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PLATFORM DEVELOPMENT AS AN ITERATIVE PROCESS: AN OER DESIGN CASE OF EDTECH BOOKS

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In this design case, we review the iterative process of designing EdTech Books (ETB)—an online platform through which open educational resources can be published and accessed by the public. We discuss the context and framework within which the platform was created. We then review the chronology of the platform's evolution through the lens of discovering and addressing challenges the developer faced, particularly those that relate to the 5 Rs of Openness and challenges specific to the publishing of open educational resources (OER).

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INTRODUCTION

In an era where materials can be shared widely and efficiently through a variety of online formats—such as books, textbooks, videos, audio, and text documents—open educational resources (OER) provide an opportunity to break down barriers that limit access to knowledge. In an effort to alleviate the barrier of textbook costs for students and provide materials to the public that are open and free, the developer, Royce Kimmons, who was, at the time, an assistant professor (now an associate professor) of Instructional Psychology and Technology and strong proponent of OER, developed EdTech Books (ETB) at edtechbooks.org. In this paper, we will review and reflect on the design case of ETB by first exploring the design context. We will then chronologically review the three versions of ETB, including the design choices encountered during each phase.

This paper was written by students pursuing a master's or doctoral degree in Brigham Young University's Department of Instructional Psychology and Technology. The developer of ETB was the supervising author for this design case.

Our primary source of information was three in-person interviews with the developer, as well as follow-up email correspondence to fill gaps in our understanding. We also drew upon implementation logs maintained by the developer,

historical Twitter data, historical data from Google Analytics, images and file structures from the Wayback Machine, and the findings and coded interview data from an evaluation of the platform performed two years prior to our research.

DESIGN CONTEXT

Overview

ETB was created and released in 2018. Sharing this resource through multiple venues, such as conferences and social media, increased its popularity. In 2020, the global COVID-19 pandemic stirred more interest in educational technology, drawing more educators to the ETB platform. The growing popularity, needs of users, and developer motivation have driven a process of continual improvement, resulting in the creation of multiple editions of the platform.

ETB was created to host OER publications related to educational technology. OER are openly licensed educational materials accessible at no cost to the public and may be retained, reused, revised, remixed, and redistributed (Creative Commons, 2023; Wiley, 2014). OER is a subset of open access (OA) and a collaborator to open educational practices. Educational technology (edtech) is the ethical study and application of theory, research, and practices to advance knowledge, improve learning and performance, and empower learners through strategic design, management, implementation, and evaluation of learning experiences and environments using appropriate processes and resources (Association for Educational Communications and Technology, 2023).

The 5 Rs of Openness

Because the purpose of ETB was to provide open access to materials, its development was centered around the framework of the 5 Rs of Openness, which are Reuse, Retain, Revise, Remix, and Redistribute (Wiley, n.d.). These 5 Rs are defined by Wiley (n.d.), as shown in Figure 1.

Reuse

OER offer a wealth of benefits to educators and learners alike. By enabling reuse, OER facilitate the creation of a more expansive collection of resources for teaching and learning. This, in turn, promotes a more sustainable approach to education while reducing costs (Conole & Ehlers, 2010; Hilton, 2016).

Retain

The "Retain" clause allows users to keep a readable and editable copy of the content, with access controlled by the user. This gives students access to materials after a class is completed—contrasting with the popular subscription model, where students/readers lose access at the end of the subscription period.

Revise

The "Revise" aspect of OER allows educators and learners to collaborate and create more relevant and engaging learning content. Hilton (2016) highlights that utilizing the "Revise" aspect of OER fosters a culture of innovation and collaboration where educators and content creators can work together to improve and adapt existing OER materials. Conole and Ehlers (2010) suggest that revising OER materials allows for content localization, promoting a sustainable approach to education and reducing costs associated with developing new teaching materials.

Remix

Remixing allows educators and learners to create customized materials that suit their specific needs (Wiley, 2014). By utilizing the flexibility of OER, educators can create and distribute new resources based on existing ones, providing learners with a more personalized and engaging learning experience. When instructors have a variety of OER to draw upon, they can create content that is tailored to the needs of their students and/or readers. Providing students with a range of OER that can be remixed and adapted fosters creativity, critical thinking, and collaboration, as open pedagogy emphasizes (Hegarty, 2015). Many open resources

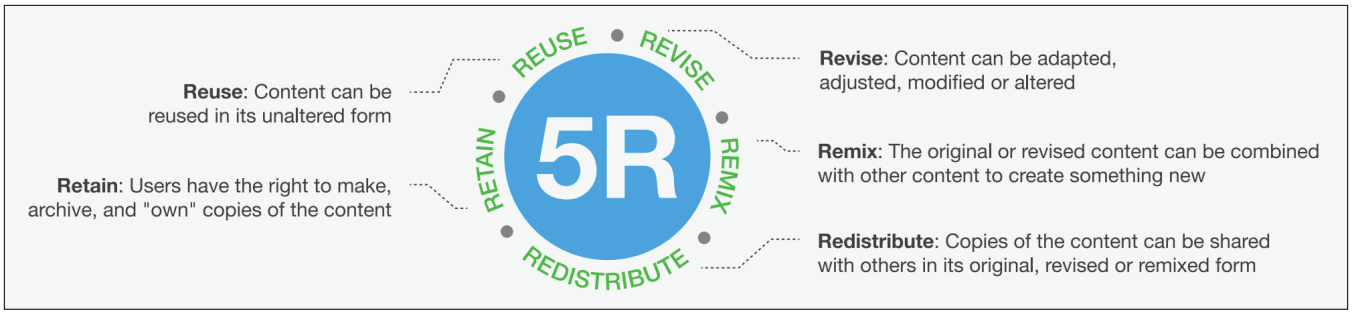

FIGURE 1. "David Wiley's 5 Rs of openness" by BCOER Librarians is licensed under CC BY 4.0 (BC Campus, n.d., as cited in Snider, 2020). While open content is free in the monetary sense, the idea of openness implies that the content itself is freed. Open content can be changed, shared, and combined with other content, allowing it to become part of the collaborative and ongoing effort of many people.

are published under the CC-BY license, which allows for remixing, provided credit is given to the original author and the copyright notices and license terms are preserved when distributing the material. This allows for flexibility in content creation, which is particularly important in rapidly evolving fields where educational materials can quickly become outdated (Hilton et al., 2010).

