



Open educational resources (OER) in higher education courses in aquaculture and fisheries: opportunities, barriers, and future perspectives

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Abstract

The purpose of this study was to evaluate whether educators and students in the aquaculture and fisheries sector might use and benefit from Open Educational Resources (OERs). The use of OERs has the potential to increase teaching efficiency, increase quality of teaching, and reduce economic and geographic barriers to education. The main barriers to use are academic competition between institutions and educators, low awareness and availability of OERs and copyright policies, mistrust in OER quality, and technological limitations around adaptation and sharing. This study used online questionnaires of students and educators in aquaculture and fisheries subjects to examine perspectives and opinions on OERs and other online educational resources. Questionnaire data showed that a demand for OERs exists from both educators and students, who already utilize online materials for learning and teaching. Furthermore, students were more likely to enroll and respect institutions that offered OERs but were not willing to pay higher tuition fees. Despite the demand, little OER material exists for higher education in the aquaculture and fisheries sector, mainly due to lack of awareness, institutional support, and technological structure, which are common barriers found in other sectors. This paper concludes that OER initiatives associated with higher education institutions in aquaculture and fisheries subjects have the potential, in theory, to support the enhancement of a skilled workforce that will meet the increasing global demand for seafood production.

Keywords Aquaculture · Aquatic resources management · Fisheries · Higher education · Learning · OER · Open educational resources · Pedagogical innovation · Rural development · Teaching · Training

Abbreviations

CC Creative Commons (Licensing)
MIT OCW Massachusetts Institute of Technology's OpenCourseWare

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MCA	Multiple correspondence analysis
OER	Online Education Resource
ORP	Online Resource Practices
UNESCO	United Nations Educational Scientific and Cultural Organization

Introduction

UNESCO defines OERs as “any type of educational materials that are in the public domain or introduced with an open license. The nature of these open materials means that anyone can legally and freely copy, use, adapt, and re-share them. OERs range from textbooks to curricula, syllabi, lecture notes, assignments, tests, projects, audio, video, and animation” (Hoosen 2012). Creative Commons (CC) licensing is the most common OER copyright licensing, and allows authors to specify usage policies surrounding permission to copy, modify and redistribute, and whether or not users must acknowledge the original author in any versions (CreativeCommons.org 2017).

As the importance of OERs is increasingly recognized in international policies (Cape Town Open Education Declaration 2017, European Commission 2013, UNESCO 2012, Bologna Declaration 1999), individual countries have responded with national OER centers such as the Australian DEHub or OERAfrica (Falconer et al. 2016). Both national and private higher education institutes have established OERs and OER repositories (Wiley 2007). Falconer et al. report that as of 2016, there were over 1700 courses from seven university-based projects in the USA, 451 courses from 176 university members in China, 350 courses from ten universities in Japan, and 178 courses by 11 universities in France.

Increased utilization and dissemination of OERs have potential benefits, including increasing collective efficiency of educators (Hoosen 2012), increasing the average quality of teaching and breadth of course offerings (Hoosen 2012; Falconer et al. 2016), and reducing economic and geographic barriers to higher education (Butcher and Hoosen 2012). The most significant barriers to OER use are academic competition and branding (Dholakia et al. 2006; Ehlers 2011; Falconer et al. 2016; Sexias et al. 2014), low awareness and availability (Sexias et al. 2014), quality and trust concerns (Grodecka and Sliwowski 2014; Clements and Pawlowski 2012), and ease of technological integration (Atkins et al. 2007; Clements and Pawlowski 2012; Kortemeyer 2013; Sexias et al. 2014).

Champions of OERs believe that OERs associated with and/or developed by institutions have “the potential to generate indirect revenue by marketing institutions’ reputation and the quality of their materials, which may convince [prospective] students to enroll in fee-paying courses” (Butcher and Hoosen 2012). Massachusetts Institute of Technology’s OpenCourseWare (MIT OCW) analysis found that 35% of prospective freshmen who were aware of the OCW project said that their decision to attend MIT was influenced by the project and its availability (Carson 2006), although this result may be confounded by the pre-existing prestige of the university. Regardless, the repository is clearly utilized: MIT OCW usage metrics show that the repository receives over 1 million visits per year, and 46% of educators reuse its material (Bentley and Chib 2016).

MIT OCW and Rice University’s Connexions have reported benefits in improved efficacy and are satisfied with the quality, distribution, and breadth of topics (Bentley and Chib 2016; Dholakia et al. 2006). Higher institutions’ educators have seen improvements in the efficacy of their lessons after incorporating OERs (Bentley and Chib 2016). Houston Community College’s Mathematics department’s OER inclusion program found that the program made no

difference in students' grades, but that students saved money and both students and educators had overall positive experiences with the OER materials implemented (Hilton et al. 2013).

