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

Authors: Christopher Hassall[1,3], David I. Lewis[2,3]

Affiliations: [1]School of Biology, University of Leeds; [2]School of Biomedical Sciences, University of Leeds; [3]University of Leeds Biosciences Education Research Group

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Corresponding author details:

Name: Christopher Hassall

Address: School of Biology, University of Leeds, Leeds, UK

Telephone: +44 0113 3435578

Email: c.hassall@leeds.ac.uk

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**Abstract**

Open educational resources (OERs) are becoming increasingly common as a tool in education, particularly in medical and biomedical education. However, three key barriers have been identified to their use: (i) lack of awareness of OERs, (ii) lack of motivation to use OERs, and (iii) lack of training in the use of OERs. Here, we explore these three barriers with teachers of medical and biomedical science to establish how best to enhance the use of OERs to improve pedagogical outcomes. An online survey was completed by 209 educators, many of whom (68.4%) reported using OERs in their teaching, and almost all (99.5%) showing awareness of at least one OER. Results suggest that key problems that prevent educators from adopting OERs in their teaching include suitability for particular classes, time, and copyright. Most (81.8%) educators were somewhat, very, or extremely comfortable with OERs so there is no innate motivational barrier to adoption. A lack of training was reported by 13.9% of respondents, and 40% of respondents stated that there was little or no support from their institutions. OER users were no more comfortable with technology or better supported by departments, but tended to be aware of a greater number of sources of OERs. Our study illustrates key opportunities for the expansion of OER use in physiology and medical teaching: increased breadth of awareness, increased institutional support (including time, training, and copyright support), and greater sharing of diverse OERs to suit the range of teaching challenges faced by staff in different subdisciplines.

**Keywords:** blended learning, open educational resource, medicine, physiology, pedagogy, online, technology.

## Introduction

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, recognising 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 UK universities have invested significantly in policy, training, and infrastructure to realise this strategic aim, including 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, interactive quizzes) and use contact time with staff to consolidate learning (9). This has been facilitated by the rise of the internet, Web 2.0 technologies, virtual learning environments, open educational resources, MOOCs and other internet-based educational solutions.

The term open educational resource (OER) was first introduced in 2000 in a UNSECO conference, and the generally accepted definition is “digitised 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, software which can enable the use of learning content and open intellectual property licences, which together lead to the democratisation 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 randomised 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 programmes (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 1$^{st}$ 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).

This study takes two complementary approaches to the issue of the use of OERs in medical and biomedical education. We consider OERs separately to other blended learning approaches as they involve a distinct set of challenges around openness vs copyright, producers vs 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 which seeks to evaluate the 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 out online between 01 February 2016 and 04 March 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:

(i) First order barriers (awareness): familiarity with technology (computers, smartphones, tablets, technology in general, and open educational resources) and awareness of sources of open educational resource,

(ii) Second order barriers (motivation): behaviour around OERs (creation, sharing, modification), attitudes to the link between OERs and student engagement, and willingness to pay for OERs.

(iii) Third order barriers (opportunity): reasons for not using OERs, support for OERs are departmental, faculty, and institutional level, and whether students expected supplementary e-resources.

The survey collected information specific to participants on (i) location of the institution to evaluate geographical variation in use of OERs; (ii) percentage of your time spend on teaching, research, or administration; (iii) percentage of time spent teaching medical or dental students, physiology students, medical/biomedical science students, or health science students; and (iv) participants' view 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.

## Results

Survey respondents

A total of 209 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), and 17 respondents did not state their location. Participants were involved in teaching a variety of undergraduate programmes, including medicine/dentistry (n=97), physiology (n=97), biomedical sciences (excluding health sciences, n=114), and health sciences (e.g. nursing, occupational therapy, physiotherapy; n=102).

1st Order Barriers – Awareness of OERs

Out of 209 participants, 143 (68.4%) reported using OERs during their teaching. Of those 143, 40 participants reported creating their own OERs, and 28 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 (Figure 1). On the other hand, 23 participants listed a total of 24 additional resources with which they were familiar and which 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.

