the end of a first-year Fundamentals of Medicine module. Secondly, students' use of, and preferences for, online live or pre-recorded lectures, in addition to other physiology resources provided in this module, were also determined.

Methods

Participants and setting

The current study was undertaken at University College Cork (UCC), Ireland as part of the physiology component of a ten-week pre-clinical module, GM1003 (Fundamentals of Medicine III), which was integrated with anatomy, biochemistry, microbiology, pathology and pharmacology components. The physiology material delivered within this module comprised gastrointestinal, endocrine and reproductive physiology and was taught over 15 one-hour lectures, delivered over a six-week period from the middle of March to the end of April 2020. The GEM class (n = 85) included students of different ages (21-40 years), gender (female and male), origin (Ireland, UK, Canada, USA, Australia and Hong Kong) and degree backgrounds (biomedical and non-biomedical).

As part of the normal physiology teaching in the first year of the GEM programme (running from September to April), a number of continuous assessment sessions are run in each of the three modules that are designed to provide summative and/or formative (here simply defined as tests for which marks were, or were not, awarded, respectively) feedback to the students. Both forms of assessment were delivered synchronously, in person and on campus using 20-30 single best item (SBI) questions (*e.g.* questions with, usually, five answer options, only one of which is correct). However, summative assessments were run in a proctored setting for a fixed period of time (~30 minutes), with each student sitting the tests individually (the scores from which made a marginal (1%) contribution to the students' overall end of module physiology exam grade which, in turn constituted 30% of the students' final end of year score), whereas formative assessments, for which no formal marks were awarded, were delivered in person-to-person teaching sessions, primarily within lecture rooms, using the

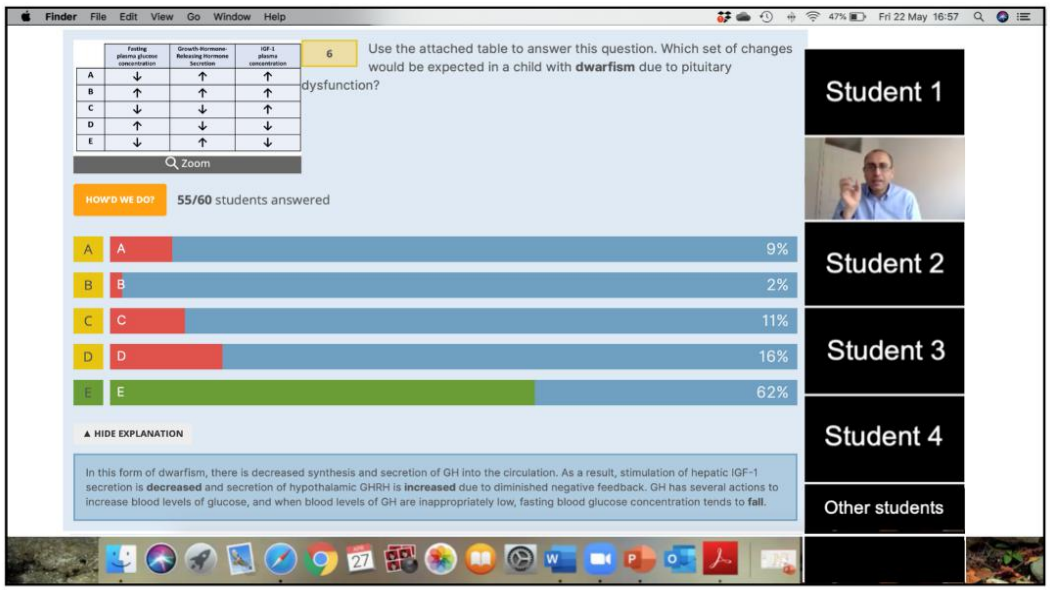
online student response system, Socrative, which can be easily accessed by students using any Web-enabled electronic device [15, 17]. For these assessments, students were able to work in groups or individually to answer each SBI question using their own choice of device, with immediate feedback on their answer selections being provided by a results display, and further explanation by the instructor if required.

However, on 12th March, 2020 the Irish government closed all educational facilities in the state due to the COVID-19 outbreak. Thus, in addition to swiftly having to move all taught material online in time for the commencement of the final GEM module, GM1003, on the 16th March, we also had to devise a means of synchronously delivering the four formative physiology assessments scheduled for this module. We sought to achieve this by incorporating the formative SBI questions that had been posted to Socrative, into Zoom virtual meetings. Zoom incorporates a number of features that are available to users with a free, full-featured basic subscription (listed in Table 1) that allows a maximum of 40 minutes per meeting (*N.B.* longer meeting durations can be purchased with a paid monthly subscription). For each of the four assessments, a meeting was scheduled in Zoom, with the host then providing a link and password for the meeting by e-mail to students through UCC's VLE, Canvas (Instructure, Utah, USA). Prior to each tutorial session, students were also provided with a list of instructions regarding the assessment format, such as the material it would cover, the number of questions and the expected duration of each session. After these instructions had been reiterated at the start of each session, the instructor shared his computer screen with students using the 'share screen' option in Zoom. This broadly simulates what happens normally in the lecture hall where the instructor shares the screen of their podium computer with students *via* a projector screen [15]. During this process, the lecturer's live camera can still be viewed at the margin of the page to facilitate interaction and engagement with students during the session (Figure 1). However, students were free to leave their webcams on or off during the sessions.

