

Driving Broad Adaptation of Open On Line Educational Resources

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ABSTRACT

The world is full of educational materials created by faculty but there has been insufficient progress in disseminating even the best of these and without broad dissemination there is little penetration of open materials into higher education. Dissemination of open educational materials cannot be limited to textbooks but systems must be created to support students and faculty as are provided by commercial publishers. LibreTexts addresses this across a broad range of science and technology fields with a new reach into social science and liberal arts. LibreTexts design makes it simple for instructors to build their own courseware, either by mapping components created by others or writing their own. LibreTexts is working towards implementing a complete learning management system including testing software, homework systems guided by artificial intelligence, classroom response software and more to provide an open, online educational system suited to the students and faculty of today.

INTRODUCTION

Discussion about textbook price is anchored to cost which has grown faster than that of pharmaceuticals, to the point that it matches or exceeds *pro rated* tuition at community colleges or comprehensive public institutions [1]. Yet, cost is a relatively minor issue in the choice of books by instructors but rather ancillary services offered by the publishers dominates [2,3]. Textbooks are marketed and in great part selected based on the services offered to faculty including “traditional” features as publishers representatives, desk copies, solution manuals, test banks and presentation material and more modern apps including online homework systems. Such support is vital for faculty at teaching institutions who teach three or more courses per semester. Moreover, each of these components has a value to students above its ability to lighten the load of the faculty. Thus, any attempt to replace published textbooks with open online educational resources (OER) must pay careful attention to creating a similar level of support for faculty.

The LibreTexts project started in 2008 as the ChemWIKI. Delmar Larsen at the University of California Davis designed a framework to provide high quality on line textbooks for chemistry [4]. The MindTouch software is WIKI-like but organized to provide structured

content. In the next few years others began to use the ChemWiki and to add content. The project, still under the name ChemWiki, grew to include other texts in chemistry, physics and biology. At this time, LibreTexts is one of the top links in any search for learning chemistry. As shown in Figure 1 pages have been accessed over 180 million times since 2008. The reach is international, and although English functions as the language of science, there is now work to provide LibreTexts in other languages

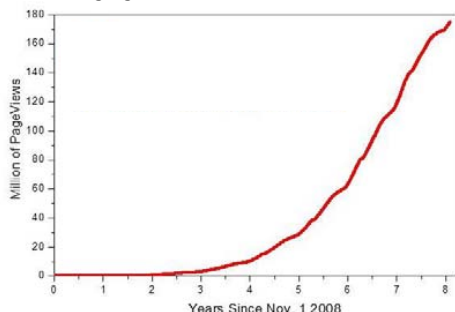


Figure 1: Cumulative page views from LibreTexts/ChemWiki over the past eight years. Bumps in the curve correspond to vacation periods. The larger bump at the end is a result of renaming of the project, resulting in a slowdown as search engines re-established their links.

A major part of this success is that LibreTexts provides a no-cost framework whereby instructors can provide OER to their class or use OER that has been created by others and put onto the LibreTexts site. In the latter case it is simple, WIKI like if one wishes, to modify and even brand the OER for one's own classes, the only restriction being that everything must remain under a Creative Commons 3.0 copyright. However, since creators can link out of LibreTexts to other websites, students can be directed to copyrighted materials.

Commercial textbook marketing

Increasing the adoption of OER requires understanding how textbooks have been marketed by commercial publishers in the past and how commercial textbook marketing is changing to meet online challenges. Textbook marketing can be described as an odd version of "business to business" (B2B) marketing most closely resembling how pharmaceuticals are marketed to physicians who then prescribe them for their patients. In normal B2B transactions the buyer resells what they have bought to their customers. In the traditional textbook market faculty select textbooks for their course but do not buy them and they do not sell them to their students. The college bookstore functions as a more traditional B2B marketer, passing the cost of the textbooks onto the customers, the students, but does not specify what should be ordered. The separation between marketing, ordering and selling leads to the current economic dysfunction in the textbook market [5].