Redistribute

Redistribution allows content creators and users to copy and distribute works according to the works' assigned licenses (Wiley, n.d.). This aspect of OER can eliminate the cost associated with paying for a copyrighted work, printing through a publisher, and/or paying for usage rights—whether in print or online.

OER Publishing: Barriers to Creation

An OER publishing platform should address the barriers to the creation of OER, which are distinct from the challenges of publishing with a commercial publisher. Such barriers include issues such as the concerns of content creators about demonstrating the impact of their work; lack of expertise in graphical layouts, editing, accessibility, and other services provided by publishing houses; the perception by potential content adopters that OER is of low quality; a need for confidence among content creators that their work will remain available, open, and revisable; misunderstanding of Creative Commons licensing; and monetary costs incurred when publishing in journals where an open access option is made available to the authors for a fee.

Demonstration of Impact

For many authors, spending time creating OER content comes at the cost of other scholarly work, most notably writing and publishing in scholarly journals. Not only does journal publishing influence a scholar's prestige in their field, but it can also directly affect their ability to achieve tenure at the university or institution at which they are employed (Marshall & Rothgeb, 1990). As described by ETB's developer:

> *As a faculty member, if I had a choice between writing a research article that's published in a Tier 1 journal or writing an open textbook, the journal article would be valued more by the institution, even though the textbook is more beneficial to the world. The question has always been, "How do we get institutions to value the creation of the open textbook on the same level as publishing a Tier 1 article?" Authors who aren't sure if they'll be able to get tenured can't risk doing this kind of work. The whole goal here is to encourage people to be generous and to make a better world, right? But we shouldn't have to choose between being generous and keeping our jobs. So, as I've been doing this, I've also been trying to advocate for and articulate how institutions should value this kind of work.*

Publishing Expertise

Authors working with a publishing house have the assistance of many professionals when editing and preparing their content for publishing. These experts can review the material for technical correctness, readability, and syntactical correctness. They can handle layout and graphic design and help create a product that looks and feels professional, as well as adding features for usability and accessibility. When publishing digitally, as is standard for OER, the mobile accessibility of the content should be strongly considered. In many cases, to make adoption easier, the publishing house also creates student- and teacher-resources to accompany the textbook. Authors creating open content may not have access to these human resources and are unlikely to have experience or skill in all these areas. They may also not have time (in addition to their scholarly activities) to spend on work that is typically done by a team of people.

Perceptions of Quality

For instructors given the task of designing a course and adopting a text, OER is an appealing option; the content is free to students and is revisable and remixable. However, textbooks published by a known publisher are known to be written by expert authors, peer-reviewed, and edited by teams of professionals. These are common proxies for identifying high-quality work. In the case of OER, it is difficult for adopters to know which resources are of high quality. Additionally, there is a common perception that OER generally is of lower quality.

Ownership Uncertainty

In order for a content creator to share an open resource, they must choose a platform through which potential users will be able to discover and gain access to the resource. For the content creator, this choice could be inherently risky, because they may have no control over the platform itself, including its ongoing accessibility.

In addition, potential content creators may not have a good understanding of Creative Commons licensing, and/or they may not feel comfortable creating content without knowing how it will be redistributed, revised, or remixed once it is released. For some types of content, such as sacred knowledge or work that loses its meaning when fragmented, understanding how to preserve the integrity of that work is a prerequisite to an author feeling comfortable creating the content in an open format.

Academic Publishing

Although some journals publish all articles openly, most open-access articles are published in hybrid open-access journals, which charge the author an "article processing charge" to make the content open to readers (Borrego, 2023). In addition, the process of publishing openly in such a

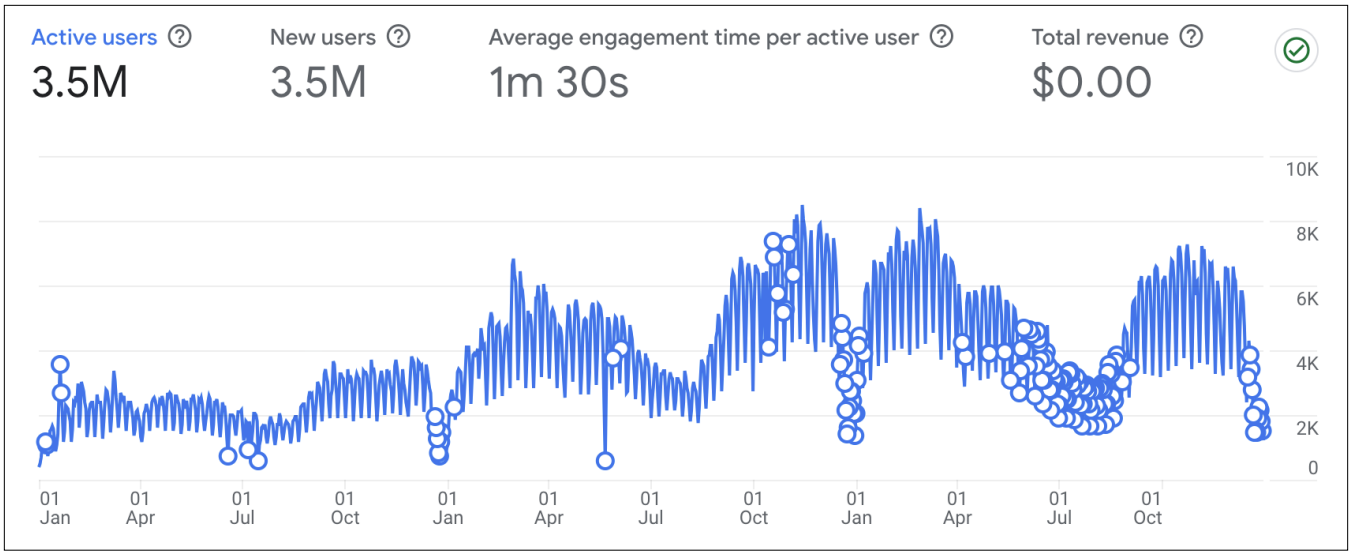

FIGURE 2. Daily website activity on EdTech Books. Created in October of 2018, the platform grew to 3.4 million users in just four years and has received multiple rewards. Its rapid growth demonstrates the worldwide demand for resources that support OER. (Image used with permission from Dr. Royce Kimmons, personal communication, May 2023),

journal can be confusing and difficult enough to discourage authors from doing so.