Table 1: Key features of the Zoom e-meeting platform.

Participants can join from any location with internet coverage and on any device (e.g. computer, iPad, phone)
For security, meetings can be encrypted therefore only authorised participants can join
• Allows real-time synchronisation of contents using the 'share screen' tool and multi share option

Allows participants to mute/unmute their microphones and to switch on/off of their cameras for convenience
• It allows up to 1000 participants at the same time (Depends on subscription package)
• It allows recording of the sessions and storage on the cloud (Depending on subscription package) so videos can be shared later with students
• There is a built-in option for assigning participants to chat rooms by the host for collaborative learning and the host can join these rooms and switch between rooms
It allows the host to share links to material with participants using the chat feature and vice versa
• A free full-featured basic subscription is available that allows free 40 minutes group meetings.
• Allows high definition video and audio calls, and virtual backgrounds



Figue 1: Zoom/Socrative layout presented on a MacBook Pro computer. Socrative allows a 'teacher-paced' presentation of one question at a time. *Inset* shows Zoom panel with author MHA providing verbal feedback to students. After students select their answer option the host clicks on 'HOW'D WE DO?' to reveal class performance. Written explanations for each question can be provided using the feedback section below each question.

After each question appeared on students' screens, a short period of time, usually between 60-120 seconds, was provided for students to select their answers. After this time, immediate feedback on overall class performance for each question was provided to both the instructor and students *via* Socrative by the lecturer pressing the 'HOW'D WE DO?' button (Figure 1).

Verbal feedback, if required, could then be given by the host to clarify any obvious misunderstandings or why an answer was correct/incorrect. If students required further clarification about a particular question, they could also unmute themselves to ask their question directly, use the 'raise hand' option in their Zoom window and wait to be asked what their question was or, if the students did not wish to ask their question out loud, they could write out their query using the 'chat' function that is also presented in their Zoom window. Additional explanatory material such as relevant lecture slides or videos could also be easily incorporated into any discussion simply by means of the instructor switching the view they shared with the students. At the end of the series of questions, the lecturer answered any further questions and then concluded the session. However, instructors routinely informed students that they would remain online in Zoom for a further five minutes afterwards to talk one-to-one with any students who wished to do so. It is worth noting that all of the authors found both Socrative and Zoom to be very user-friendly, with little technical expertise required for their set up or utilisation (provided that one possessed a fast and reliable internet connection). Similarly, due to the screen share functionality of Zoom, the integration with Socrative was seamless.

Pre-recorded lectures and self-assessment quizzes

A range of online resources related to the required teaching material was posted to Canvas in advance of each assessment/tutorial. These resources include pre-recorded lectures, supplementary notes and videos, self-assessment quizzes for each lecture and Canvas-linked McGraw-Hill Engage self-study quizzes. Thus, akin to the flipped, or inverted, classroom [21, 22], the formative assessments provided students with opportunities to apply their knowledge of material that should have reviewed prior to each assessment session. The majority of lecture recording was performed using the online video platform, Panopto, but two lectures were recorded in the form of audio integrated into PowerPoint presentations.

Data collection and analysis

An end of module survey questionnaire containing both Likert- and essay-type response options was posted on Canvas at the end of the GM1003 module. Since this study was embedded in the course as part of an end of module feedback survey, no ethical approval was required. However, all participants were informed that should they chose to participate

(participation was voluntary), their responses would be anonymised (by the 'unlinking' of data from the contributors' names by author EB) and could not influence students' course grades. These data were stored securely in UCC's cloud-based secure server and subsequently analysed independently by author MHA.

Likert-scale responses were converted to a 0–5 numerical value: specifically, strongly agree 5, agree 4, neither agree nor disagree 3, disagree 2, strongly disagree 1. All survey data from respondents were downloaded from Canvas by author EB, collated, analysed and entered into GraphPad Prism for graph preparation by author MHA.

Results

Student demographics

For the current study, 55 out of 85 (65%) eligible students enrolled in the GEM module GM1003 completed the survey towards the end of April 2020. Furthermore, 31 respondents (56%) were female, with 24 (44%) male. Twenty-three respondents (42%) indicated that their region of origin was Europe, while 32 (58%) were from non-European countries.

The demographics of the survey respondents were comparable to those of the GM1003 class as a whole (n=85), where 45 students (53%) were female, and 40 (47%) male. Similarly, 39 students (46%) were from Europe, while 46 (54%) were based in non-European countries.