Research currently offers little quantitative data on the wider impact of these repositories, possibly because either the movement is too young to have realized measurable impact, or because these data are difficult to collect, particularly quantitative data describing the impact on impoverished or marginalized communities (Bentley and Chib 2016). India has been a leader of the OER movement in Asia but, apart from “click” rates, few studies have been conducted to assess the effect of these initiatives (Das 2011). The usage of OERs in higher education both in and out of India has not met expectations due to unaddressed adoption barriers (Kortemeyer 2013; Falconer et al. 2016). While many OERs adopters have seen anecdotal benefits and show great potential, usage does not seem to be extensive due to the lack of ORPs (Open Resource Practices) and difficulty evaluating efficacy in a quantitative manner (Kuman 2009). Researchers at Athabasca University suggested that the University's OER implementation program, including training and institutional support, positively influenced OER adoption and allowed organizers to develop quantify impact metrics through engagement (McKerlich et al. 2013).

OERs in Aquaculture and Fisheries

With barriers appropriately addressed, the aquaculture and fisheries community may benefit from the use of OERs and ORPs that are learner-centered, robust enough to stand independently from other pedagogical resources, and accessible via internet, as these characteristics facilitate lifelong learning and access to education regardless of geographic or economic barriers (Sexias et al. 2014). These features may be particularly relevant in aquaculture and fisheries studies, where the evolving industry's production relies on knowledge from a variety of disciplines, such as biology, engineering, and business (Eleftheriou and Sexias 2014).

In theory, the free nature of OERs may enhance accessibility for farmers in impoverished communities, who may not have financial resources for paid materials. While these farmers may not have access to a computer, the number of mobile smartphones and cheap data plans in developing areas is on the rise (Tabuenca et al. 2012). Mobile smartphones could eventually provide these learners with access to OERs (Tabuenca et al. 2012), provided OER designs were compatible with smaller screens and other constraints imposed by this technology. The degree of impact would depend on the variety of languages in which the materials were provided (Tabuenca et al. 2012).

OERs dedicated to aquatic sciences are still in their infancy. The European Commission's VOARAA (EC 2017) and the AQUA-TNET's project AquaCase 3.0 (Norwegian University of Life Sciences 2016) were OERs dedicated to aquaculture and fisheries, but both have stalled due to lack of funding despite massive initial investments. While the VOARAA has been terminated, the AQUA-TNET's AquaCase 3.0 website is the most exemplary project of OERs in aquaculture and fisheries and is still maintained by two volunteers. The AQUA-TNET community hopes to continue and expand on the success of AquaCase in the EU Horizon2020 project “EURASTiP” that will run from 2017 to 2019 (EU 2017).

In future initiatives, such as deployed by EURASTiP, aquaculture and fisheries educators and policy-makers will require data to guide decisions around directing funds, including whether or not to invest in OERs. This paper aimed to explore students' and educators' perceptions and current usage of OERs in the higher education aquaculture and fisheries sector, in order to gather quantitative and qualitative data on the potential feasibility, demand for, and use of future OER initiatives in the aquaculture and fisheries community.

Methods

This study used two online, un-proctored, open-mode questionnaires aimed at students and educators in the aquaculture and fisheries sector. These questionnaires were part of a larger project at the University of Stirling's Institute of Aquaculture, part of which examined the current use of online educational materials and OERs, perspectives on barriers to use, and whether respect for institutions and educators was associated with whether they offered OERs (Pounds 2017).

Both surveys requested basic demographic data and asked about how respondents usually searched for and used online materials for educational purposes. The questionnaires then differentiated: the student questionnaire asked how their respect for institutions and teachers changed should OERs be offered and used at the institution. Separate from respect, it asked whether students would be willing to pay more to enroll in institutions that offered OERs. In contrast, the educators' questionnaire asked whether they looked for specific licensing information before reusing information to examine the assumption that higher educators actively adhere to copyright licensing. Neither survey inquired as to type of resources used, in order to shorten the surveys and focus on perspectives and needs of usage rights rather than preferred learning methods.

The questionnaires were designed using methods described by Callegaro et al. (2015) and tested using cognitive testing methods described by Collins (2003) and Krosnick (1). Both questionnaires used a mix of open-ended, closed, nominal response, agree/disagree statements, and a vignette to check respondents' accuracy on perceived versus actual behavior and for gamification purposes. Questions were grouped by topic and became more specific to OERs towards the end of the survey so as not to bias initial responses to online material usage (Callegaro et al. 2015). The questionnaires were submitted to and approved by the University of Stirling's Ethical Review Panel prior to testing and administration.

Questionnaires were administered through Google Forms software and promoted through social media, blog postings, and email networks. Both surveys were accessible via a landing page, which advertised a raffle with monetary reward. Convenience sampling was used, targeting educators and students in higher education aquatic sciences globally. The survey was kept open for approximately 6 weeks.