OER Publishing: Affordances

An OER publishing platform should empower content creators to take advantage of the affordances that are unique to OER.

Dynamic Editing

One of the premier affordances of open publishing is the dynamic nature of the content. Although the content may undergo less editing than would take place in a commercial publishing venture, typos and small oversights that survive through publication can be fixed immediately once discovered, rather than waiting years for the next version of a book to be printed.

Similarly, links that have gone stale since publishing can be quickly removed or resolved. Open resources often contain links to other resources not created by the same author, so this is especially important in an OER publishing context.

Although open publishing gives creators the ability to make corrective edits with a low turnaround time, they can only take advantage of this affordance if they have timely information about where corrections are needed.

Dynamic Presentation

Digital distribution allows for dynamic formatting and presentation of content, such as providing instant glossary access with a click, formatting for a mobile device, or including links to other resources.

Continuous Improvement

On a scale grander than copy editing, the dynamic nature of open resources allows authors to make timely updates to their actual content in response to changing user needs. To take advantage of this affordance, authors need actionable data.

Remixing and Revising

Although the ability to remix and revise is an essential characteristic of OER (Hilton et al., 2010; Wiley, 2014), content creators still must find the resources they want to use. When they have chosen one, they need to transfer the content they wish to use to their desired format. As mentioned above, even after the content creator has chosen and used the open content of their choice, the original referenced content may change without the creators of derivative works being aware of it. If they are aware, they may or may not want their own content to reflect the changes. If their work depends on revisions to the original, such as translation to another language, keeping derived content up to date may involve significant time and support.

These affordances of open publishing contribute to the perceived power and usefulness of OER. However, the degree to which they are utilized depends on content creators having access to timely information and tools.

Design Rationale

To make OER more fully a part of our educational institutions, we need successful models of open creation, adoption, and remixing of resources for institutions and individuals to follow (Jhangiani et al., 2018). ETB is an example of an open textbook platform that has found widespread

FIGURE 3. The platform's first home page – The developer designed it as a simple dashboard with links to the open textbooks that he and his colleagues were hosting on Pressbooks and other platforms. The original intent was simply to make the books easy for students to find. However, as the developer added functionality not available on other platforms, it grew into an independent hosting site specifically designed for publishing and accessing OER content in a way that supported the ideals of openness. (Image used with permission from Dr. Royce Kimmons, personal communication, May 2023).

use and recognition in recent years, earning a number of awards—the most recent being the 2022 Association for Educational Communications and Technology (AECT) Annual Achievement Award (Association for Educational Communications and Technology, n.d.). The platform now hosts more than 10,000 chapters, which have been accessed by over 3.4 million users, with about 45,000 unique users accessing content each week (see Figure 2). By exploring the historical design and evolution of this platform, we hope to better understand (a) how this tool was created and how it evolved; (b) how the project developer went about creating, supporting, and expanding a network of authors; (c) how the platform manages updates and responds to emergent user needs; (d) how the skills, attitudes, literacies, and perceptions of content creators affect the development of the platform; (e) what barriers were faced and how they were overcome; and (f) how the project addressed barriers to openness.

Version 1.0: An "Awesome OA Book Creation/ Host Service"

EdTech Books emerged from the efforts of the developer and his colleagues to take advantage of the benefits of OER and to overcome a significant barrier to OER publishing. Their primary efforts in this early stage focused on easy remixing of their content and the creation of open textbooks that take advantage of their digital format to provide a dynamic presentation of content. In addition, confidence in the continued ownership and availability of their content was low. The first version of ETB focused on these core issues (see Table 1).

In its inception, however, the platform was simply a convenient dashboard with links to another hosting service. Believing that open textbooks would provide a better learning experience for their students, the developer and his colleagues had begun creating open content for use in their classes, much of which was published on Pressbooks, a common open textbook platform based on WordPress. To make the content easier for students to find, the developer created a simple HTML dashboard with links to the open texts. Book covers were displayed, and clicking on one would take a reader to that book on Pressbooks (see Figure 3).

As their content offering expanded, they became frustrated with Pressbooks, designed primarily to host individual books rather than an organized collection. It was impossible to access the content through an application programming interface (API), which gives controlled access to one software platform's content to other software tools. Without API access, the developer could not build additional tools for accessing and improving content in place on the Pressbooks platform. Analysis and other tasks involving more than one book were difficult and time-consuming. Scaling such a system by adding more books meant an exponential increase in time and effort.

To deal with these shortcomings, the developer gradually expanded the capabilities of the open textbook dashboard by adding PHP and MySQL on a Linux backend. Direct access to the content and meta-data of each text allowed the implementation of features such as an index, a glossary (see Figure 4), and author biographies that automatically synchronized across all titles when updated.

Remixing

While creating and maintaining open content hosted on Pressbooks, the developer and his colleagues discovered that the attributes of the hosting platform directly impacted the openness of the content from a practical standpoint. Although their content was legally remixable and revisable, and they intended to do so and allow others to do so, it was difficult in practice.

Content could not be edited in place and was displayed on the platform in a format different from the one in which it was edited. To make a small change, the author would have