Students' attendance of, and attitude towards, Zoom/Socrative integrated assessment sessions

When students were asked to respond to the question, '*How many of the interactive Zoom/Socrative CA sessions hosted by the Physiology department did you join?*', 96% of respondents reported attending at least one of the four physiology Zoom/Socrative sessions, with 65% attending all four. Only 4% (two respondents) indicated that they had not attended any of the sessions (Figure 2A).

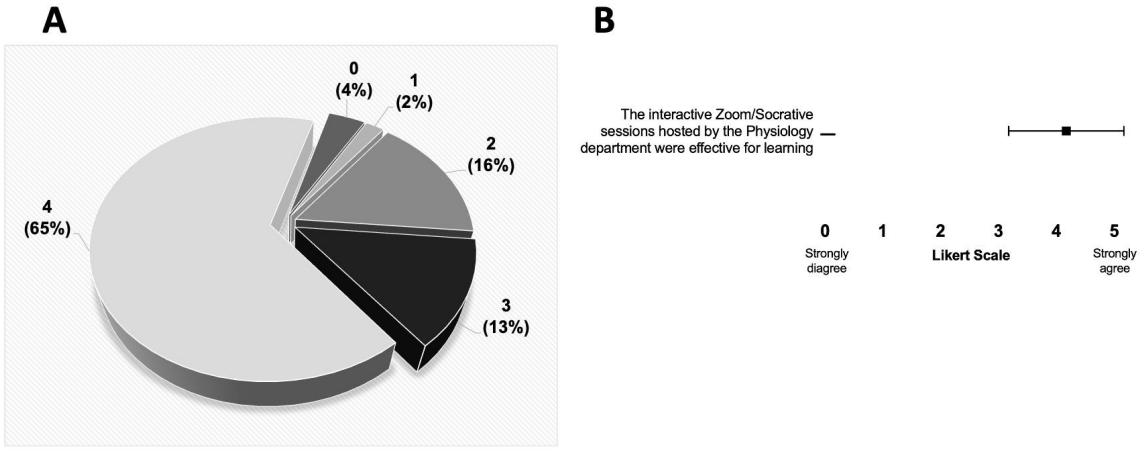


Figure 2: Students' attendance of (*A*), and attitude towards (*B*), Zoom/Socrative sessions. (*A*) Students responded to the question '*How many of the interactive Zoom/Socrative CA sessions hosted by the Physiology department did you join?*' (*B*) Students responded to the statement "*The interactive Zoom/Socrative sessions hosted by the Physiology department were effective for learning*", with 55 (64%) responding. Each line represents the mean ± SD.

In response to the survey item, '*The interactive Zoom/Socrative sessions hosted by the Physiology department were effective for learning*', 82% of respondents indicated that they either 'strongly agreed' or 'agreed' that the sessions were effective for their learning [mean = 4.17 (SD 0.99)], with only 7% (four students) either disagreeing or strongly disagreeing (Figure 2B). Furthermore, analysis of responses (40 students commented out of 55 total respondents) to an open-ended survey item which invited students to suggest ways of improving the Zoom/Socrative sessions, showed that 36% of respondents (20 responses) stated explicitly that the Zoom/Socrative approach had been useful for their learning of physiology. However, 20% of respondents (11 responses) commented that they felt that the sessions ran too slowly. Finally, 9% of respondents (5 responses) to this survey item indicated that they had no suggestions to make. A selection of these responses are listed in Table 2.

Table 2: Students' comments on the faculty-led Zoom/Socrative formative assessment sessions. Students' comments were provided in response to the request "*Please use the comment box below to suggest anything that you feel could improve the Zoom/Socrative sessions*".

• The Zoom/Socrative questions were really good. The Socrative quizzes always help me enhance my learning and learn from my mistakes.
I liked that the Zoom/Socrative sessions for physiology were led by the instructor, and students only jumped in if they had questions. It was much smoother for following along.
• The sessions overall were incredibly helpful... I think it would be far more effective to have a set time for each question. For example, if a timer was similar to the exam setting (~90s per question)
• I liked doing the Socrative quizzes - I thought they helped me see what I did know and what I needed to go back over.
• To make them more efficient perhaps a timer should be used for each question to keep it moving.
• It was helpful when if there was a harder question for the lecturer to go back to a slide and say here's the answer and explain again that part of the lecture (quickly).
• I think the sessions went very smoothly and facilitated learning.
• I enjoyed having questions to do with the class, and have an explanation.
• Thought they were well done, lots of information given during the CAs and both Dr Rae and Dr Abdulla did well going through their questions
• I think the zoom sessions were run just fine despite connectivity issues.
• The formative CA's were very helpful in gauging what I understood and what I didn't really know.