The survey had several limitations. Results may have been affected by self-selection bias as well as over-reporting of altruistic beliefs (Krosnick 1999), which could bias results towards OER development. The limited scope of the project inhibited the compilation of an accurate sampling frame, which meant the results could not be extrapolated to the entire population. Furthermore, the timescale of the project did not allow for the surveys to be translated and tested in several languages; therefore, the respondents were limited to English speakers. As with all surveys, it may have been affected by acquiescence, non-differentiation, and decision fatigue.

Binomial confidence intervals at 95% confidence levels estimated sampling error to interpret whether the results could be extrapolated to the entire population, questionable due to uneven distribution among regions. As many regions had limited number of responses, the binomial confidence intervals were calculated using methods that are appropriate for smaller sample sizes, as described by Wilson (1927). Chi-squared tests were used to examine differences in responses between students and educators (Wilson 1927). In some cases, a Yates' continuity correction was applied to the chi-squared test because the sample distribution was not a continuous chi-squared distribution (Wilson 1927). Multiple correspondence

analysis (MCA) was used to compare responses from similar questions, which could indicate overarching shared values that drive similar responses between certain groups of respondents. Binomial confidence intervals were calculated in Excel (2013), while chi-squared tests and MCA analysis were calculated in RStudio, using methods outlined by the RStudio User Manual (RStudio Team 2015).

Results

Most respondents were full-time postgraduate students or educators who taught postgraduate students in the aquaculture subjects (Table 1). Other subjects included those related to aquaculture and fisheries, like capture fisheries, environmental management, and biotechnology. Most respondents were located in Europe and Asia, followed by a smaller number of respondents in North America, South America, Africa, and Oceania. Because a sampling frame was beyond the scope of the project and language was a large barrier to participation, inter-region comparisons based on geographical population distribution were not possible.

The completeness status was measured by the question non-response rate, which was calculated by averaging how many questions were skipped within a completed questionnaire. For educators, the non-response rate was 9% (ranging from 3 to 28%) and the student rate was lower at 2% (ranging from 0 to 19%). Much of the educator non-response was in the OER opinion statements at the end of the questionnaire. The educator opinion statements had an item non-response rate of 23%, whereas the student opinion statements had an item non-response rate of less than 1%. In the qualitative comments, five educators explained that their non-response was because they felt that they did not have enough information or experience with OERs to form an opinion. For example, one educator wrote: “I cannot answer most of the questions on this page as I have never heard of OERs before.” None of the students said that they did not have enough information or experience with “online materials” to form opinions. Both educators and students had higher item non-response rates for open questions than for closed or nominal questions. Google Forms was not able to record break-off rates; as such, it was not possible to measure or compare non-response in the contact phase (initial advertisement) versus the cooperation phase (mid-survey).

Educators responded that they use online educational materials to learn (95%), to prepare for their lessons (96%), and within their lessons (93%). Students responded that they use online materials for learning (91%) and that they are not willing to pay for online materials (93%).

Table 1 Demographics of student and educator respondents

	Students	Educators
Total number of respondents	109	77
Postgraduate	82	47
Undergraduate	16	36
Continued professional development (CPD)	7	13
Vocational	0	5
Aquaculture	84	45
Capture Fisheries	6	6
Both	16	5

Figures 1 and 2 show educator and student responses, respectively, to agree/disagree opinion statements at the end of the questionnaire. Individual non-response for this subset of educator opinion statements ranged from 16 to 26%, whereas student opinion statement non-response was only 0 to 2%.

In a scenario exercise, educators were given some online materials from the AquaCase 3.0 website and asked to imagine how they might prepare a lesson using those materials. The percentages represent the number of respondents who answered “yes” to the following questions: “Did you look for licensing information in the scenario?” (54%), “Do you normally look for licensing information before using online materials?” (59%), “Have you heard of OERs?” (19%), and “Have you heard of Creative Commons licenses?” (53%). In addition, 64% of educators reported that they use others’ lecture slides in their lessons.

As shown in Fig. 3 a and b, respondents reported that they usually used general search engines like Google and topic-relevant academic journals to locate materials. Students confirmed this self-analysis in the scenario exercise, where 79 out of 109 students (72%) actually used a general search engine like Google to search for materials. As educators were provided materials in their scenario exercise, the results only reflect what educators think they do and not necessarily what they actually do. Students reported receiving online materials from their supervisors significantly more than teachers reported receiving online materials from their superiors (using a chi-squared test, p value = 0.005).

Educators’ qualitative comments commonly used the following words: “easy,” “good,” “online,” “illustrate,” “help,” “visual,” “update,” “videos,” and “diverse.”

As shown in Table 2, materials associated with a respected university or respected researchers were most commonly trusted sources. Table 3 shows student opinions on OERs associated with higher education institutions.