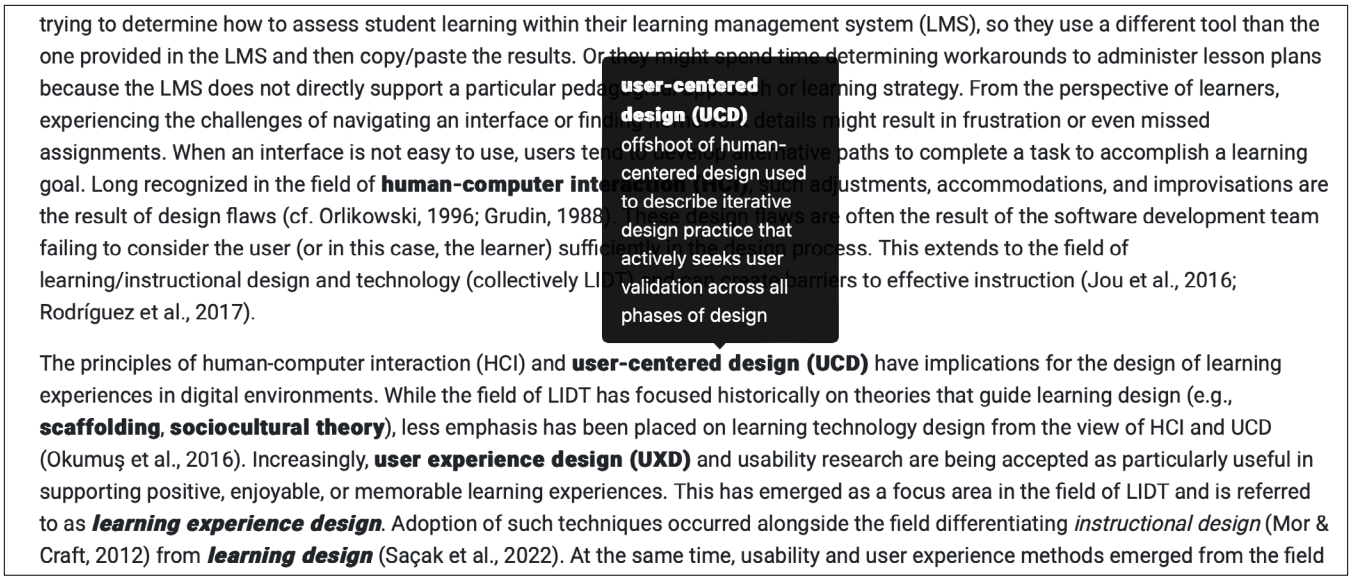

FIGURE 4. Screenshot of pop-up definition function (Text shown is Schmidt et. al, 2023) – Direct access to the content and meta-data of open textbooks allowed the developer to add features, such as on-demand definitions, that authors could not provide on other platforms. An important factor in the development of EdTech Books was the developer's desire to take advantage of this and other affordances of digital open content. These affordances were significant for both content consumers and content creators. (Image used with permission from Dr. Royce Kimmons, personal communication, May 2023)

FOCUS	DESCRIPTION	DESIGN DECISION
OER Publishing Affordances: Dynamic Presentation	Many open textbooks were inferior to printed textbooks, with fewer features.	Design a platform that would take advantage of the digital format and open nature of the content to create resources that were superior to printed texts.
5Rs of Openness: Designing for Remixing	One of the hallmarks of OER is that it can legally be remixed, but very few systems allow you to remix it easily enough that it is practical to do so.	Design for easy remixing of resources that could already legally be remixed but weren't because of the difficulty.
OER Publishing Barriers: Ownership Uncertainty	Users would be wary of a platform that seemed unstable or low-quality.	Design with an attentiveness to quality and the perception of quality and ease-of-use.
GOAL: Get a high-quality, basic solution in place as quickly as possible **DESIGNER'S VIEWPOINT:** "An overarching consideration was that an open textbook should be its own thing that took the best of existing textbooks and magnified that with digital technologies, whereas it felt like many open textbook approaches in the past were "less-than" versions of traditional print books with fewer features, affordances, etc. For instance, no open textbooks provided indices. Few provided glossaries. Few were mobile friendly. I think this is because folks were trying to coerce existing blogging and low-level word processing tools to create products, and this led to many assumptions/features being implemented that were blog-like rather than textbook- or OER-like."		

TABLE 1. Design Objectives for EdTech Books Version 1.0.

to keep a separate copy of the content, which they would need to retrieve, edit, and upload in order to fix something as small as a typo. Similarly, a content creator who wanted to remix content from another author would have to obtain the editable copy from the original author first, incongruous with the ideal of remixability.