Students' use of online physiology resources

Although we have routinely provided recordings of physiology lecture material (prepared using Panopto) to students on the first year GEM programme for several years, it should be noted that they have not been tailored specifically for online delivery and are primarily used by students as revision aids [20]. However, for the 19-20 GM1003 module, in the absence of on campus, live lectures, these pre-recorded versions were the primary source of directed physiology learning for GEM students. As such, we wanted to determine how many students actually viewed them. Thus, in response to the question, '*How many of the recorded lectures (either Panopto or PowerPoint) provided by the Physiology department in GM1003 did you*

view?', 51% of respondents viewed all of the recorded lectures provided online, with a further 31% reporting that they had viewed more than 50% of them. Interestingly however, 12% of students viewed fewer than 50% of the pre-recorded lectures, whilst three students (5.5%) had not viewed any (Figure 3A). This latter finding was supported by responses to the survey statement, '*The recorded lectures provided by the Physiology department were more effective for learning than (un-narrated) PowerPoint slides alone*', whereby the same three students 'disagreed' with the statement that recorded lectures were more effective than un-narrated PowerPoint lecture slides (Figure 3B). However, 77% of respondents either 'strongly agreed' or 'agreed' that recorded lectures were more effective for learning than un-narrated slides alone [mean = 4.35 (SD 0.78)], thereby confirming the overall preference of students for recorded lectures over un-narrated PowerPoint slides.

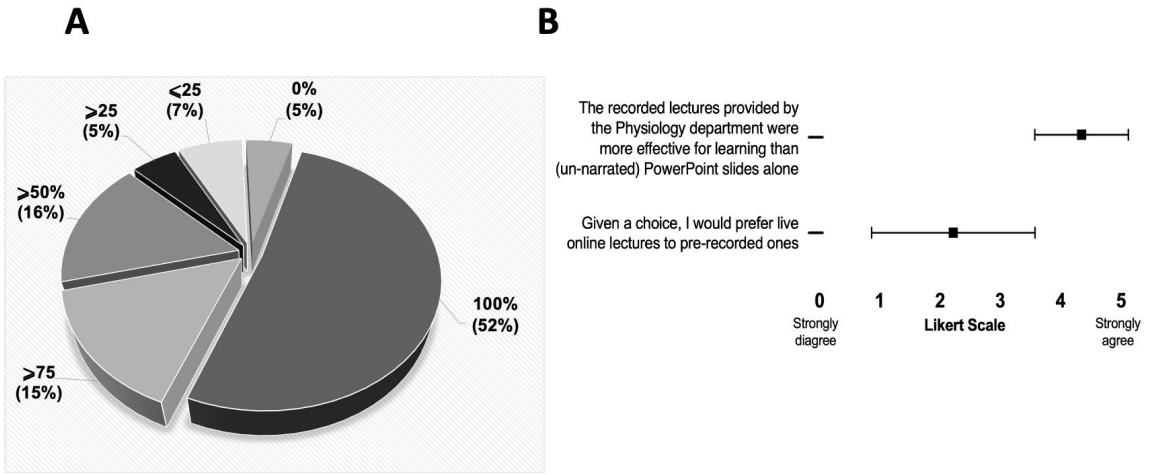


Figure 3: Students' attitude towards using the pre-recorded lectures provided by the physiology department during the COVID crisis. (*A*) Student responses to the question "*How many of the recorded lectures (either Panopto or PowerPoint) provided by the Physiology department in GM1003 did you view?*" were analysed for 55 (64%) survey participants. (*B*) A Likert style survey question "*The recorded lectures provided by the Physiology department were more effective for learning than (un-narrated) PowerPoint slides alone*". Students also ranked their agreement or otherwise with the statement "*Given a choice, I would prefer live online lectures to pre-recorded ones*", with each line representing the mean ± SD.

Pre-recorded lectures or online live lectures

At the time of writing, where, due to social distancing limitations, severe restrictions on the numbers of students allowed into lecture halls remain, there is a continuing discussion about the relative merits of providing students with online, synchronous *versus* asynchronous (*e.g.* pre-recorded) lectures. To that end, in response to the survey item, '*Given a choice, I would prefer live online lectures to pre-recorded ones*', we found that 66% of respondents either 'disagreed' or 'strongly disagreed' that they preferred online live lectures to those that were pre-recorded [mean = 2.22 (SD 1.36)] (Figure 3B). Conversely, only 18% of students either 'agreed' or 'strongly agreed' with the statement, with a further 16% neither agreeing nor disagreeing (Figure 3B).

Students' selection of online resources of physiology material in GM1003

Finally, students were asked which, if any, of the physiology resources that were provided for them on Canvas in GM1003 (listed in Figure 4), they had actually used. Thus, in response to the question, '*Please indicate which of the following resources made available by the Physiology department in GM1003 you utilised*', for which students could select more than one option, the greatest number of students indicated that they had utilised the online self-assessment quizzes (91%). This was followed in terms of student popularity by Zoom/Socrative sessions (89%), our pre-recorded lectures (84%) and supplementary videos (53%) (Figure 4). It is unclear why there is a slight mismatch between the percentage of students who had watched the pre-recorded lectures here (84%) compared to those who claimed to have watched at least one pre-recorded lecture (94%), shown in figure 3A, but it may have been due to some students misunderstanding that rather than an 'either/or' choice of the options, they could in fact select multiple options for the latter survey question, '*Please indicate which of the following resources made available by the Physiology department in GM1003 you utilised*', which would account for the lower number of students indicating that they had watched the pre-recorded lectures in this survey item than the earlier one.

