Institutional and technological barriers to the use of open educational resources (OERs) in physiology and medical education

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Higher education globally is going through a period of rapid, innovative, and revolutionary change, with a shift from the educator as the sole provider of knowledge and information to a collaborative partnership between staff and students to provide an exceptional student education experience (1). Many universities and colleges now describe their educational approach within a blended learning framework, recognizing the benefits of flexible learning, deeper learning, collaboration, social learning, and enhanced employability afforded by this approach. Examples include offering students opportunities to enrich their face-to-face learning through use of in-class technologies, online resources, and interactive materials. Furthermore, many universities in the United Kingdom (UK) have invested significantly in policy, training, and infrastructure to realize this strategic aim, including the use of virtual learning environments, event capture systems, technology-equipped learning spaces, simulations/virtual experiments, mobile voting solutions, and a wide range of multimedia resources. These institutional changes have been accompanied by pedagogical changes such as an increase in the use of a flipped classroom approach, where students are provided with online learning resources (e.g., recorded lectures, computer simulations, and interactive quizzes) and use contact time with staff to consolidate learning (9). This has been facilitated by the rise of the Web 2.0 technologies, virtual learning environments, open educational resources, massive open online courses, and other internet-based educational solutions.

The term open educational resource (OER) was first introduced in 2000 in a United Nations Educational, Scientific and Cultural Organization conference, and the generally accepted definition is “digitized materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research” (28). This definition broadly includes learning content and software that can enable the use of learning content and open intellectual property licenses, which together lead to the democratization of learning resources. Rather than spending significant time producing educational materials, often with limited resources, educators can now draw on a significant pool of high-quality, freely available open educational and open access resources that can be found online [e.g., the Osmosis library of medical OERs (12)]. Large meta-analyses have demonstrated that the incorporation of such technologies into student education enhances learning outcomes (2). Blended learning approaches have been shown to be effective in enhancing learning within clinical training (25), and the use of OERs is also widespread as students move into clinical practice, with almost all residents and program directors using a combination of wikis, e-textbooks, and podcasts (23). Specific randomized controlled trials have shown that online resources such as virtual patients (17) and surgery simulators (10) produce significant improvements in learning.

However, rather than this being a liberating experience for the educator, the shift in role from the “sage on the stage” to the “guide at the side” (15) brings with it a series of barriers or issues. Educators may have a lack of awareness of these tools and technologies or lack the infrastructure or support to implement blended learning techniques into their programs [first-order barriers (8)]. Medical students and faculty have been shown to use a wide array of resources but often of variable quality, which suggests that first-order barriers may act through...
a lack of awareness of high-quality resources rather than resources per se (3). Second-order barriers occur when the educator may have the opportunity to engage with blended learning (i.e., there are no significant first-order barriers) but lacks the motivation to do so and therefore chooses not to. Often, this is a result of a lack of trust in the pedagogical effectiveness of blended learning or a personal dislike of technology (8). Finally, third-order barriers occur when the educator wishes to use blended learning but lacks the experience or knowledge to implement it effectively (27). Often these three barriers act together to create a complex set of issues that have held back the transformative potential of the new technologies (22).

The present study takes two complementary approaches to the issue of the use of OERs in medical and biomedical education. We consider OERs separately from other blended learning approaches as they involve a distinct set of challenges around openness versus copyright, producers versus consumers of resources, and the rapidly growing body of OERs with little or no control over quality. In this study, we report on a survey of educators that sought to evaluate first-, second-, and third-order barriers as described above to identify barriers and opportunities for the application of OERs in medical and biomedical higher education teaching.

METHODS

A survey was carried online between February 1, 2016 and March 4, 2016 of educators involved in the teaching of physiology and medicine at colleges and universities. The survey was designed to investigate the presence and prevalence of different barriers to the use of OERs, as outlined above. Participants were recruited through professional networks, personal contacts, and social media. Specific questions then focused on the following key areas:

1. First-order barriers (awareness): familiarity with technology (computers, smartphones, tablets, technology in general, and OERs) and awareness of sources of OERs.
2. Second-order barriers (motivation): behavior around OERs (creation, sharing, and modification), attitudes on the link between OERs and student engagement, and willingness to pay for OERs.
3. Third-order barriers (opportunity): reasons for not using OERs, support for OERs at the departmental, faculty, and institutional level, and whether students expected supplementary e-resources.

The survey collected information specific to participants on the location of the institution to evaluate geographical variations in the use of OERs; 2) percentages of time spent on teaching, research, or administration; 3) percentages of time spent teaching medical or dental students, physiology students, medical/biomedical science students, or health science students; and 4) participants’ views of the development of pedagogy in their field. Questions were validated through discussions with colleagues at the University of Leeds who provided qualitative feedback to ensure that wording was clear.

