Online learning combining virtual lectures, at-home experiments and computer simulations: a multidisciplinary teaching and learning approach

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Abstract: We developed a fully-remote biophotonics workshop integrating webinars, computer simulations and at-home experiments to meet the needs of undergraduate students with diverse backgrounds and learning styles. Similar strategies/resources could be used in multidisciplinary programs.

1. Introduction

The growth of distance learning has exponentially increased as universities adopted online courses over the years and as schools completely moved their courses to online platforms upon closure due to social distancing restrictions after the COVID-19 outbreak. Most educators have adopted combinations of virtual labs, online apps, computer simulations, massive open online courses (MOOCs) and other resources to complement online lectures given via recordings and video/audio conferencing. However, most online resources were not designed to be integrated into courses and thus can show inconsistencies when their content, structure, duration of activities and other factors does not suit the requirements of a certain class or outreach activity. These inconsistencies challenge educators moving their courses entirely to an online teaching and learning setting (OTL). This movement has decreased the quality of instruction, which led to decreased student attendance together with other causes including negative psychological effects of students' isolation [1]. Keeping students' interest and engagement in courses in an online environment can be improved by fostering interactive activities and shorter high-quality lectures. Also, previous OTL studies have shown that self-paced courses and lecture recordings enhanced the performance in reading compared to traditional school courses [1]. With the above-mentioned aspects of OTL in mind, we have developed activities for a short-term virtual biophotonics workshop (BW) integrating a variety of activities involving webinars, computer simulations and at-home experiments for self-paced learning over the duration of the workshop and to meet the needs of learners with diverse learning styles. Conditions for self-paced learning were met by making webinars recordings available to students [2], as well as designing at-home experiments and computer simulations which could be performed immediately or explored in more detail to reinforce learning and knowledge sharing at home. The material and activities of our BW targeted an audience with diverse backgrounds at undergraduate level and could be incorporated in outreach activities or short-term events of biophotonics related areas including physics, chemistry, biology, engineering, computer science and others.

2. Material and methods

Our virtual BW was intended to replace our previous 7-hour BW conducted during the Irish Photonic Integration Centre (IPIC) annual undergraduate and postgraduate summer student bursary program at Tyndall National Institute [3-5]. In 2020, the audience of the virtual BW involved 15 undergraduate students participating in this 10-week long program undertaking a photonics research project while attending professional development webinars and workshops. Students had diverse backgrounds (from biomedical sciences, over chemistry to mathematical physics to electronic engineering) at different years of undergraduate training. The virtual BW was primarily designed to foster students' interest in pursuing a career within the field or related area by first providing them with an overview of biophotonics concepts, technologies and applications.

To keep the length of the online activities of the virtual BW similar compared to our previous in-person BW, its schedule comprised of a total of five 1.5 h webinars. These webinars included (1) three featuring biophotonics concepts, applications and career aspects, (2) one on computer simulations in diffuse media, (3) half webinar to discuss key at-home experiments using an educational kit we have provided to Irish-based students, and (4) half webinar for a quiz on biophotonics concepts covered in the workshop. At the end of each webinar, anonymous feedback was

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requested in a form of a multiple-choice questionnaire. Part of the students were also interviewed afterwards for more detailed feedback. Also, the webinar material (presentation slides) was made available to all students shortly after each webinar. Similarly, instruction manuals were provided to students for at-home experiments [6] as well as installation and activities of our computer app [7].

3. Results

Our students' feedback (Fig. 1) indicated that >90.9% of participating respondents (excluding the "Not applicable respondents) considered the BW activities important for their learning process. Also, >91.7% "Very good" and ""Good" responses were found for overall learning, >70% for co-ordination, and >90% for quality of subject matter of BW activities among the participating respondents. Our results suggested that the BW activities were well integrated for biophotonics teaching and received positive feedback from an undergraduate audience with diverse backgrounds.

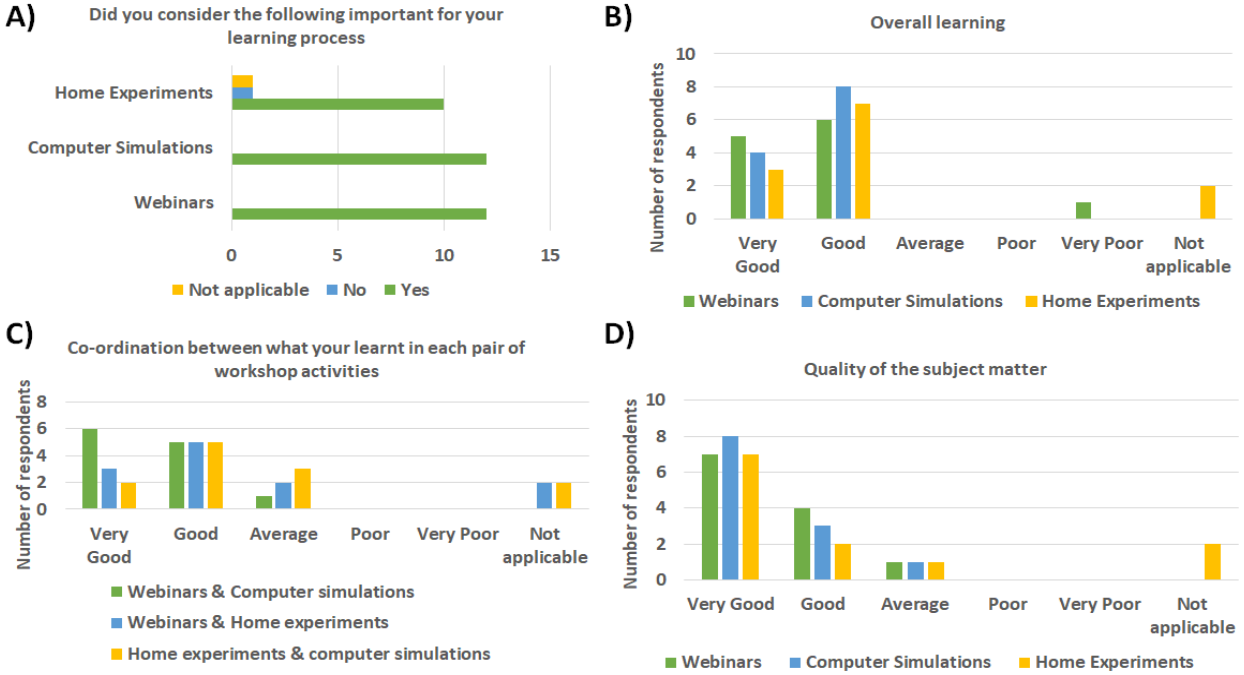

Fig 1: Students' feedback in terms of A) importance of BW activities for their learning, as well as B) overall learning, C) co-ordination and D) quality of subject matter of BW activities. "Not applicable" responses refer to participants who were not able to do specific activities.

4. Conclusions

Our BW successfully combined webinars, at-home experiments and computer simulations to meet the needs of an audience with diverse backgrounds in a fully remote program. Similar strategies and resources could be used to foster the interest of students in STEM subjects. Our resources can be found available at [2,6,7].

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