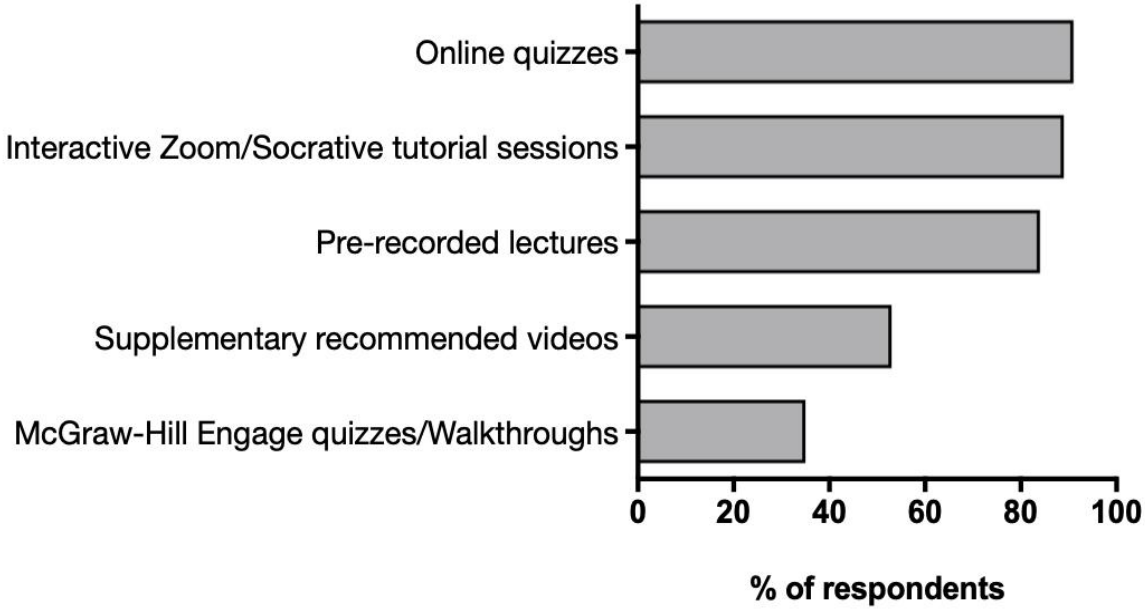


Figure 4: Students' preferred online resources from the options provided by the physiology department during the COVID-19 crisis. Students responded to the question "*Please indicate which of the following resources made available by the Physiology department in GM1003 you utilised*" was analysed for 55 (64% of class) survey participants. Respondents could select more than one resource for this question.

Discussion

For the current COVID era and possibly beyond, both academic staff and students have been required to rapidly adapt to the shift in teaching and assessment from on campus to VLE. Although this was challenging for some faculty due to a lack of preparedness for such sudden move [23, 24], students, arguably, have had to make an even larger adjustment to studying the entirety of their taught material remotely, without any of the normal supports provided by being able to attend campus teaching. That said however, being 'digital natives' [25] and students' facility for autonomous learning, many students may have adapted to this new state of affairs more readily than staff [26].The mass movement towards online teaching and learning also triggered an unprecedented surge in the use of video conferencing tools such as Zoom, not only in academic teaching and assessment [18, 27], but also in many other aspects of life, ranging from political conferences to recruitment and training [28].

When schools, colleges and universities across Ireland closed on 12th of March 2020 amidst a rise in COVID cases in the country [29] all teaching for the final module of the first year GEM programme had to be moved online, meaning that pre-recorded lectures of physiology

GM1003 material, in addition to a range of other online resources, such as supplementary notes, videos and self-assessment quizzes, were posted to UCC's VLE [30]. A decision was also made to proceed with the four scheduled GM1003 physiology formative assessments that would normally take place on campus, but would this year take place online by integrating the Socrative student response system with Zoom e-meetings. The selection of Zoom from the rapidly increasing array of online communication hubs for the present study was mainly due to the fact that, not only was it already being widely used in UCC as well as elsewhere [6], but also because, in the authors' experience, it seemed to provide the most stable platform upon which to deliver this type of teaching in comparison to, for example, MS Teams. Thus, the current format was centred upon the synchronous virtual presentation of the instructors' screen *via* Zoom e-meetings combined with the Socrative online student response system in order to simulate normal live classroom teaching as much as possible under the current circumstances.