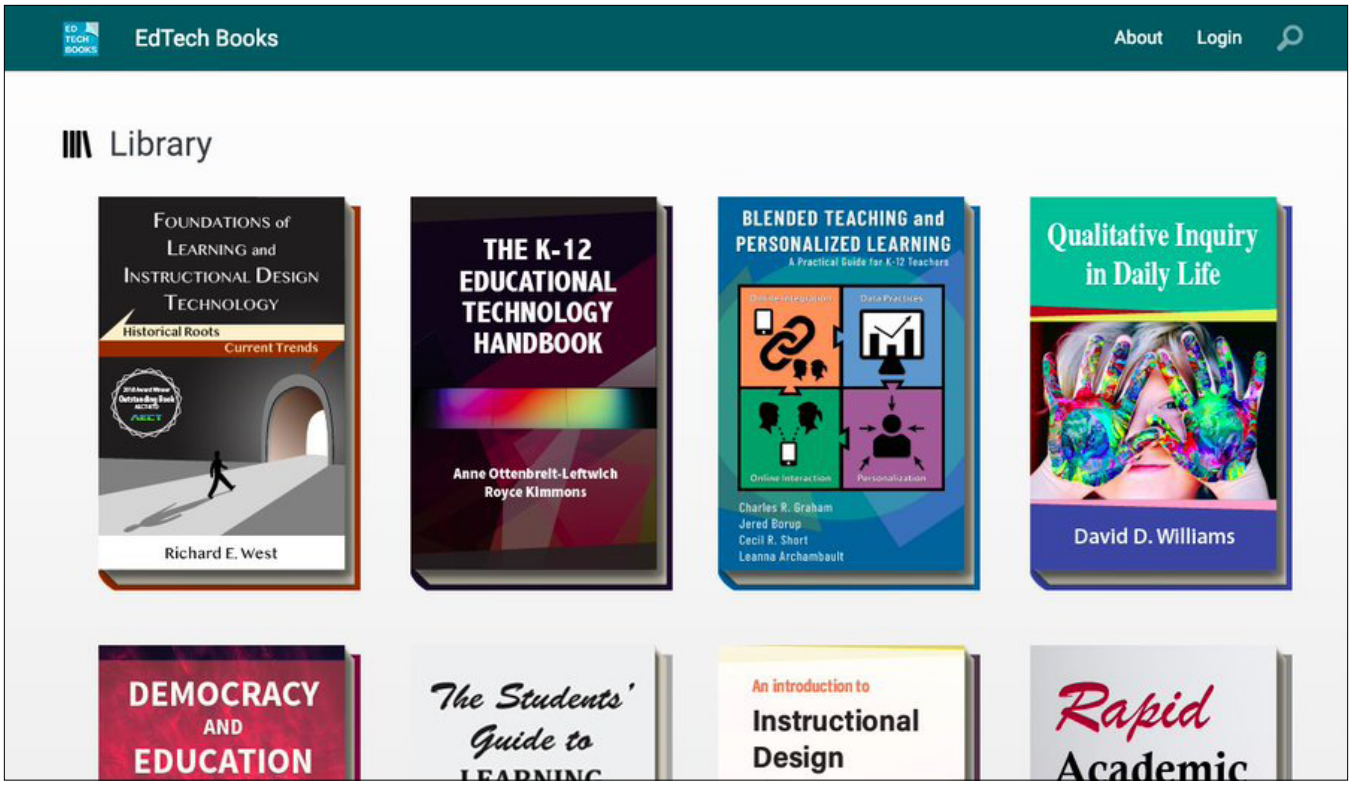

FIGURE 5. ETB's "new skin" (Kimmons, 2019) – The platform had a new identity as an independent hosting service. Not only did it host content on the platform itself—rather than presenting links to other platforms—it was designed with tools and features specific to hosting and authoring OER. It was presented at AECT in October of 2018 along with some examples of open textbooks to demonstrate the tools available to content creators and consumers.

Dynamic Presentation

In order for open content to be revisable and remixable in truth, the developer determined that it would need to be editable in place, allowing for easy changes and the copying of source material without any need to contact the original author.

TinyMCE, a rich-text editor, was used to provide a mostly WYSIWYG (what you see is what you get) editing interface for content creators, allowing them to revise and remix their open content in place on the front-facing side of the platform, rather than having a separate author interface. TinyMCE includes HTML formatting, allowing open textbooks to be displayed in the same format in which they are edited.

Because TinyMCE is open source, tools could be added to give functionality the content creators needed while providing a cohesive environment for browsing, creating, editing, reading, and accessing meta-data about the open textbooks in the library.

With regards to remixing, the developer stated,

> *I learned that most people don't want to remix, which is fine, but the flexibility to allow for remixing allows for a wide array of use because remixing takes many forms. Even though someone might not remix an entire book, they may use the flexibility of the system to provide their students with a unique path through the content, which is a type of low-level remixing.*

Gradually, as features were added and the system became more robust, the developer and his colleagues began moving books previously hosted on Pressbooks over to the new platform and to author content directly in it, bypassing Pressbooks altogether.

Though this change was not pre-planned, it came about as the new system came to address user needs better than the previous system. With this gradual shift, the platform evolved into a new hosting service not dependent on any other publishing platform.

Ownership Uncertainty

As it became apparent that an entirely new platform was emerging, another aspect of open publishing became relevant. Historical precedent in OER platforms has led some to feel that creating OER was risky because there is no way to guarantee that the hosting platforms on which OER are created will continue to exist as open and available. This concern turned out to be well-founded in the case of Pressbooks, which later changed its funding model to a paid platform.

FOCUS	DESCRIPTION	DESIGN DECISION
5RS:		
Revising and Remixing	Revising and Remixing are such common tasks in OER creation that they warranted additional tools.	Features were added to allow easy importing of chapters from other resources and syncing chapters hosted on the platform.
Reuse and Redistribution	Instructors wanted to make content available in media and formats more accessible to all their students.	A mobile-first policy, LMS embedding, and conversion to Microsoft Word and PDF formats were implemented.
OER PUBLISHING BARRIERS:		
Lack of Publishing Expertise	Content creators lack the expertise and human resources of publishing houses.	Auto-formatting was provided for imported chapters, and a checklist for accessibility and quality was provided to content creators.
Perceptions of Quality	Potential adopters have difficulty identifying high-quality resources.	A variety of badges were added to demonstrate aspects of quality.
Academic Publishing	Scholars desired a platform for open publishing of academic papers in peer-reviewed journals.	The system was restructured to allow for the meta-data and formatting required by journal publications.
Demonstration of Impact	Authors need to demonstrate the impact of their scholarly work.	Impact pages were automatically generated, including usage data.
OER PUBLISHING AFFORDANCES:		
Continuous Improvement	Content creators need data to improve their content.	Usage data and A/B testing were made available.
Audience Diversity	Scholars wanted to publish open content that wasn't directly related to educational technology.	OpenScholars Press and institutional portals were created as different ways to access content on the platform.
Framework Inflexibility (not detailed in the text)	Rapid development revealed design decisions that made it difficult and time-consuming to add new features.	Parts of the initial framework were redesigned to make development of new features faster and less error prone.
GOAL: Open up the possibilities **DESIGNER'S VIEWPOINT:** "Initially, our primary intended user was probably the LIDT faculty member creating content for their own courses, but in this version, we had to rethink much of the system to accommodate editors, non-LIDT faculty, university communities, and other professionals. We also gained a more realistic understanding of users' diverse source documents, which meant that the formatting features had to be more responsive to a variety of input types (GDocs, Word Docs, PDFs, other sites, etc.)."		

TABLE 2. Design Decisions in EdTech Books Version 2.0.

In addition to expediting content creation, revising, remixing, and facilitating the affordances of open publishing, a platform designed specifically for OER should guarantee that content will remain permanently open and accessible. For the platform to be effective at scale, potential authors would need to perceive it as being stable, high-quality, and easy to use.

The developer felt that it was essential to have a perception of quality from the very beginning, stating:

> *Our perceptions of tech tools linger. Most users on EdTech Books will get on and create a book and maybe one chapter and then stop. They're dipping their toes in the water. If they think it's too hard or if a button doesn't work, they assume that the entire system is too hard or broken.*

The first book officially hosted on the new platform was the first edition of *Foundations of Learning and Instructional Design Technology* (LIDT), edited by Richard E. West, who tweeted the announcement of his new book and the hosting service on October 1, 2018: "New launch of the LIDT

Foundations Open textbook! … Many thanks to *@royce-kimmons* for creating the awesome …OA book creation/host service. This new version of the book includes pdf downloads of chapters or book" (West, 2018a, October 1). By October 15, the platform had a name, EdTech Books, and a new logo (see Figure 5). The platform and some of the open textbooks were presented at the annual conference of the Association for Educational Communications and Technology (AECT) as "a new service for hosting and authoring open textbooks for our field!" (West, 2018b). Two days later, it was the most shared link of the conference.