A modern textbook costs of the order of \$250 or even more in advanced courses. This is about tuition for a three credit course at a community colleges, and a substantial fraction of the

cost at state colleges and universities. Students resist registering for courses with expensive textbooks and when they do, often do not purchase the text which degrades their performance.

In order to escape this trap students have in the past purchased used books and today access bootleg versions of the texts on the INTERNET. Most concerning, they often do not have a textbook to learn from. Traditionally publishers have resisted this by introducing new editions every few years or offering packages, again specified by faculty, at reduced cost from the unbundled price. Increasingly today, publishers include software access to the text and online homework systems in the packages sold to students while charging significantly more for the online homework system if the book is not purchased new. Publishers have also begun to rent online editions of the text to students, but this means that the students will not have access to the information in the text that they may need later on. Finally, just as the pharmaceutical manufacturers, commercial publishers have started to market directly to students and their parents.

Increasing OER dissemination

Within the past twenty years faculty have created a wide range of educational materials. Individuals, educational institutions, foundations and funding agencies have invested considerable time and resources to these projects. Research on science education has become a major focus. The INTERNET provides a global low cost distribution channel for educational materials but broad adoption of open on-line educational materials and software lags.

While many STEM faculty can and have created educational materials, marketing of the materials to others for the most part requires a skill set and resources that they do not have, nor for OER is it clear what the rewards are. There has been a strong effort to create educational materials, but there has been no systematic effort to evaluate these materials and to disseminate them. NSF and AAAS sponsored a Symposium in Spring 2016 titled Envisioning the Future of Undergraduate STEM Education at the end of which a working group on dissemination provided some recommendations [6].

The working group, composed of STEM educational material creators and evaluators, first determined that there was little work on what encourages wide adoption. It was recommended that NSF should undertake a metastudy on this, including study of how institutions change around the availability of these materials. The results of such a study would lead to common understanding of best practices.

The working group further recommended development of a conceptual model for dissemination within any project's life cycle. Dissemination plans should be required as part of solicitations including mechanisms for longer-term support. Marketing and outreach specialists should be part of project teams. Curated websites for open on-line materials are needed.

While science is a gift culture where those who contribute the most are the most highly valued this is often not true for those who create educational materials, especially at research universities. A key to establishing high quality OERs will be extending this ethic to educational resources so the effort of all who participate is rewarded. Such sponsorship will be important not only at teaching oriented institutions but also in traditional research centered departments to create and maintain a broad range of OERs,

Faculty creating educational materials need support. Administrators should provide rewards for faculty, with increasing rewards as the OERs they create, and market are adopted nationally and globally. This will require measurable outcomes. For promising OERs,

universities should consider hiring outside consultants and advertising experts. The contribution of a successful OOER to institutional reputation and recruiting can be significant.

Faculty seeking to disseminate their materials needed to learn marketing skills that will influence adoption. Moreover it is important for creators to work with evaluators to continually evaluate their materials and modify them to best meet the market.

The LibreTexts OOER materials are well curated, broadly known and available. They can be easily modified by instructors to meet class needs. LibreTexts is expanding beyond its textbook roots to incorporate educational resources in a complete learning management system. The WIKI roots of LibreTexts encourages participation by both faculty and students. The high visibility of LibreTexts is attracting creators to incorporate their materials within the flexible LibreTexts environment.

DESIGN AND STRUCTURE OF LIBRE TEXTS

The ChemWIKI provided open, no cost, on line chemistry textbooks of high quality. Chemistry remains the most developed area, but STEM subjects including physics, biology and geosciences added a few years ago are growing. This year with the change of the ChemWIKI into LibreTexts provision is being made to accommodate many other areas including engineering, mathematics, statistics, agriculture, medicine, and social sciences. LibreTexts can accommodate this because content is created by the community, not by isolated individuals. Currently LibreTexts with over 7.5 million page views by over 5.3 million visitors per month is a powerful mechanism for dissemination of content. The LibreTexts project is growing into a complete Open Online Educational System.