Ethics. This project had ethical approval from the University of Leeds Faculty Of Biological Science Ethical Review Committee (ref: BIOSCI 13-001).

RESULTS

Survey respondents. A total of 209 respondents completed the survey, predominantly based in North America (n = 94) and Europe (n = 73), with other respondents from Australasia (n = 11), Africa (n = 6), Asia (n = 4), and South America (n = 2); 17 respondents did not state their location. Participants were involved in teaching a variety of undergraduate programs, including medicine/dentistry (n = 97), physiology (n = 97), biomedical sciences (excluding health sciences, n = 114), and health sciences (e.g., nursing, occupational therapy, and physiotherapy, n = 102).

First-order barriers: awareness of OERs. Of 209 participants, 143 participants (68.4%) reported using OERs during their teaching. Of those 143 participants, 40 participants reported creating their own OERs, and 28 participants then went on to share their OERs with other educators. Awareness of at least one OER was almost universal, with only one respondent reporting that they were unfamiliar with any of the options presented (Fig. 1). On the other hand, 23 participants listed a total of 24 additional resources with which they were familiar and that were not in our predefined list, suggesting that there is far greater breadth of awareness than is reflected in the data. Hence we can conclude that awareness of OERs per se is not a reasonable barrier to their use in teaching. However, we received a number of free text comments to the effect that there were difficulties in identifying relevant OERs or that the time taken to browse and check existing resources was simply greater than the time needed to create resources de novo.

Second-order barriers: motivation to use OERs. If only 0.5% of educators are unfamiliar with OERs, then why do 31.6% of educators not use them? Our data suggest that there are three main problems that prevent educators from adopting OERs in their teaching, including 1) the utility of OERs in their particular classes, 2) a lack of time to modify teaching to incorporate OERs, and 3) a concern about the copyright implications of using third party resources (Fig. 2A). It is likely that these three are linked; the lack of time available to educators means that they are simultaneously unable to spend the effort to adhere to copyright legislation or seek out those resources that are most appropriate to their particular teaching needs. The significance of these logistical problems was emphasized by the data showing that most educators (171/209; 81.8%) were somewhat, very, or extremely comfortable with OERs (Fig. 2B). Hence, there is no innate motivational barrier to adoption; the lack of motivation stems from a lack of opportunity.

Third-order barriers: skills and training in OER use. The fourth reason for not using OERs given by participants was that

![Fig. 1. First-order barriers to the use of open educational resources (OERs), expressed as the number of OERs of which participants reported being aware.](http://advan.physiology.org/Download/fig1.png)
they were not sure how to incorporate OERs into their teaching (Fig. 3A). This third-order barrier was reported by 29 respondents (13.9%) and is likely to be related to other barriers, as a lack of awareness of pedagogical applications for OERs may also reduce educators’ capacity to identify suitable OERs or understand efficient methods for the incorporation of those resources into teaching. What is also worth noting is that many educators reported limited support from their institutions in the creation and use of OERs. Specifically, educators received no support or very little support from 49.8% of departments (n = 104), 45.9% of faculties (n = 96), and 40.7% of institutions (n = 85). The reduction in support at higher administrative levels might indicate a lack of overarching support from senior management for the provision of OERs, which could also be a cause of limited time that staff have available for pedagogical innovation.

**Correlates of OER use.** Having demonstrated that all three orders of barriers exist to different extents, are there any differences between OER users and OER nonusers that might help identify potential interventions to enhance the adoption of OERs more widely? t-Tests showed that there was no significant difference between users and nonusers in the degree of comfort with technology (t = 1.025, P = 0.307) or the level of departmental support available (t = 0.717, P = 0.475). However, there was a significant difference between OER users and OER nonusers in the extent of knowledge about OERs (t = −3.983, P < 0.001), with OER users aware of 4.47 (±0.15 SE) OERs compared with nonusers, who were aware of 3.45 (±0.20 SE) resources. These results suggest that, while there is widespread knowledge about OERs per se, there is an additional benefit to greater familiarity with the resources that was associated with increased rates of use.

**DISCUSSION**

This study shows that there is no single barrier to the increased usage of OERs in physiology and medical physiology education; instead, there are multiple, interlinked barriers.
Limited usage by educators is not due to a lack of awareness of the existence of OERs per se but difficulties in discovering relevant OERs, determining how best to incorporate them into existing teaching, and the time inefficiencies of discovery, checking suitability, and academic content. There is also conflicting evidence of the educational benefits of OERs and limited institutional support for their creation or utilization.