2nd 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 (i) the utility of OERs in their particular classes, (ii) a lack of time to modify teaching to incorporate OERs, and (iii) a concern about the copyright implications of using third party resources (Figure 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 which are most appropriate to their particular teaching needs. The significance of these logistical problems is emphasised by the data showing that most (171/209, or 81.8%) educators were somewhat, very, or extremely comfortable with OERs (Figure 2B). Hence there is no innate motivational barrier to adoption – the lack of motivation stems from a lack of opportunity.

3rd Order Barriers – Skills and training in OER use

The fourth reason for not using OERs given by participants was that they were not sure how to incorporate OERs into their teaching (Figure 2A). This 3rd order barrier was reported by 29 (13.9%) of respondents 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 non-users 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 non-users 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 non-users 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 to non-users 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 is associated with increased rates of use.

## Discussion

This study has shown 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 utilisation.

**Educational benefits**

Two thirds of respondents to this survey utilise OERs in their teaching. Whilst 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. Whilst 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 to control groups who have no access to the resource or materials (4, 21) however there is no difference in assessment performance when compared to students who receive the materials in a different format or mechanism (5). Whilst OERs don't necessarily promote learning gain, appropriately utilised, they have other educational benefits, for example developing laboratory (20) or problem-solving skills (7) which should be highlighted to educators and articulated to students.

**Student acceptance of OERs**

Whilst there is a significant increase in the use of e-learning, virtual learning environments, 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

230 friendly, requiring minimal computer knowledge or skills (14), time-efficient in promoting
231 learning in comparison to more traditional methods (11, 18), and integrated
232 appropriately within the course. They are best utilised either in conjunction with more
233 traditional learning methods or as supplementary learning resources (26). There are
234 also financial benefits. Many students can spend large amounts of money on books
235 related to their course, with some unable to afford recommended course materials.
236 Thus, an increased use of OERs by educators can particularly be of benefit to learners
237 from less financially secure backgrounds within developed countries and also learners
238 from developing countries (16).
239
240 **Increased creation, sharing and adoption of OERs**
241 An increased adoption and use of OERs by educators is only going to come about if
242 the community works together to overcome the barriers identified in this study:
243 discovery; ability to incorporate into existing teaching; academic content checking. The
244 process has to start with OER creators designing their resources with sharing and re-
245 use in mind rather than creating them primarily for use in their own teaching and then
246 sharing as a secondary outcome. Resources have to be in a format or duration so they
247 can easily be incorporated into existing teaching (e.g. short podcasts rather than entire
248 lecture presentations), accompanied by a clear set of learning outcomes, appropriate
249 support materials and guidance for colleagues on their use to facilitate this. Full author
250 details and affiliations will provide provenance and negate the need for academic
251 content checks. The latter will promote their excellence in student education, the
252 Institutional “Brand”, reducing Institutional barriers. However, many will still remain
253 including institutional concerns about sharing educational intellectual property with
254 competitor Institutions or alternatively, using a competitor institutions educational
255 resources and the negative impression this may give to students, or the substantial
256 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 on this area. In the UK, government funding for the UK open educational resources (UKOER) programme (19) ceased in 2012, with Jorum, the UKs principal OER repository closing, after 13 years in existence, in September 2016. As evidenced in this survey, many other excellent OER repositories which hold physiology OERs remain, with colleagues aware of their existence. However, these have required substantial resource for their creation and on-going development and therefore the continued support of individual organisations e.g. the American Physiological Society for LifeSciTRC, its repository of physiology OERs is essential. Others, for example OeRBITAL and the UK Royal Society of Biology's OER repository have been lost or have stagnated when funding ceased.

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.

## Conclusion

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 find little evidence for barriers related to awareness or training, but many

respondents highlighted the time needed to find, modify, and incorporate suitable OERs into individualised 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: (i) by the ongoing curation of a variety of high quality and flexible resources that can be incorporated into specific teaching cases, and (ii) through greater institutional support to provide the time and resource to incorporate OERs into the wider pedagogical landscape in an appropriate manner.

