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The Pedagogical Enhancement of Open Education: An Examination of Problem-Based Learning

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Article abstract

Open education, as embodied in open educational resources (OER) and OpenCourseWare (OCW), has met and dealt with several key problems. The movement now has a critical mass of available content. Leveraging no small amount of funding and associated development, open education has the tools to collect, disseminate, and support the discovery of open materials. Now that the foundation for openness has been laid, practitioners are experimenting with new kinds of education and pedagogies associated with open content (Weller, 2009; di Savoia, 2009). Problem-based learning is one of many progressive pedagogies that might be combined with open education. This paper defines problem-based learning in the context of open education. Unique challenges are presented and discussed alongside possible solutions, realistic limitations, and calls for implementation in the future to test validity.

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The Pedagogical Enhancement of Open Education: An Examination of Problem-Based Learning

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Abstract

Open education, as embodied in open educational resources (OER) and OpenCourseWare (OCW), has met and dealt with several key problems. The movement now has a critical mass of available content. Leveraging no small amount of funding and associated development, open education has the tools to collect, disseminate, and support the discovery of open materials. Now that the foundation for openness has been laid, practitioners are experimenting with new kinds of education and pedagogies associated with open content (Weller, 2009; di Savoia, 2009). Problem-based learning is one of many progressive pedagogies that might be combined with open education. This paper defines problem-based learning in the context of open education. Unique challenges are presented and discussed alongside possible solutions, realistic limitations, and calls for implementation in the future to test validity.

Keywords: Open education; problem-based learning; open educational resources; higher education

Introduction

For various reasons, open educational resource (OER) archives are beginning to lose external support, including the OpenCourseWare initiative at Utah State University (Perry, 2009). This comes at a time when organizations like the OpenCourseWare Consortium (2009) are starting to charge educational institutions for membership. Now more than ever, OER is in a position of needing to find ways to defray costs (Downes, 2007) or to show value to the organizations that fund them.

One possible means of showing value is partnering OER with established, vetted, and well-researched approaches to teaching and learning. Scholars are beginning to push for an

examination of the underlying pedagogies of OER and are even calling for materials that are much more progressive in their orientation (Weller, 2009, di Savoia, 2009). OER is perhaps uniquely positioned for this kind of partnership. Whereas learning objects are criticized for being a technical or engineered solution to a fundamentally pedagogical problem (McGreal, 2004), OER is comparatively less about standards and more about the pedagogically neutral concept of openness. Although there are several pedagogical approaches that OER might be partnered with, this review provides an examination of problem-based learning (PBL). As a fundamentally progressive approach, PBL answers the call of Weller (2009) with a whole host of literature, a meta-synthesis (Strobel & Barneveld, 2009), and several meta-analyses (Walker & Leary, 2009). The purpose of this review is to examine problem-based learning open educational resources (PBL OERs) and to explore the potential for a mutually beneficial relationship between the two areas of inquiry.

Because a combination of PBL and OER is scarce in scholarly writing and in empirical work, searches in each area were conducted largely in parallel. For PBL, search terms included *problem based learning* and *problem-based learning*. For OER, search terms included *open educational resources* and *free educational resources*. Sources included ScienceDirect, Wiley Online Library, EBSCO, and PubMed. For references covering both areas of research, variations on PBL were combined with the terms *free*, *open*, or *resources*. Given the emergent nature of the work, and the combination of quantitative and qualitative studies included, a qualitative literature review (Ogawa & Malen, 1991) was conducted.

Problem-Based Learning

PBL is a particularly good fit with OER. PBL has a reasonable amount of empirical research. It is progressive in its alignment, yet it needs to draw on a range of resources, including both expert-centric and those that are more egalitarian in nature. PBL is particularly efficacious with non-traditional student populations (Doucet, Purdy, Kaufman, & Langille, 1998) endemic to open education experiences. Arising in medical schools in the late 1960s, PBL is a learner-centered instructional approach (Barrows, 1996). PBL consists of student-centeredness, teachers acting as facilitators, small group learning, and beginning with problems that are ill structured and authentic (Barrows, 1986; 1996).