Educational benefits. Two-thirds of respondents to this survey use OERs in their teaching. While this is a clear majority, it is likely that other physiology educators are only going to follow suit and introduce OERs into their teaching if clear educational benefits or learning gains can be demonstrated. While student self-reported perceptions of learning gain achieved through engagement with OERs are clear (6, 24), evidence of actual learning gain, as determined by assessment outcomes, is lacking. OERs improve student assessment outcomes when compared with control groups who have no access to the resource or materials (4, 21); however, there is no difference in assessment performance when compared with students who receive the materials in a different format or mechanism (5). While OERs don’t necessarily promote learning gain, when appropriately used, they have other educational benefits, for example, in developing laboratory (20) or problem-solving skills (7), which should be highlighted to educators and articulated to students.

Student acceptance of OERs. While there is a significant increase in the use of e-learning, virtual learning environments, and semi and flipped classroom approaches in higher education, students still prefer face-to-face instruction (13). They are becoming increasingly consumerist in their approach to their education. Their acceptance of the use of OERs in courses depends on the benefits being clearly articulated or evident. OERs should be user friendly, requiring minimal computer knowledge or skills (14), time efficient in promoting learning compared with more traditional methods (11, 18), and integrated appropriately within the course. They are best used either in conjunction with more traditional learning methods or as supplementary learning resources (26). There are also financial benefits. Many students can spend large amounts of money on books related to their course, with some unable to afford recommended course materials. Thus, an increased use of OERs by educators can particularly be of benefit to learners from less financially secure backgrounds within developed countries and also learners from developing countries (16).

Increased creation, sharing, and adoption of OERs. An increased adoption and use of OERs by educators is only going to come about if the community works together to overcome the barriers identified in this study: discovery, ability to incorporate into existing teaching, and academic content checking.

The process has to start with OER creators designing their resources with sharing and reuse in mind rather than creating them primarily for use in their own teaching and then sharing as a secondary outcome. Resources have to be in a format or duration so they can easily be incorporated into existing teaching (e.g., short podcasts rather than entire lecture presentations) accompanied by a clear set of learning outcomes, appropriate support materials, and guidance for colleagues on their use to facilitate this. Full author details and affiliations will provide provenance and negate the need for academic content checks. The latter will promote their excellence in student education, the institutional “brand,” reducing institutional barriers. However, many will still remain, including institutional concerns about sharing educational intellectual property with competitor institutions or, alternatively, using a competitor institution’s educational resources and the negative impression this may give to students or the substantial academic and financial resources required to create excellent OERs. Funding for large-scale OER projects and repositories has also become an issue, limiting further growth in this area. In the UK, government funding for the UK OER program (19) ceased in 2012, with Jorum, the UK’s principal OER repository, closing after 13 yr in existence, in September 2016. As evidenced in this survey, many other excellent OER repositories that hold physiology OERs remain, with colleagues aware of their existence. However, these have required substantial resources for their creation and ongoing development, and therefore the continued support of individual organizations is essential (e.g., the American Physiological Society for LifeSciTRC, its repository of physiology OERs). Others have been lost or have stagnated when funding ceased (for example, OeRBITAL and the UK Royal Society of Biology’s OER repository).

As part of our contribution to this goal of sustained, online repositories for OERs, we have created an online repository to complement those already in existence. The Repository of Physiology E-resources (ROPE; http://www.fbs-wp.leeds.ac.uk/repository/rope/) is hosted at the University of Leeds and currently contains >150 resources including images, slides, apps, animations, and videos. Since the Jorum resource has closed down, ROPE was established to mirror as many of the physiology resources from that site as possible. We welcome submission of materials to be hosted on the repository and hope that ROPE can be an important companion site to other online repositories in the future by adding to the resilience of online platforms for OERs.

Conclusions. OERs can form an important part of a blended learning approach to higher education teaching, but OER use varies widely among educators in medical and physiological fields. We found little evidence for barriers related to awareness or training, but many respondents highlighted the time needed to find, modify, and incorporate suitable OERs into individualized teaching practice while adhering to copyright laws as a deterrent to the use of OERs. Use of OERs did not vary with the self-evaluated skill with technology, nor with support from institutions, but educators did use OERs more if they were aware of a greater range of resources. Our results suggest that OER use may be enhanced through two main actions: 1) by the ongoing curation of a variety of high-quality and flexible resources that can be incorporated into specific teaching cases and 2) through greater institutional support to provide the time and resource to incorporate OERs into the wider pedagogical landscape in an appropriate manner.

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