Each LibreTexts library [7] starts from a Core which itself is separated roughly into course areas and contain what can be thought of as chapters that can be read independently, assembled into textbooks or used as supplementary material. Textbook maps connect elements of the core which cover similar material to chapters in commercial texts. They can be used by those who need access to a particular text, but, for one reason or another, principally financial, do not have the text. Finally, LibreTexts are custom designed online Wikitexts developed for individual instructors/courses and schools. Recently, independently developed online texts are being deposited into LibreTexts by their authors driven by visibility, curation and synergy with other LibreTexts materials. Core material, material from other open sources or that written by the course instructor can be included in each LibreText. Other components that are being added include simulations and demonstrations, case studies, worksheets, homework exercises, etc.

LibreTexts sections can only be created by authorized users who control access by others. A wiki does not mean lack of control, nor lack of vetting. Levels include private for both editing and reading, semi-public which can only be edited by selected users but found and read by all, and public which is completely open. Curating is done by owners, local collaborators including students and by the overall project primary vetting panel.

DISCUSSION

OOER have a number of advantages over textbooks. First, they are easy to modify which means that they benefit immediately from formative evaluation. Textbook publishers operate as gatekeepers between instructors and students. OOER can be an unbiased middleman with a bidirectional flow of information. While that is conceptually good, the important question is how

well do OERs work. Studies on this are emerging. There are a number of important questions about OERs that need to be answered. While there are only a few published studies, their results are encouraging if not wildly so. Allen, et al., compared the ChemWiki against a printed text in different sections of an introductory course taught by the same, and then by different instructors [8]. They could find no statistically significant difference. While the results may appear unexciting, it cannot be denied that free is better for the students than having to pay more than \$200 for the book. Robinson, et al., published a large study comparing students who used OER and those who did not [9, 10, 11]. There were ~11,000 students in the control group and ~5,000 who used the OER in both teaching and community colleges. While they also did not find any significant difference between the two groups in course performance they did find a significant difference in favor of the OER users who went on to take more advanced courses in the same area at a higher rate. Robinson et al., speculate that this effect is simply a reflection that money spared on buying expensive texts can be used to cover tuition and living costs. For a student taking four courses a semester such savings can be over \$1,000.

Textbooks are static. OER can link to illustrative simulations, video demonstrations, and other interaction driving components. If they are as good as textbooks now, future developments may make them better across the board.

Cooney surveyed students using OER at the City College of Technology, part of CUNY [12]. He found that the students preferred accessing OER over multiple devices rather than reading texts, and that what they did not like was Wi-Fi problems. Using OER requires good online access, something that should not be taken for granted.

Kandiero surveyed instructors at Africa University in Zimbabwe to try and discover why OER have not been much used [13]. The findings were that adoption is positively influenced by belief that OER will help teaching, peer opinion, the ease of finding, using and customizing the OER and support from the university administration.

It almost certainly is true that students stealthily adopt OER in order to not pay for expensive texts, a factor which needs to be investigated further. We know that many students do not buy textbooks and this negatively affects their performance.

While it is also true that many instructors do not feel comfortable adopting OER rather than commercially published texts, they may not be able to do so much longer. State boards of education are looking into the matter and making recommendations that OER should be preferentially adopted [14, 15]. Rhode Island has started a state-wide initiative to provide and adopt OER in the state, including private universities such as Brown [16]. While this effort is carrot centered, the writing is on the wall that sticks may be used in the future, especially in more administratively centered institutions such as community colleges.

CONCLUSIONS

The LibreTexts project is well situated and structured to benefit from the coming restructuring of education. Software to be integrated in the near future include a single sign on point, virtual labs, peer learning and assessment.

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