Our results clearly show that the vast majority of survey respondents enrolled on the GM1003 module indicated that the innovative use of this technology had facilitated their understanding of asynchronously delivered pre-recorded physiology lectures. This finding aligns with previous work from two of the authors (MGR and MHA) showing that Socrative was overwhelmingly popular with pre-clinical medical students as an in-class, active learning tool [15, 17]. As with this earlier work, and as indicated by the student comments listed in Table 2, the primary reason why students felt that it enhanced their learning was that it allowed them to accurately gauge their knowledge of specific areas of physiology and to learn from the real-time feedback and explanations provided by the instructor. The fact that in the current study this type of interaction occurred online rather than in person does not appear to have diminished GEM students' enthusiasm for the format [17]. However, although not mentioned by any of the students in the current study, one important element missing from these online Zoom/Socrative sessions, that is normally encouraged by the authors during in-class assessments/quizzes, was that it did not permit students to readily communicate with each other either whilst answering questions or after the answer and explanation had been provided. This type of peer learning demonstrably improves student learning and understanding [31-34].

Regarding the physiology resources that were posted online for the students on Canvas during GM1003, respondents indicated that not only were the pre-recorded lectures heavily utilised by the students as a learning tool, but also that the majority preferred them to un-

narrated PowerPoint slides, which tallies with previous studies [35]. However, it is also notable that most students made full use of all of the supplementary physiology resources provided for them on Canvas.

It was also interesting to note that, given a choice, the majority of students responding to our survey preferred pre-recorded lectures to synchronous online live lectures. This is probably due to the fact that even though viewing live online lectures does afford students the opportunity of asking their lecturers questions about the taught material in real time, they are relatively inflexible in that both students and instructors must attend lectures at specific dates and times [36]. In contrast, pre-recorded lectures afford students the flexibility to decide how and when they choose to study the material [37-39] compared to synchronous live lectures. Indeed, the students' preference for pre-recorded lectures here may have been increased further by the different geographical locations of students in this particular cohort of students (ranging across the globe from Vancouver, Canada to Adelaide, Australia) which would have made it extremely challenging to find universally compatible start times for all of their scheduled lectures. It is important to note however, that should students be allowed back into the classroom in the previously normal manner in future, the majority, at least with this cohort, much prefer live, in-person teaching sessions to those that have been pre-recorded [20].

Limitations and suggestions

Herein we provide an example of a useful, efficient and student-friendly use of novel technologies for the remote assessment of physiology in the COVID-19 era. However, the study presented here does have some limitations. For example, it is clear from some survey comments that approximately 20% of students felt that the time devoted to certain questions, as well as some explanations provided by the instructors were sometimes too long, *e.g.* "*I do think that there is a lot of time being given to answer the question and then some of the explanations were being rushed due to the time*" and "*Would be useful to speed the process up a bit, like give 45 seconds to answer a question*".

Although the obvious response might be to propose that instructors strictly limit the time allowed both for students to answer questions and to provide explanations, there is a delicate balance to be had between rushing those students who wish to carefully consider all of the options, *versus* those who quickly select any answer (sometimes, in our experience, even

before the question stem had been read out) without engaging with the question at all just to be provided with the answer sooner.

Tied to this is our suggestion to limit the duration of such sessions to no more than one hour as we noted, although did not empirically record, that the number of participants in the sessions decreased steadily from this point onwards. This effect was probably further exacerbated by the fact that the vast majority of students attended these remote sessions individually, which likely affected their motivation to engage [40]. Furthermore, consideration should also be given to the fact that students' participation and enthusiasm levels may also vary significantly depending upon which time zone they are dialling into the session from. For example, for the assessments discussed here (which took place between 4-5pm Irish Standard Time, which is 1 hour ahead of Coordinated Universal Time (UTC), *i.e.* GMT+1 when the formative assessments took place), it was commonplace to see North American-based students looking tired and eating breakfast, whereas students based in Hong Kong and Australia also looked tired as, for them, it was into the early hours of the next day. Although little more than an inconvenience here, this factor could have serious implications if one were planning to conduct simultaneous online summative assessments using such methodology with students located in different time zones. We would also suggest encouraging participants to keep their cameras on during such sessions as this provides a sense of presence [41] in this simulated classroom setup and helps both learners and teachers to engage in an enhanced educational experience. Other forms of anonymous communication should be sought to encourage questions in this setup [42].

One element of the study tied to the time zone issue outlined above that may limit its translatability to other courses, is the international diversity of this particular GEM student cohort

which is relatively unusual for most Irish courses. Finally, although the vast majority of GEM students indicated that they felt the formative assessment sessions improved their understanding of physiology, we did not empirically assess if this was the case or not.