PBL has been widely adopted and applied in a variety of social science disciplines since its inception in medical education. Initial writing about PBL was coupled with ambitious aims for the development of domain or content knowledge structured for problem solving, as well as for problem-solving skills, for critical thinking and reasoning, for self-directed learning, and for increased motivation for lifelong learning (Barrows, 1986). According to the empirical research base, those aims have been largely met. When compared to lecture-based students on their general content knowledge alone, PBL students appeared to perform slightly worse initially (Albanese & Mitchell, 1993; Vernon & Blake, 1993), but subsequent research showed that they perform at about the same level (Dochy, Segers, Van den Bossche, & Gijbels, 2003; Gijbels, Dochy, Van den Bossche, & Segers, 2005; Walker & Leary, 2009). When assessments become more complex, asking students to explain the underlying relationships between concepts or to

apply their knowledge in the solution of novel problems, PBL students perform markedly better (Gijbels et al., 2005; Walker & Leary, 2009). PBL also results in better retention over time (Strobel & Barneveld, 2009) and has shown particularly positive results with adult learners (Doucet et al., 1998) and in disciplines outside of medical education, including teacher education, social sciences, and business (Walker & Leary, 2009). Overall, the learning outcomes of PBL are positive. PBL students have as much content knowledge as their lecture-based counterparts, perform better at more complex forms of assessment, and retain more of what they learn. In addition, the approach has proven robust in several different disciplines and with older students (Doucet et al., 1998), indicating that it may be efficacious and a good fit for OER. Although traditionally delivered in face-to-face settings, PBL has expanded recently to include distance learning, which may be better suited to the digital nature of OER.

Distributed problem-based learning (or dPBL) specifically refers to online implementations of PBL. With dPBL, learners around the world can work together and expand their problem-solving skills. Online learning environments provide PBL learners with opportunities to be involved in different stages of work as a group and to continue their collaboration on projects, despite physical separation, using communication technologies. Some dPBL studies use synchronous interventions, requiring simultaneous interaction by students (Sulaiman, Atan, Idrus, & Dzakiria, 2004). Others use asynchronous technologies, allowing students to take part in discussions over a period of days or weeks (An & Reigeluth, 2008; ChanLin & Chan, 2007; Kenny, Bullen, & Loftus, 2006; McConnell, 2002; Steinkuehler, Derry, Hmelo-Silver, & Delmarcelle, 2002; Stewart, MacIntyre, Galea, & Steel, 2007). Still others combine the two, with some synchronous elements and some asynchronous (An & Reigeluth, 2008; Dennis, 2003; Gale, Wheeler, & Kelly, 2007; Ronteltap & Eurelings, 2002; Waters & Johnston, 2004). The research findings for PBL are favorable: It is well suited for combination with OER, and emerging trends to deliver PBL at a distance are well positioned to take full advantage of the digital nature of OER.

The Combination of PBL and OER

A quick search using the Folksemantic engine reveals over 20,000 resources related to PBL, suggesting some overlap between these two communities (http://www.folksemantic.com/). Additionally, Falagas, Karveli, and Panos (2007) suggest the use of free Internet resources for case studies, presumably including open educational resources. Kerfoot, Masser, and Hafler (2005) note the use of the repository PubMed, which includes works in the public domain.

Those looking for resources to support PBL design directly or to support students seeking information during a PBL implementation might look at Academic Earth (http://academicearth.org), Scientific Commons (http://en.scientificcommons.org/), or other specialty portals like Project OSCAR (http://oscar.iitb.ac.in/). The following is a discussion of the unique challenges and benefits of combining PBL and OER alongside relevant examples. Two PBL cases are discussed, neither of which is open. One teaches non-physics majors about basic forces through accident reconstruction (http://www.udel.edu/pblc/samples/badday/). The other is

an Earth science investigation of fire management in the Yellowstone National Forest (http://www.cotf.edu/ete/modules/yellowstone/YFsituation.html).

