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Biophotonics computer app: fostering multidisciplinary distance self-paced learning with a user-friendly interface

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Abstract: The biophotonics app enables multidisciplinary and self-paced learning in both in-person or virtual environments. The app can work offline and has a user-friendly interface well accepted by students. App instructions are publicly available. © 2021 The Author(s)

1. Introduction

Computer simulations (CS) are widely used in a range of fields, especially (1) for education in low-resource settings lacking specified equipment, (2) to narrow down applications of a product based on the feasibility to achieve the required product performance, and (3) to calculate the necessary parameters for the design of specific instrument. After the COVID-19 outbreak, the importance of CS has grown substantially, especially after the closure of schools, universities, laboratories and other facilities, which fully blocked the access to lab resources. In an education perspective, CS played a key role in allowing students to model measurements to be previously obtained from experiments during in-person activities. In this case, it is essential for simulations to be simple and quick. This would avoid delays due to technical issues and lack of training on efficiently using computer resources faced by many educators and students during the pandemic. Such issues are potential sources of reduced quality of instruction and student attendance (along with negative psychological effects due to students' lack of access to high-speed internet and home isolation) [1]. With this in mind, standalone simulations with a user-friendly interface, capable to be run offline, and not requiring programming experience from the user would be ideal. These simulations should preferentially feature concepts tested in experiments as well as daily-life applications while still providing useful knowledge to students. In the past (2018 and 2019), we have designed a biophotonics app which meets the aforementioned ideal and preferential criteria (except by the offline functioning feature) [2]. The app was tested in the annual 7-hour biophotonics workshop as part of Irish Photonic Integration Centre (IPIC) annual undergraduate and postgraduate summer student bursary program at Tyndall National Institute [3,4]. In 2020, we have adapted our app to work offline upon software installation [5] and used it in our virtual biophotonics workshop to provide students with a tool to simulate measurements of high technological lab equipment and estimate optical properties of biological media upon knowledge of its biochemical constitution. Also, in contrast to previous in-person workshops, students (1) were not motivated to model experimental measurements obtained in the lab (inexistent in a virtual environment), (2) could not access specialized software and (3) carried out simulations in their own computers. In this study, we show the student feedback received by our biophotonics app after its adaptation to a virtual environment.

2. Material and methods

Our biophotonics computer app has been adapted to a standalone app which required no MATLAB license to work. This adaptation was done by generating an executable to install our app. Since some of the functionalities of the app are still dependent on MATLAB, students not having a MATLAB license needed to install MATLAB Runtime R2019a. The standalone biophotonics app used the same graphical user interface (GUI) from the 2018 and 2019 workshops, which has been considered user-friendly during in-person CS sessions [2,3].

The app was used in a virtual CS session (or CS webinar) during the aforementioned 2020 virtual biophotonics workshop, which targeted undergraduate students with diverse backgrounds (from biomedical sciences, over chemistry to mathematical physics to electronic engineering) with potentially no programming experience. The CS webinar had a similar relative dedicated time of 1.5 hours out of 7.5 hours of webinars compared to in-person activities in previous workshops (1.5 hours out of 7 hours). In the CS webinar, the students were divided into groups in Zoom breakout rooms to discuss computer exercises. The proposed exercises introduced tissue optics concepts and diffusion theory, as well as showed students how to apply such concepts to design medical devices based on estimating biomolecule concentrations from reflectance spectroscopy measurements. Students were given instruction manuals

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for software installation and guidelines to operate the software [5]. Students also had the opportunity to make simulations at home for self-paced learning a few days before the CS webinar and after such webinar. Students' feedback on the biophotonics app and CS webinar was collected in a form of multiple-choice questions (with option for comments) after finishing the workshop activities.

3. Results

The students' feedback (Fig. 1) showed that 100% of respondents found CS using our app important for their learning, 83.3% found the app user-friendly, >91.7% rated their overall learning, quality of (1) CS manual instructions, (2) CS subject matter, and (3) teaching on the CS webinar as "Good" or "Very good" and 100% covered >75% of the instructions of experimental manuals. Our results suggest that the app was useful in a short-term fully virtual event.

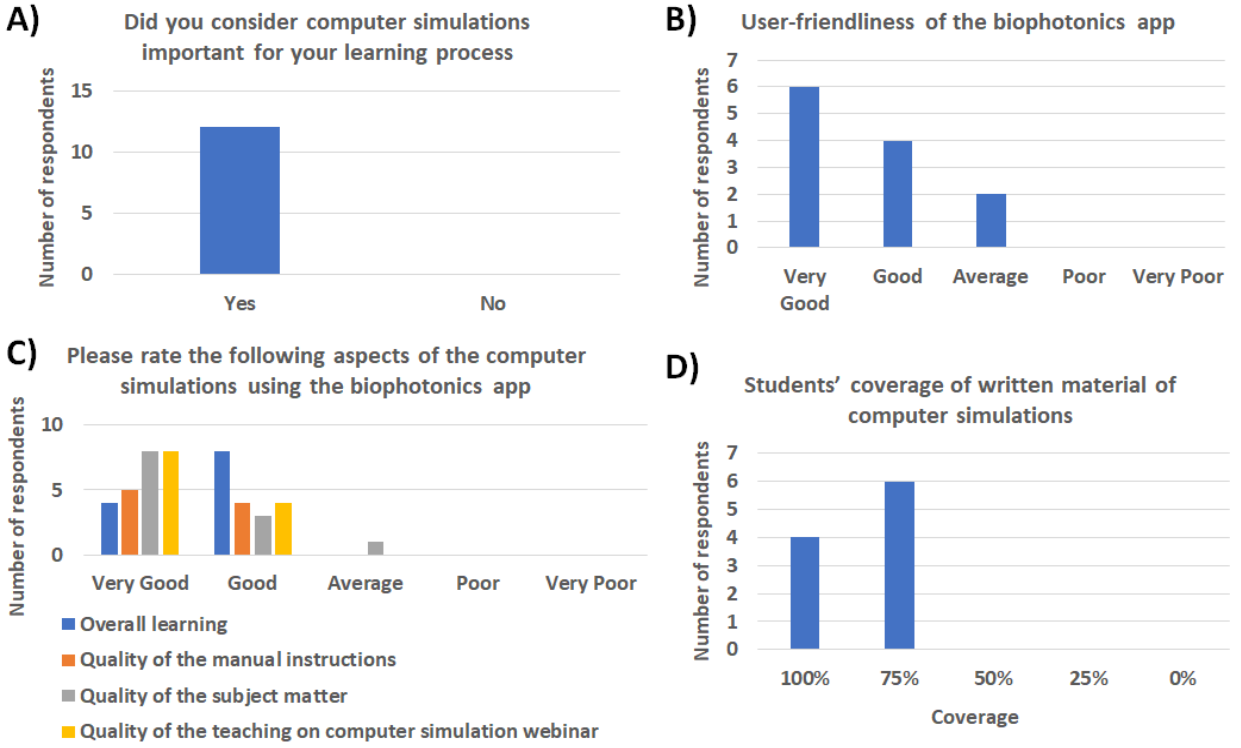

Fig 1: Students' feedback in terms of A) importance of CS for their learning, B) user-friendliness of the biophotonics app, C) overall learning, quality of (1) CS manual instructions, (2) CS subject matter, and (3) teaching on the CS webinar, D) students' coverage of CS instruction manuals.

4. Conclusions

The biophotonics app received positive student feedback upon instructions given by manual and the CS webinar. The biophotonics app offers CS for multidisciplinary distance teaching and learning across physical and life science disciplines and can be related to medical device design and its applications.

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