Summary

This study describes a novel approach for synchronous online assessment using the cloud-based online response, Socrative integrated with the e-meetings platform, Zoom, which allows students to convene in virtual classrooms for the provision of real-time formative

assessment and feedback from their instructors, irrespective of where they are located in the world. In general, in addition to finding this approach rewarding in terms of assisting student learning, the Zoom/Socrative format was also very convenient and both student- and instructor-friendly. As such, this approach could be utilised by faculty who have limited knowledge or experience with such communication technologies. Importantly, students found that this approach facilitated their understanding of physiology and indicated that they would like to see these sessions utilised by other disciplines contributing to the GEM programme. Finally, although the combined use of Socrative and Zoom described here relates to only one module, in one medical school, and also reflects the authors' preference for these particular online platforms, we believe that this approach has an inherent utility that would be transferable across multiple other online response systems and video conferencing platforms.

Author Contributions

MHA and MGR conceived and designed the study; drafted manuscript; edited and revised manuscript; approved final version of manuscript.

EB and MHA gathered and conducted the statistical analysis of submitted student responses; edited and revised manuscript; approved final version of manuscript.

References

[1] Sandars J, Correia R, Dankbaar M, de Jong P, Goh PS, Hege I, Masters K, Oh S-Y, Patel R, Premkumar K et al: Twelve tips for rapidly migrating to online learning during the COVID-19 pandemic. MedEdPublish 2020, 9(1):82.

[2] Vela K: Using Slack to communicate with medical students. J Med Libr Assoc 2018, 106(4):504-507.

[3] Sutterlin J: Learning is Social with Zoom Video Conferencing in your Classroom. In., vol. 2020: eLearn, ACM 2018; 2018: 5.

[4] Sayem ASM, Taylor B, McClanachan M, Mumtahina U: Effective use of Zoom technology and instructional videos to improve engagement and success of distance students in Engineering. In: 28th Annual Conference of the Australasian Association for Engineering Education (AAEE 2017) 2017.

[5] Martin L, Tapp D: Teaching with Teams: An introduction to teaching an undergraduate law module using Microsoft Teams. Innovative Practice Higher Educ 2019, 3(3):58-66.

[6] Langford M, Damsa C: Online Teaching in the Time of COVID-19: Academic Teachers' Experience in Norway. In., vol. Retrieved from https://www.jus.uio.no/cell/digitaldugnad/report-university-teachers-16-april-2020.pdf. University of Oslo, Norway: Centre for Experiential Legal Learning (CELL); 2020.

[7] Almarzooq ZI, Lopes M, Kochar A: Virtual Learning During the COVID-19 Pandemic: A Disruptive Technology in Graduate Medical Education. J Am Coll Cardiol 2020, 75(20):2635-2638.

[8] Lloyd C, Agnes D, Jayaraman R, Jothiswaran V: Web-Based Platforms for Virtual Learning. Biotica Research Today 2020, 2(5):184-186.

[9] Awedh M, Mueen A, Zafar B, Manzoor U: Using Socrative and Smartphones for the support of collaborative learning. Int J Int Technol Educ 2014, 3(4):17–24.

[10] Dervan P: Increasing in-class student engagement using Socrative (an online Student Response System). All Ireland J Teach Learn Higher Educ 2014, 6(3):1801–1813.

[11] Valdez L, Gray A, Ramos G, Siu H: Medical Education in Infectious Diseases. Using Smartphone Apps for Active Learning. In: Open Forum Infect Dis: 2017; 2017: S444.

[12] Dakka S: Using Socrative to enhance in-class student engagement and collaboration. Int J Integ Technol Educ 2015, 4(3):13-19.

[13] Faya Cerqueiro F, Martín-Macho Harrison A: Socrative in Higher Education: Game vs. Other Uses. Multimodal Technologies Interact 2019, 3(3):49.

[14] Kim K-J: Enhancing students' active learning and self-efficacy using mobile technology in medical English classes. Korean J Med Educ 2019, 31(1):51-60.

[15] Abdulla MH: The use of an online student response system to support learning of Physiology during lectures to medical students. Educ Inf Technol 2018, 23(6):2931-2946.

[16] Al Sunni A, Latif R: Determining the effectiveness of a cell phone-based student response system. J Taibah Univ Med Sci 2020, 15(1):59-65.

[17] Rae MG, O'Malley D: Using an online student response system, Socrative, to facilitate active learning of Physiology by first year graduate entry to medicine students: a feasibility study. MedEdPublish 2017, 6 (1), Paper No: 9

[18] Major S, Sawan L, Vognsen J, Jabre M: COVID-19 pandemic prompts the development of a Web-OSCE using Zoom teleconferencing to resume medical students' clinical skills training at Weill Cornell Medicine-Qatar. BMJ Simulation Technol Enhanced Learn 2020.

[19] Karnad A: Student use of recorded lectures: a report reviewing recent research into the use of lecture capture technology in higher education, and its impact on teaching methods and attendance. In. London: LSE: School of Economics and Political Science; 2013.

[20] Rae MG, O'Malley D: Do prerecorded lecture VODcasts affect lecture attendance of first-yearpre-clinical Graduate Entry to Medicine students? Med teach 2017, 39(3):250-254.