Benefit of Lowering Costs

PBL stands to benefit directly from the inclusion of the shared resources possible with OER. Generally, faculty commits more time to interacting with students in PBL contexts than in traditional classroom settings (Berkson, 1993). This presents several difficulties for PBL. Faculty is generally expensive and does not scale to large numbers (Donner & Bickley, 1993). Irrespective of cost, faculty actually hampers PBL outcomes. Although the exact reasons are unknown, the use of peers as facilitators results in better learning outcomes than the use of faculty (Walker & Leary, 2009). Thus, PBL may improve as students go to outside resources in addition to faculty. For example, students in the forest fire case are encouraged to explore resources on Yellowstone Park and fire science (http://www.cotf.edu/ete/modules/yellowstone/YFlinks.html) that get at the underlying nature of the problem. Utilization of OER within PBL contexts might decrease the time that course instructors spend with learners, specifically the time that content experts spend answering direct student questions. This may further benefit the PBL process in that students will have less exposure to faculty who, uncomfortable with the PBL approach, turn discussion sessions into ad hoc lectures (Moust, de Grave, & Gijselaers, 1990).

In any PBL context, learners are required to identify their learning needs and to collect resources or information regarding the assigned topic. For learners in a conventional PBL situation, information needs can be fulfilled by access to printed materials, such as journal articles, reference books, or textbooks. Yet access to such resources might be limited or costly for the institution providing them. Print-based materials are rivals in the sense that no two groups can access them simultaneously. Because print-based resources are even more problematic in online settings, with time required to mail resources, OER makes even more sense in dPBL contexts. Digital resources like OER may alleviate some of the demands on print-based collections. Although there are substantial upfront costs, the marginal cost of serving 10 or even 1,000 more students with OER approaches zero (Catone, 2009). While this is not a new concept for OER, it is a pronounced benefit in the context of PBL. As an example, an interactive Java applet (http://www.udel.edu/pblc/samples/badday/) visualizing motion and acceleration (or deceleration), found through Project OSCAR, might assist students with accident reconstruction. Another benefit of incorporating OER is the ability to respond directly to criticisms of PBL.

PBL Criticism

According to Kirschner, Sweller, and Clark (2006), cognitive load may arise for students in minimally guided settings like PBL. Their argument is that strong guidance is necessary, especially for the learners who do not have enough background knowledge at the beginning of learning. In essence, this is about germane load. If learners are devoting a substantial portion of their mental capacity learning background material, they will have comparably less capacity for engaging in problem-solving and for learning the new material surrounding the problem at hand. Relevant background knowledge might be disseminated via OER. There are certainly risks with

this approach. Overly focused background knowledge may detract from the ability of students to engage in free inquiry (Barrows, 1986), essentially labeling the underlying issues of the problems by virtue of the associated background content. If resources are closely related to the problem at hand, this can be avoided. For example, in the physics problem (http://www.udel.edu/pblc/samples/badday/) all of the student resources deal with accident reconstruction, allowing free inquiry to proceed. Scaffolds may suffer from similar problems; in the Yellowstone scaffold (http://www.cotf.edu/ete/modules/yellowstone/YFsituation1.html), students are quickly made aware of a critical relationship between forest fires and the biosphere, lithosphere, atmosphere, and hydrosphere of the park. While the nature of that relationship remains for student discovery, the fact that the relationship exists does not.

Barriers to Open PBL

The combination of PBL and OER presents other unique challenges. In order for the free inquiry process to be meaningful, it is important that the problem solution be unknown to students. Yet if a PBL course were made available as OpenCourseWare (OCW), then students as well as teachers would have access to it. In essence, this forces a dual course design with one course intended for student consumption and one supplement intended for teachers. There are several possible solutions, each presenting different challenges.

Close part of curriculum.