## Ethics

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

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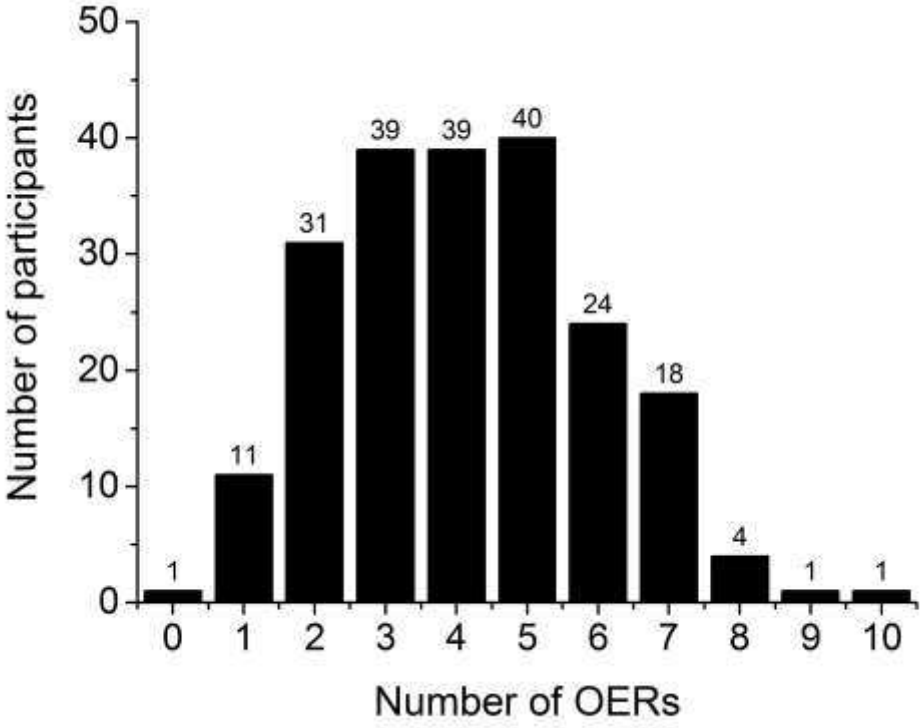
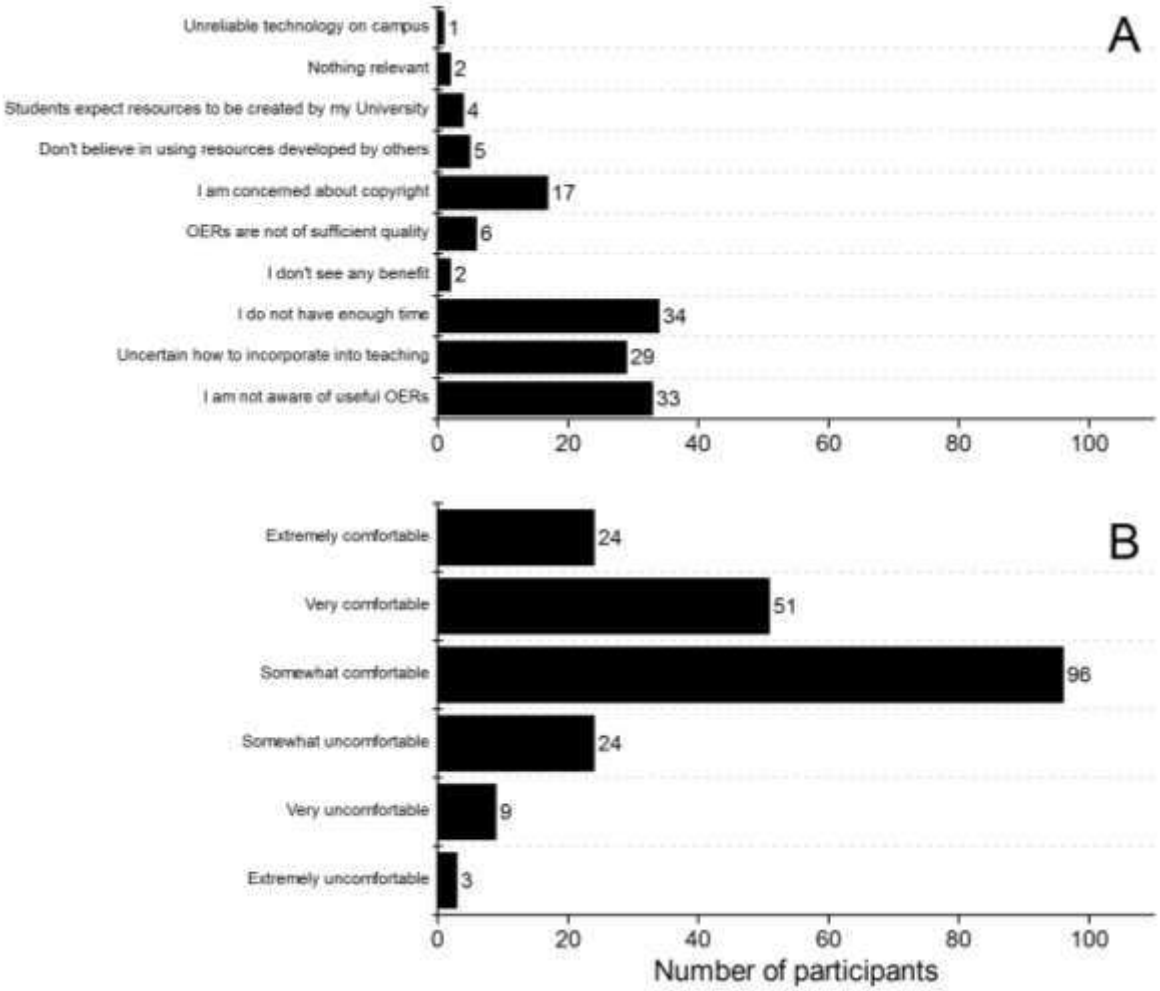
377 **Figures**