MCA statistical analysis was selected to find associations between student respondents who answered similarly to “OERs can be high quality” (labeled “quality”), “I would have more

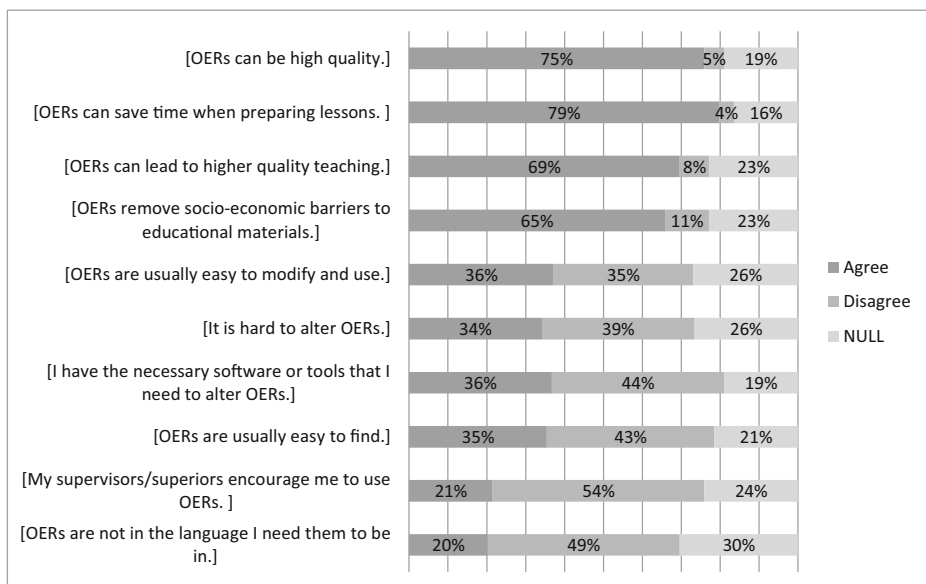


Fig. 1 Educator responses to opinion statements

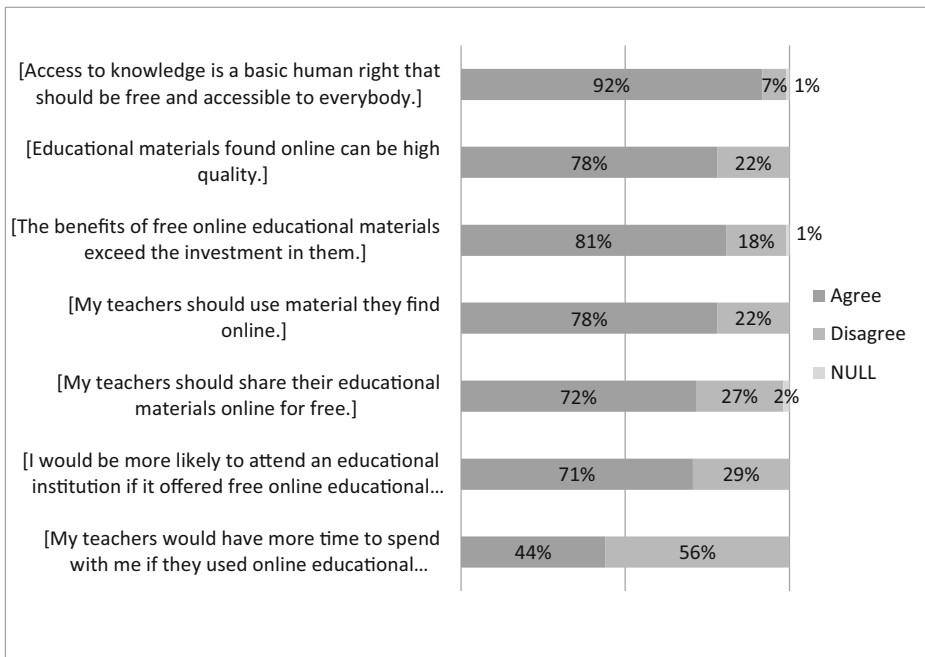


Fig. 2 Student responses to opinion statements

respect for institutions that offered OERs” (labeled “respect”), and “I would be willing to pay more for tuition if the institution offered OERs” (labeled “pay”). Table 4 shows the results for each of these questions.

Figure 4 from the MCA results shows that those who answered that they were willing to pay more tuition (Pay-Y) were also likely to answer that they would have more respect for an institution that offered OERs (Respect-Y) and that OERs can be of high quality (Quality-Y). Respondents who were not willing to pay more tuition (Pay-N), were not likely to have more respect for an institution that offered OERs (Respect-N) and did not agree that OERs could be of high quality (Quality-N) were not associated, as seen by their separation of the secondary dimension.

Table 5 shows the percentage of students and educators that agreed with the following opinion statement: “OERs have a role in the classroom” (Classroom), “OERs can be high quality” (Quality), “OERs save teachers time” (Time), and “OERs have altruistic benefits” (Altruistic). These opinions were compared using an MCA.