Version 2.0: EdTech Books for a Diverse Audience

With the success of Version 1.0 and the ensuing stream of requests from content creators, the developer set out to expand the platform in ways that would facilitate the 5Rs for content creators and users and help authors overcome barriers to OER publishing while taking advantage of its affordances. Underlying structures were improved for continued growth, and audiences who needed an OER platform for content unrelated to edtech were accommodated (see Table 2).

Revising and Remixing

Although Version 1.0 of ETB made it practical to revise and remix open content, these activities are so integral to OER that in Version 2.0, a collection of features was put in place to make this kind of creation even easier.

Creators were allowed to import chapters from other books on the site. A creator might use this feature to import specific chapters of a general textbook such as *Foundations of LIDT,* to be used in a textbook designed for a particular course such as "The History of Instructional Design." The chapters could be imported into the new textbook in the exact order they would be used in the course.

Additionally, the course instructor could add their material, translate the original, or make other modifications that would make the content most useful for the students in that course. In some cases, however, the author would want the chapter to stay up-to-date and synced with whatever modifications were made to the original. Hence, auto-syncing with the original chapter was provided with a simple checkbox.

Reuse and Redistribution

Most early adopters were content creators planning to use their content in their classrooms. To take advantage of the "Redistribute" aspects of OER, they wanted to make their content available to students in ways that were most accessible, such as embedding the content directly into a learning management system (LMS) and allowing students to print it out, if needed.

A mobile-first policy was implemented to increase accessibility for those who access ETB through their mobile devices.

To further facilitate redistribution, a cross-site embedding view allowed the embedding of content in Canvas and other learning management systems, and a Reading Application Programming Interface (API) allowed other developers access to content. Another feature allowed the automatic conversion of content into Microsoft Word documents for offline storage and editing. These features allowed students to read in a format that worked best for them and to save an editable copy of their readings if they chose. When reading online, students could access glossary definitions by hovering over a word, improving the accessibility of the content.

One of the early disasters of the platform involved the first version of its PDF generation tool. PDFs are static files, so they must be rebuilt every time content is updated to reflect changes. To allow PDF downloads to be as up to date as possible, the developer initially designed the system to build PDFs when requested by readers.

However, generating PDFs can be a CPU-intensive process, with some books having 1,000+ pages of images and text. This meant that if a PDF was requested 10 times in a minute, the server would have to generate 10,000 pages of content in a minute, in addition to all the other services it was providing. This resulted in the ETB server completely crashing when one of its more popular books was first shared as a PDF.

To address this, the developer moved to a caching system for both PDFs and generated HTML pages so that content would only be rebuilt if it had changed or had not been rebuilt recently. This drastically reduced server load while also allowing static content to be served in a relatively dynamic and up-to-date manner.

In addition to these improved methods of *reading* the content, other features helped users to *find* content. Specific content could be found using an author/book search with autocomplete and saved on a user home page with a "My Books" list. New content could be discovered from the landing page in the "Recommended Textbooks" section, the "Topics" section, a "Browse the Library" option, a keyword navigation section, or a provided custom Google search.

All these changes were implemented to help draw attention to relevant content for users and to feature content that was valuable. However, as the site became more popular, it also became apparent that the vast majority of readers were finding and accessing content from search engines and indexing services such as Google Scholar, so additional effort was focused to ensure that metadata was accurate and optimized. In some earlier iterations, malformed metadata yielded inaccurate representations of content in Google Scholar and elsewhere. Efforts to improve internal navigation and findability included keywords, breadcrumbs, and so

forth. However, more important efforts for ensuring findability focused on improving metadata quality and alignment with various standards (e.g., Google Scholar, PRISM, Dublin Core) as well as the inclusion of abstracts for all content, which Google Scholar now requires for a document to be indexed.

Though the design has improved in these respects, at least two core challenges remain. First, though relying heavily upon external indexing for findability has ensured greater discovery of content, it also means that authors and developers have less control over such mechanisms. For instance, if metadata is updated, it may not be re-indexed by an external service for six months or more. Though including search-engine notifications in the site map can help encourage re-indexing, authors may be stuck with incorrect indexing until the external service catches up. Second, though providing multiple formats of content improves the possibility of redistribution, not all features can be carried over to all formats (e.g., glossaries in MS Word and PDF, learning checks in audiobooks). This means that learners' experiences will always be somewhat different depending upon the format they choose.

Lack of Publishing Expertise

Early adopters of the new platform faced a challenge common to open textbook creators: they lack the human resources that are dedicated to copyrighted content published by a commercial publishing house but still wish to create high-quality resources that also have the look and feel of quality.

In some cases, chapters imported from external sources, such as Google Docs or Wikipedia, might lose some formatting. Import tools were created for popular sources to format them nicely in the new environment. Support for additional formats, such as LaTeX (a markup language commonly used for typesetting formulas and equations) was also added.

To help authors create high-quality, accessible content, an extensive checklist was included for authors to review before publishing content.

Perceptions of Quality

The growing body of users highlighted another significant barrier to OER adoption. Without the expert formatting and the assumption of trustworthiness associated with a printed text from a publishing house, potential content adopters may not recognize OER as high-quality work.

Some authors on the platform suggested the possibility of using badges to signify value. The developer designed badges that could be applied to mark high-quality content. "Peer-reviewed" was one of the badges, but because of the variety of types of OER being offered, badging only for peer-reviewed publications was not deemed sufficient.

Badges were also included for publications that achieved a "high quality" status from readers' rankings. Other badges included "Expert Author," for authors with a terminal degree in the field they are writing in; "Original Research," for publications that report on original empirical data; and "Trending," for publications that are currently popular or relevant.

Users were given the ability to filter by these badges when browsing. Some of these badges, such as the Trending badge, could be awarded automatically, but others, such as the Expert Author badge, required the site administrator to make an informed evaluation.