378

379 Figure 1: First order barriers to the use of open educational resources (OERs),

380 expressed as the number of OERs of which participants reported being aware.

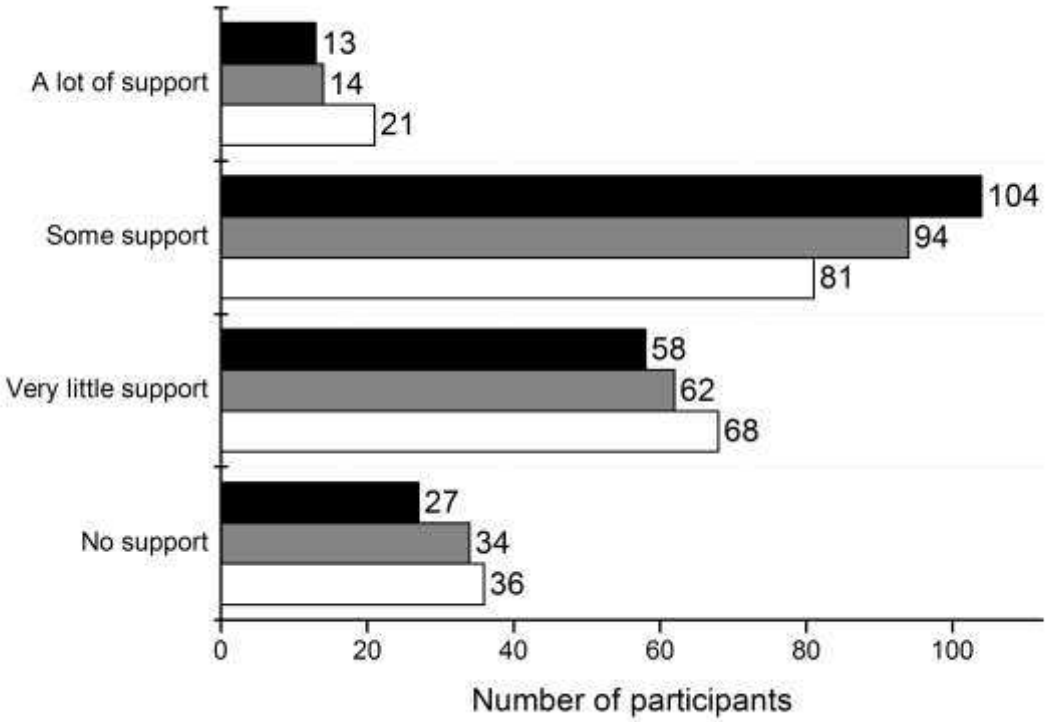



381

382 Figure 2: Second order barriers to the use of technology expressed in terms of (A)

383 specific issues with the implementation of online educational resources (OERs), and

384 (B) self-rated confidence in using OERs.




385

386 Figure 3: Third order barriers to the use of open educational resources in terms of

387 support at institutional (black), faculty (grey), and departmental (white) level.