Figure 5 illustrates the results of a MCA looking for associations between opinions for all respondents. People who agreed that OERs would save teachers time (Time_Y) were more likely to agree that there were altruistic benefits to OERs (Altruistic_Y), as the figure shows that these factors are separated by the others by both dimensions. Also separated by both dimensions, those who believed that OERs could be of high quality (Quality_Y) were more likely to respond that OERs had a place in the classroom (Classroom_Y). Those who disagreed that OERs could be of high quality (Quality_N) were more likely to respond that OERs did not have a place in the classroom (Classroom_N). There was not a strong association with those who disagreed that OERs saved teachers’ time (Time_N) or that OERs did not have altruistic benefits (Altruism_N), as these points are quite spread out on the figure. The shaded areas in

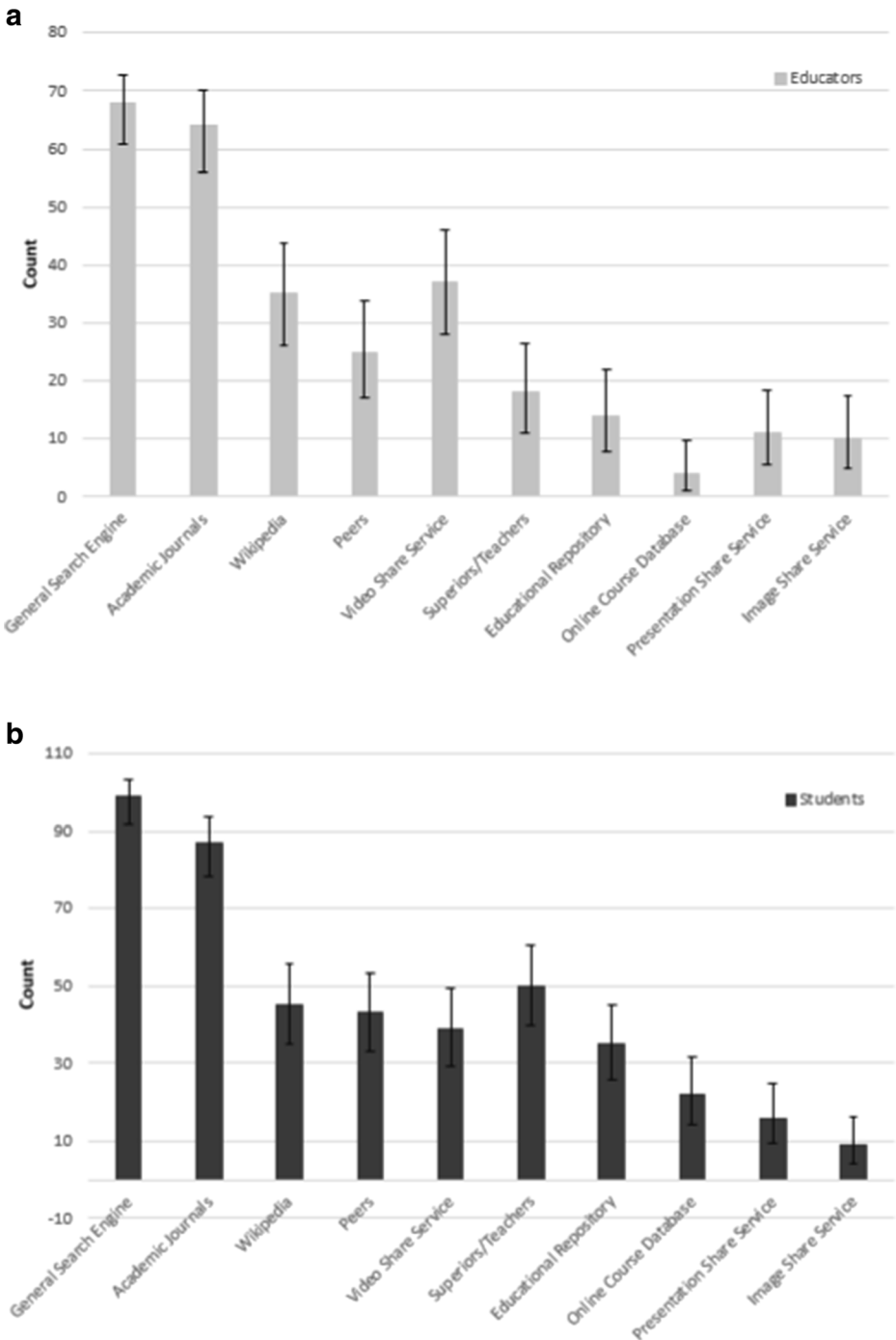


Fig. 3 **a** Educator methods of locating materials with 95% confidence intervals. **b** Student methods of locating materials with 95% confidence intervals

Table 2 How students trust the quality of materials (multiple answers allowed)

Method of trust	Percent of students in agreement
It's associated with a respected university	71%
It's associated with a respected researcher	66%
It's associated with a government organization.	47%
The material looks professional.	22%
It has many citations	52%
Other	10%

this figure show that educators were more likely to agree with all four statements, whereas students had a broader distribution of answers.