[21] Lage MJ, Platt GJ, Treglia M: Inverting the classroom: A gateway to creating an inclusive learning environment. J Econ Educ 2000, 31(1):30-43.

[22] Tune JD, Sturek M, Basile DP: Flipped classroom model improves graduate student performance in cardiovascular, respiratory, and renal physiology. Adv Physiol Educ 2013, 37(4):316-320.

[23] Sahu P: Closure of Universities Due to Coronavirus Disease 2019 (COVID-19): Impact on Education and Mental Health of Students and Academic Staff. Cureus 2020, 12(4):e7541-e7541.

[24] Schneider SL, Council ML: Distance learning in the era of COVID-19. Arch Dermatol Res 2020:1-2.

[25] Prensky M: Digital natives, digital immigrants. On the horizon 2001, 9(5):Retrieved from https://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part21.pdf.

[26] Hunter E: Responding to the COVID-19 Crisis: Moving from Desperation to Hope in Theological Education. Insights J 2020, 6:1-10.

[27] Mohanty M, Yaqub W: Towards Seamless Authentication for Zoom-Based Online Teaching and Meeting. 2020:Retrieved from https://arxiv.org/pdf/2005.10553.pdf.

[28] Vining CC, Eng OS, Hogg ME, Schuitevoerder D, Silverman RS, Yao KA, Winchester DJ, Roggin KK, Talamonti MS, Posner MC: Virtual Surgical Fellowship Recruitment

During COVID-19 and Its Implications for Resident/Fellow Recruitment in the Future. Annals of Surgical Oncology 2020.

[29] Crawford J, Butler-Henderson K, Rudolph Jr, Malkawi B, Glowatz M, Burton R, Magni P, Lam S: COVID-19: 20 Countries' Higher Education Intra-Period Digital Pedagogy Responses. J Appl Learn Teach 2020, 3(1):1-20.

[30] Abdulla MH, O'Sullivan E: The Impact of Supplementing PowerPoint with Detailed Notes and Explanatory Videos on Student Attendance and Performance in a Physiology Module in Medicine. Med Sci Educ 2019, 29(4):959-968.

[31] Knight JK, Wood WB: Teaching more by lecturing less. Cell biol educ 2005, 4(4):298-310.

[32] Liu DY, Taylor CE: Engaging students in large lectures of introductory biology and molecular biology service courses using student response systems. In: Proceedings of The Australian Conference on Science and Mathematics Education (formerly UniServe Science Conference): 2013; 2013.

[33] Smith MK, Wood WB, Adams WK, Wieman C, Knight JK, Guild N, Su TT: Why peer discussion improves student performance on in-class concept questions. Sci 2009, 323(5910):122-124.

[34] Smith MK, Wood WB, Krauter K, Knight JK: Combining peer discussion with instructor explanation increases student learning from in-class concept questions. CBE Life Sci Educ 2011, 10(1):55-63.

[35] Shah S, Cox AG, Zdanowicz MM: Student perceptions of the use of pre-recorded lecture modules and class exercises in a molecular biology course. Curr Pharm Teach Learn 2013, 5(6):651-658.

[36] Rowe S, Ellis A, Bao T: The evolution of audiographics: A case study of audiographics teaching in a business faculty. In: Proceedings of the 23rd Annual ASCILITE conference: Who's learning? Whose technology?, Ascilite conference. vol. 2. Sydney, Australia; 2006: 707–716.

[37] Basilaia G, Dgebuadze M, Kantaria M, Chokhonelidze G: Replacing the Classic Learning Form at Universities as an Immediate Response to the COVID-19 Virus Infection in Georgia. Int J Res Appl Sci Eng Technol 2020, 8:101-108.

[38] Rae MG, McCarthy M: The impact of vodcast utilisation upon student learning of Physiology by first year graduate to entry medicine students. Journal of the Scholarship of Teaching and Learning 2017, 17(2):1-23.

[39] Tolks D, Romeike BF, Ehlers J, Kuhn S, Kleinsorgen C, Huber J, Fischer MR, Bohne C, Hege I: The online inverted classroom model (oICM). A blueprint to adapt the inverted classroom to an online learning setting in medical and health education. MedEdPublish 2020, 9.

[40] Moore S, Armstrong C, Pearson J: Lecture absenteeism among students in higher education: A valuable route to understanding student motivation. J High Educ Policy Manag 2008, 30(1):15-24.

[41] Herbelin B, Vexo F, Thalmann D: Sense of presence in virtual reality exposures therapy. In: Proceedings of the 1st International Workshop on Virtual Reality Rehabilitation: 03/18 2002; Lausanne, Switzerland; 2002.

[42] Roberts LD, Rajah-Kanagasabai CJ: " I'd be so much more comfortable posting anonymously": Identified versus anonymous participation in student discussion boards. Australas J Educ Technol 2013, 29(5).