The solution set could be made available freely upon request from a teacher. An example of curricula with closed teacher guides is the Problem-Based Learning for College Physics (http://rea.ccdmd.qc.ca/en/pbl/). The teacher guides for each project are password protected, but the portions meant for student consumption and use are freely, but not openly, available. There are two difficulties associated with this approach: The first is administrative overhead, including the necessity to vet an OCW user as a teacher, which in this case is done via email, and the second is blocking access to information, which is in ideological opposition to the goals of open education.

Encourage localization.

Features of the problem could be altered to meet the needs of a specific class. Since this "remixing" for the class is one of the purposes of OER, it is a good fit with the intended goals of education (Gurell, 2008). The problem is a massive disincentive to make the modified version of the problem and associated materials equally open. Once open, students may be able to find the solution for their localized version of the problem. In essence, localization encourages teachers to share, but not to share alike. A shift in licensing to allow a period of closed use before providing full open access to teacher guides might be needed.

Leverage existing OER in support of PBL.

In this approach, the PBL portion does not become OER; rather, it uses OER to help students fulfill their information needs in pursuit of a problem solution. Fitting traditional OCW/OER into a PBL curriculum may be awkward and inefficient. For example, students may need to watch a 50-minute lecture in order to gain three minutes of relevant information. The pedagogy built into the OER may be at odds with the PBL approach, a departure from the inquiry-based foundations that is stark enough to subvert the self-directed learning nature of PBL.

Structure the curriculum to have an instructor-provided solution.

A PBL curriculum could be structured in such a way that the answer would be obvious to a domain expert (e.g., the instructor), but not to students. This method reduces the responsibility of repositories to manage the answers while providing authentic PBL instruction at the same time. As an example, the accident reconstruction problem eschews a provided solution to the problem (http://www.udel.edu/pblc/samples/badday/solution.html). Here the disadvantages are about existing research and cost. The expertise necessary for this approach, such as college faculty, is relatively expensive.

Sustainability

Best practices surrounding the sustainability of OER as a whole are largely unknown, and the body of literature is only beginning to emerge. Stephen Downes, a noted scholar on open education, has suggested several funding models (2007). Some have already been implemented and evaluation efforts are ongoing. MIT OCW derives its funding from MIT, with some help from non-profit foundations (O'Liveira, n.d.). Brigham Young University has been experimenting with offering OCW courses for credit (Wiley, 2009a, 2009b). Results of that research indicate that the cost of converting existing online courses to OCW adds to paid enrollments, so much so that the effort is self-sustaining (Johansen, 2009). The costs of PBL tend to be much higher than traditional forms of instruction. For those willing to invest in PBL irrespective of openness, the utilization of OER represents a cost-saving mechanism from the beginning.

Conclusion

Many of the technical and legal barriers to open education have been alleviated, and a critical mass of content has been achieved. Colleges and universities have a stake in quality teaching and learning, which may be advanced by coupling PBL with OER. Rarely can practitioners take advantage of such mutually beneficial situations. PBL does provide strong learning outcomes in certain disciplines (Walker & Leary, 2009)and with certain types of assessment (Gijbels et al., 2005). Depending on the discipline and assessments, OER creators could certainly bolster their case for funding by partnering their open course material with PBL. With that said, much work remains. Studies are needed to determine if PBL is equally efficacious with OER. It should be noted that Barrows (2002), in particular, was skeptical about whether or not tools existed to

support the interactions necessary for PBL fully at a distance. However, those comments were made well before many of the social software tools that are readily accessible now and would not apply to some of the face-to-face combinations of OER and PBL described above.

We want to emphasize our stance that PBL is not a single solution to every educational need. If the focus is on memorizing facts, for instance, PBL may take longer and may cost more (Donner & Bickley, 1993) to arrive at similar learning outcomes when compared to the traditional lecture. Nor is PBL the only approach that might be meaningfully combined with OER. Future research should explore not only the efficacy of PBL and OER but also the union of PBL with other well-researched approaches to teaching and learning. Although licensing is still a critical concern, OER needs to start devoting equal effort to the underlying pedagogy of open materials.

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