Discussion

Current use

Most students and educators in higher education already utilize online educational materials. Educators depend on online materials to construct and prepare for their lessons, using online materials as supplements to their own original educational materials as a way to save time when preparing lessons and increase the variety of educational materials offered to students. Other research has also found that digital tools, including e-tools and tools related to mobile table devices (Park and Burford 2013), are increasingly sought out in both formal and informal education settings (Riehemann and Jucks 2017; Trinder et al. 2008).

Drivers

Student and teacher comments generally reflected positive perceptions of online educational materials. When describing reasons for using online educational materials or OERs in the open answers, many educators believed these materials were easy to use, could be updated, offered a variety of diverse materials that were visual or illustrated, and were of good quality.

Students and educators agreed that freely accessible online educational materials have altruistic benefits, such as removing socioeconomic barriers to education and increased access

Table 3 Student opinions on free online resources and higher education institutions

Opinion	Percent of respondents who answered “yes”
Do you think that higher educational institutions should offer free online educational materials?	92%
Would you be more likely to enroll in higher educational institutions that offered free online educational materials?	73%
Would you respect a higher educational institution more if it offered free online educational materials?	75%
Would you be willing to pay more tuition if the higher educational institution offered free online educational materials?	39%

Table 4 Student response rates on various agree/disagree statements

Question/Statement	Agree/yes	Disagree/no	Null
Educational materials found online can be high quality. (quality)	85	24	0
Would you respect a higher educational institution more if it offered free online educational materials? (respect)	82	26	0
Would you be willing to pay more for tuition if the higher educational institution offered free online educational materials? (pay)	43	66	1

to knowledge as a basic human right. Students believed that the benefits of free online educational materials exceed the investment in them.

Students may have been more likely to respect higher institutions that offer OERs because they believed these had contributed to increased access to knowledge as a basic human right. Students believe that while online educational materials could be of high quality and would enhance their respect for institutions that offered them, they were unwilling to pay more for these materials or to pay more tuition to attend an institution that offered them. These data and MCA suggests that higher education institutions, much like MIT OCW (Carson 2006), should offer OERs, but should not alter student tuition rates in response.

Student comments also indicated that just because they believed OERs would be beneficial, they thought the creators should still be compensated for sharing their work. For example, students commented: “I think nobody should be made to do stuff for free. That is why I disagree with the

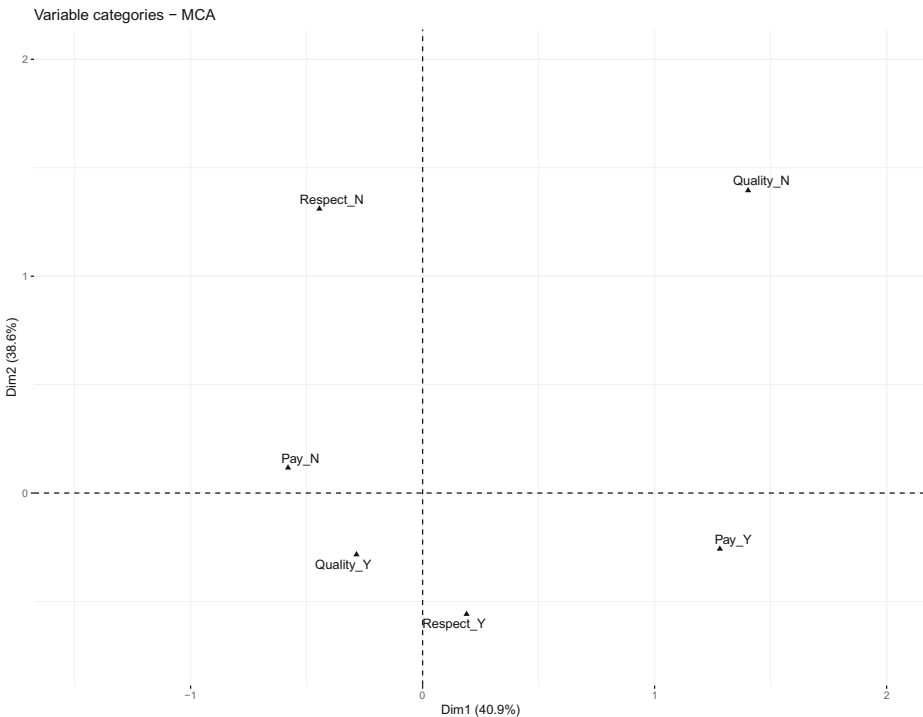


Fig. 4 MCA Factor map associating students’ opinions on “OERs can be high quality” (quality), “I would have more respect for institutions that offered OERs” (respect), and “I would be willing to pay more tuition if the institution offered OERs” (pay), including data points

Table 5 Educators and students response rates to opinion statements

	Classroom	Quality	Time	Altruistic
Students	78%	78%	44%	81%
Educators	69%	75%	79%	65%

knowledge is a basic right question, because at that point you ask people who research (and work hard to do it the right way) to give away what they work for free. Is that fair?” and “I am a big believer in free knowledge, but appreciate that people have to be paid to provide an education.”