Access to these quality markers allowed would-be readers and adopters to identify quality resources and justify their selections. Though this feature has been implemented for some time now, no evaluation work has been done to see if the inclusion of such badges influences reader perceptions of quality. Anecdotally, authors make requests for badges to be issued to their content upon publication and have also recommended others that they believe would be valuable to add in the future, such as a badge to identify content that has been updated in the past six months.

Academic Publishing

As 2020 drew to a close amid global lockdowns, ETB tackled another barrier of OER: academic publishing. Numerous scholars who were already using the system for publishing books expressed frustrations to the developer over journal editorial work and lamented that a similar product to ETB was not available to make open access journal publishing easier.

Recognizing the possibility of adjusting the platform to serve both needs, the developer began slightly restructuring the system to allow for different citation, metadata, and formatting needs so that journal articles could also be published and treated differently from book chapters. "Books" were reframed as "Publications," and "Chapters" were reframed as "Content."

Ideas for several new journals were floated, but a clear pain point arose as the AECT-sponsored Journal of Applied Instructional Design (JAID) took on new leadership that no longer wished to use print-focused tools such as Microsoft Publisher and PDFs as their only digital medium. As the editor of JAID and the developer of ETB discussed the needs of the journal, it was decided to try ETB as the journal's hosting platform (see Figure 6). The developer was named a production editor of JAID, and the first issue was made available online in July 2020.

FIGURE 6. Landing page for a journal with serial issues. (The Journal of Applied Instructional Design, n.d.)—The first academic journal (JAID) was hosted in July 2020, requiring the platform to be restructured to accommodate the citation, metadata, formatting, and other needs of journal publishing. Later, functionality was added for editorial review, submission management, academic indexing, etc. (Image used with permission from Dr. Royce Kimmons, personal communication, May, 2023).

This transition brought its own challenges, as editing and publishing a journal is quite different from publishing a monograph or edited book. In later iterations, ETB gradually evolved to address various recurring needs that were specifically important for journal editing, such as DOI registration, proper academic indexing, serial collection, editorial management, submission management, and so forth.

These changes continued to evolve for several years and into later versions of the platform but were also found to be useful in other situations as encyclopedias began to come online that needed editorial review systems. Authors of all types of publications wanted their works to receive DOIs, academic indexing, etc.

Continuous Improvement and Demonstration of Impact

An important advantage to OER is the ability to update published content based on usage data. This allows the author to correct errors, update information, and increase the usability of their content in a cycle of continuous improvement. For this important potential of OER to be realized, authors need good data.

Usage data is also related to another significant barrier to OER creation: the demonstration of impact, which allows an author to receive acknowledgement for creating open content as a scholarly contribution, similar to publishing in an academic journal.

teacher-values	1.37	336	0.82	1.46	270	0.85	0.09	1.32	NS	0.13
networked-thinking	0.72	410	0.69	0.78	308	0.55	0.06	1.35	NS	0.16
stimulus	0.81	389	0.58	0.78	299	0.65	-0.03	-0.69	NS	0.09
inner-workings	0.74	386	0.71	0.77	298	0.7	0.03	0.49	NS	0.05
prior-experiences	0.75	379	0.6	0.81	298	0.54	0.05	1.22	NS	0.17
tech-admin-values	1.6	331	0.68	1.64	261	0.65	0.05	0.89	NS	0.11
principal-values	0.96	332	0.84	0.97	259	0.83	0.01	0.12	NS	0.01
pck	0.69	327	0.67	0.63	256	0.81	-0.06	-0.99	NS	0.11
pic	0.81	331	0.65	0.85	255	0.63	0.04	0.76	NS	0.1
rat	0.94	333	0.36	0.91	256	0.43	-0.02	-0.68	NS	0.14

FIGURE 7. Screenshot of A/B test results. The first column shows what is being tested on each version, the next three data columns show descriptives for the original version of the chapter (the A version), the next three columns show descriptives for the test version (B), and the final four show descriptives and statistical results of the comparison. In this case, the "no stock photos" version seemed to outperform the original version in most measures, but the significance was too low to be sure. (Image used with permission from Dr. Royce Kimmons, personal communication, May, 2023).

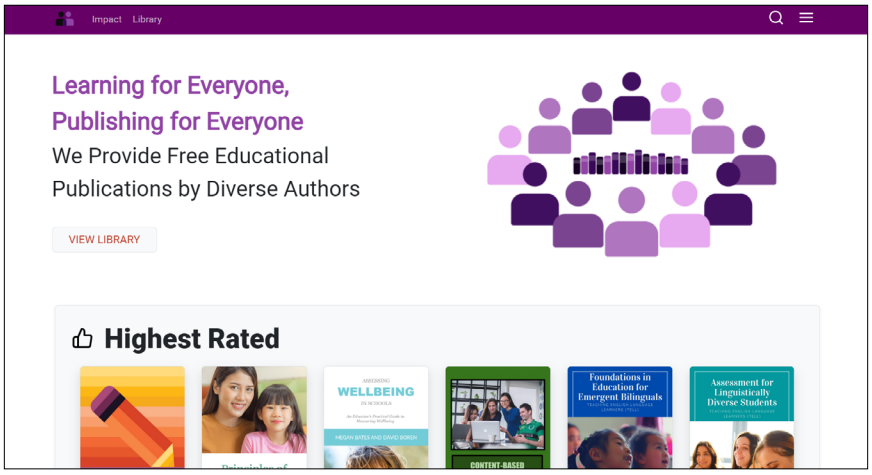

FIGURE 8. The Equity Press home page—Equity Press was created to host equity-related content, rather than EdTech-related content. Although resources for the new site were stored in the same database and edited using the same tools, they were accessed through a distinctive portal with its own branding. Similarly, other portals were created for universities to host their own content, with their own branding and restrictions. (Image used with permission from Dr. Royce Kimmons, personal communication, May, 2023).

As a first attempt to address this problem, the developer devised an impact page on which content creators could track their publications' total views, PDF downloads, cost savings estimates, chapter ratings, etc. He also embedded metadata to publications to facilitate indexing on scholarly archives, like Google Scholar, so that citations would be added to authors' Google Scholar profiles. These resources have now been cited thousands of times.