Those who believed OERs had altruistic benefits also believed that OERs saved teachers’ time and had a place in the classroom. Both students and educators were in agreement that OERs have a place in the classroom due to higher-quality teaching and time-saving during teaching preparation. This could be demonstrating an opinion that sharing materials benefits both students and teachers from a variety of socioeconomic environments or that this group of people believed that OERs can improve the learning experience. The converse was also true, suggesting that people’s opinions on whether OERs have a place in the classroom depends on their perception as to the quality of materials. The analysis also shows that educators were more likely to agree to all four statements while students’ opinions were more diverse; however, the data do not describe why.

Barriers

Educator and student responses and qualitative comments reflected that lack of awareness, lack of trust in quality, difficulty in modifying resources, and language were major barriers to usage. While pedagogical concerns mostly revolved around OERs reducing the originality of teaching, these were concerns rather than barriers.

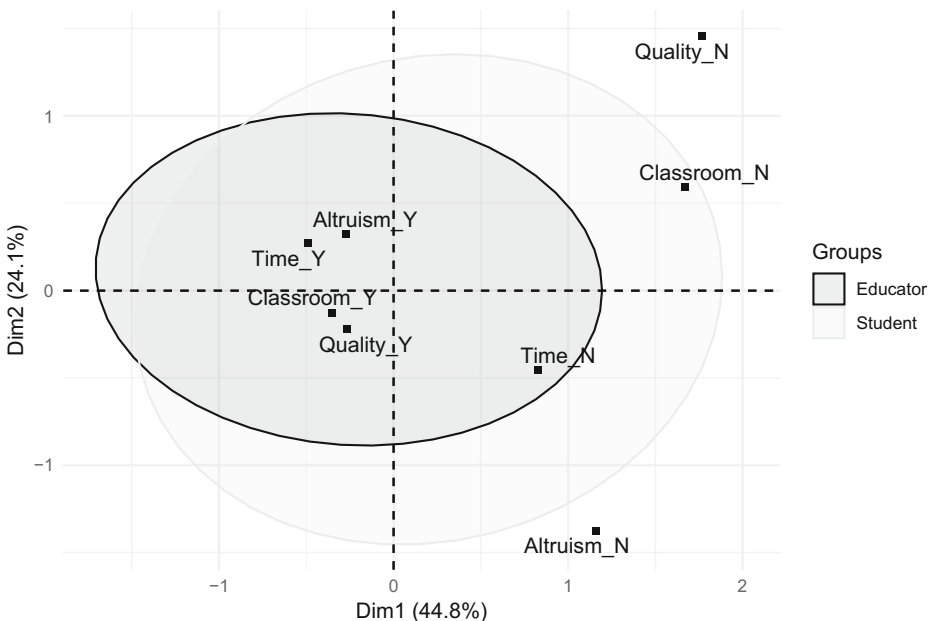


Fig. 5 MCA factor map associating educators’ and students’ opinions (excluding blank answers)

Lack of awareness

Educator responders were unaware of the difference between “OERs” and “online (educational) materials,” and, as such, this discussion uses the terms interchangeably. Over 50% of educators revealed that they do not usually look for copyright usage permissions when using online materials to prepare or use in a lesson; educators thought they could use any online material for educational purposes, as long as they referenced it. While non-response may have been a result of waning motivation or mental fatigue towards the end of the survey, five educators’ comments revealed that they felt that they did not know enough about OERs to form an opinion. For example, comments included, “I cannot answer most of the questions on this page as I have never heard of OERs before.”

In contrast, more educators had heard of Creative Commons licensing; however, comments on the scenario exercise also reflected a lack of awareness and practice. For example, comments included: “It’s been brought to my attention that I need to be better at checking permissions,” and “I am missing a question on quoting the information used from such resources—many [fellow] lecturers tend to use the information found in internet (text/photos, etc.) but they do not add information concerning the authorship.” While both quotes express opinions that educators lack appropriate practices, the latter commentator indicates that this educator uses material regardless of licensing, but feels that attributing the original author is enough to respect intellectual property. These results show that educators are already using online materials, possibly illegally breaching property rights due to misconceptions around best practices. This result supports the common argument that copyright licensing may be inferior to OER licensing in protecting the author’s intellectual property (Grodecka and Sliwowski 2014) unless the former is actively defended.

High levels of educator non-response contrasted with low levels of student non-responses. Students may not have experienced the same reservations because they were asked about online educational materials rather than OERs, which have more nuanced complexity around licensing issues. Because students are learners, their needs for OERs and online educational materials are different than those of teachers, and their usage is not impinged or restricted by copyright policies. Differences in copyright rules do not affect the use of these materials for students who are always expected to submit original work.

Low rates of receiving online materials for educational use and lack of encouragement from superiors reflect minimal sharing of materials among educators. While some of the respondents may be senior staff without supervisors who are involved in their work at that level of detail, the results of these questions suggest that institutions may not be supporting educators to use OERs or facilitating awareness of these materials. In contrast, educators commonly encourage and send online materials to their students. Students are encouraged by their superiors to utilize online educational materials significantly more than educators are. Despite the lack of institutional support and encouragement for OER usage, both teachers and students still seek out online material independently to enhance student learning. Rather, this effect may be decelerating proliferation and preventing increased awareness of best practices.

Lack of Trust in Quality

While educators and students believed that online materials could well be of high quality, there were many responses that considered the issue of trust. Although educators possess the level of expertise required to quickly judge the quality of a material, they still had reservations about

finding quality materials. Students with less experience are at an even greater disadvantage when judging the quality of online materials. For students, associating materials with a respected institution was the most common way of trusting whether or not the material was high quality. This suggests that OERs associated with respected universities might have reduced barriers related to quality concerns.

About the same number of educators agreed that “OERs are easy to find” and “OERs can be hard to find.” This result could be confounded with lack of awareness: it is unclear from the structure of the survey whether educators thought OERs were hard to find in general, or high-quality OERs were hard to find. This further suggests that transparency around quality is a barrier to use.

Difficulty modifying resources

About the same number of educators agreed that “OERs are easy to modify” and “it is hard to alter OERs.” These responses may depend on the needs of the educator and the format of the material used. For example, materials in Microsoft Word format in the educator’s native language may be considered easy to alter, whereas video materials in a foreign language may be considered difficult to alter. The nuances are not determinable from these survey data.

Several educators brought up the importance of originality in teaching, and open response comments by both educators and students reflected concerns that OERs might devalue the intellectual work involving teaching; however, having original materials did not seem to be as important, as opinion statement responses showed that educators disagreed that OERs diminish the role of teaching and that reusing others’ materials was acceptable. The need for originality and preserving value seemed to be about the interactions and process of communication between students and educators, rather than about the educational materials. This reflects that there is a need to compile and modify sources to create original packages of materials and classes, rather than original materials. Easily modifiable materials might allow educators to maintain a sufficient level of originality in their lessons.

Language

More educators disagreed that materials were usually in the language they needed them to be in. This suggests that language is a barrier to use, as in other sectors. Further, this result is likely understated due to survey bias: as the survey was written in English, respondents would have to speak in English in order to complete the survey, and hence, may not require that OERs are in languages other than English. Difficulties with OER languages may be higher in the entire population.

Conclusions

Analysis of the survey data suggests that OERs associated with higher education institutions have the potential to benefit educators, students, and institutions in the aquaculture and fisheries sector. This study found that both students and educators in the aquaculture and fisheries sector across a variety of regions already use online materials for learning; as such, OERs would be utilized within the aquatic management sciences sector, as long as those OERs were of high and transparent quality, easily accessible, and easily modifiable. Respondents agree that high-quality OERs have a valuable place in the formal classroom and in society, although usage would depend on increasing awareness, increasing transparency around

quality, developing user-friendly modification and hosting technology, and developing training in both the use of technology and best practices for including OERs in the classroom.

OERs have the potential to increase access to high-quality education in remote and low-income communities that are common to the aquaculture sector, as well as to increase teaching efficiency and quality within formal education settings such as higher education institutions. Despite concerns about competition with other institutions, institutions could benefit from producing OERs that would promote their brand and potentially increase enrolment. Educators would also benefit from OERs because OERs would reduce the amount of time required to prepare for lessons. Government organizations that reallocate existing educational funding to OER initiatives could increase the extended impact of funding and therefore reduce expenditure over time.

Should the aquaculture and fisheries sector develop OER initiatives, their success would depend on implementation programs and effective ORPs that encouraged and supported contribution as well as utilization in the classroom. With increased training on reuse permissions, it is feasible that OERs could become favored over online materials with more restricted usage rights, as educators would become more aware that reuse is not always allowed even if a reference is given. Implementing these ORPs may avoid aquaculture and fisheries OERs from low usage rates, which have plagued other sectors' OER initiatives.

This data suggests that funded project objectives should include developing quality online resources and ORPs to benefit the aquaculture and fisheries community. OER initiatives that include these actions have the potential to increase equal access to education within the aquaculture and fisheries sector, leading to an enhanced skilled workforce that could drive innovation and development as the sector strives to meet the growing global demands for seafood.

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Compliance with ethical standards

Ethical approval This article does not contain any studies with animals performed by any of the authors.

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