Additionally, the developer included a provision for A/B testing (see Figure 7) of content and the platform itself (Kimmons, 2021), a book-level analytics view for content creators, and a demo of how to use the analytics data for continuous improvement (see https://edtechbooks.org/userguide/google_analytics). The following features were added to allow authors to see how their content was being used: an impact page, which auto-counted accesses and the ability for individual books to send data to each author's Google Analytics account. Later, a heatmap overlay view allowed authors to see which parts of a chapter were most popular.

Audience Diversity

When content creators from a more diverse audience began to use the platform to publish their books, they needed a library that was not dedicated to educational technology. Because OER has been perceived among many scholars and practitioners as a pathway to increased equity in education (Nusbaum et al., 2020; DeRosa, 2020), many of those who are interested in equity topics are also interested in OER. Among equity researchers, there was a high demand for a cross-institutional portal specifically to host equity-related content.

OpenScholars Press was launched in November 2018 to host content unrelated to educational technology; the content was stored in the same database and edited using the same platform, but it was presented and accessed on this more general-purpose portal. Similarly, Equity Press was created in October 2020 (see Figure 8).

Although OpenScholars Press was intended to be generic, it turned out to be too generic. Universities wanted portals specific to their institutions, with their own branding and authorship restrictions. In the summer of 2021, the developer launched portals for two individual universities, with another to eventually follow. In each case, books and journals could be selectively shared or cross-referenced between sites. Focused branding allowed

usage that was more consistent with author expectations and leveraged the legitimacy of their institutions to suggest quality.

OpenScholars Press was not renewed in 2022, while Equity Press and institutional sites continued to grow in use into 2023.

Version 2.1 - The April 2021 Evaluation Study

In Winter 2021, Wadham et al. (2021) evaluated ETB to explore how meaningful and relevant an experience the platform provided for potential authors. Their evaluation focused on the design, accessibility, and perceived quality of the site. Moreover, they sought to identify barriers that would keep potential authors from publishing on ETB, what features might increase the likelihood of their publishing, and which tools would help them to continuously improve their work.

The research group presented their findings in April of that year, including many suggestions for improvement. Many of these suggestions have since been implemented, and we will discuss them here as part of the design process of ETB (see Table 3).

Ownership Uncertainty

Common misconceptions about Creative Commons and OER were identified in the evaluation as a barrier that prevented potential authors from seeing the value and process of open work.

Suggestions were made to strengthen the "About" page by making the introductory video more prominent. Training for users, including videos and infographics, was developed to address common misconceptions about Creative Commons and OER.

Additionally, a User Guide was created to address both conceptual introductions to openness and technical difficulties with creating OER. Though no formal evaluation has been conducted to determine the efficacy of these attempts, this seems to remain a challenge as many authors continue to fail to choose an open license for their work.

As a next step, efforts are currently underway to create three bootcamp strands for prospective users that will help address these and other concerns. Strands for these bootcamps are planned to align with the primary author groups that are currently using the platform, including (a) the lone faculty subject matter expert author, (b) the student who is assisting a faculty member in moving content over to an open publication, and (c) the editor who is managing contributions from other scholars.

Demonstration of Impact

Evaluators suggested that the platform should promote the reputation of the authors of ETB, similar to how Google Scholar is increasingly used as a sign of author impact.

A link was added to the "Features" section directing to the Google Analytics chapter in the "EdTech Books User Guide" that guides authors on creating a free Google Analytics account that would allow them to access the Google Analytics dashboard.

Authors were also given the ability to add links to personal websites, CVs, and various social media accounts (e.g., LinkedIn, Twitter) from their profile pages on ETB. In addition, each author was given a biography page that could be updated across publications and shared with the public, such as https://edtechbooks.org/user/548.

Remixing for Language Accessibility

By the end of 2022, only one-third of the platform's users spoke English as their native language. However, much of the content was written in English. For it to be truly accessible to users worldwide, content would need to be translated into multiple languages, a time-consuming and expensive process.

In the final months of 2022, an auto-translation feature based on the Amazon Polly engine made it possible to translate entire chapters into any of 75 languages. Once translated, the translations would be provided as a drop-down option for each chapter or article in the book or journal. Although automatic translation is still error-prone, it provides preliminary access to the content for readers who do not speak the language in which the chapter was originally written. It also provides a starting document for human translators, so the platform was designed to allow authors to edit the translations once they were made.

Automatic text-to-speech using the AWS Polly neural network was also added in various languages and accents, complementing the existing feature for English speakers.

Managing Publishing Timelines and Content Access

Authors had differing expectations of what should be published and when, who should have access to their content, and whether content should be indexed by search engines. For instance, an instructor collecting resources for a course they were teaching would want students to have access to the book, but they might not want it to be published, indexed, etc.

This was further complicated by the initial design decision to make all content always open (without a login requirement). This was intended to preserve openness but conflicted with the need to ensure that published content was high quality.

FOCUS	DESCRIPTION	DESIGN DECISION
OER PUBLISHING BARRIERS:		
Ownership Uncertainty	Potential authors don't understand Creative Commons licensing or the value of open work.	Training for new authors and a user guide were created. Bootcamp modules are in progress.
Demonstration of Impact	Reviewers suggested that the platform could be better used to promote the reputation of the content creators.	Authors were given additional guidance on using Google Analytics, as well as social media links.
Perceptions of Quality (not detailed in text)	Broken links and typos were often a problem.	Proofreading tools were implemented to help reduce the number of typos, broken links, and accessibility problems. Grammar- and spell-checking is under development.
5RS:		
Remixing for Language Accessibility	Content is less accessible for users who don't speak English.	Auto-translation and text-to-speech capabilities were implemented.
Retaining for Accessibility (not detailed in text)	Document conversion was sometimes faulty.	DOC and PDF download fidelity was improved.
Managing Publishing Timelines and Content Access	Scholars wanted to publish open content that wasn't directly related to educational technology.	OpenScholars Press and institutional portals were created as different ways to access content on the platform.
GOAL: Refine the capabilities while staying true to core principles **DESIGNER'S VIEWPOINT:** "Version 2.1 shows a negotiation and evolving vision for the project in some ways while maintaining some core expectations. Regarding the 5Rs, there has always been pressure from some authors to make content less open by restricting access to only students, etc., but we have not changed to do this. Instead, we have found a pseudo-middle road where content can be hosted but just not publicly published (i.e., easily findable). This has been important to maintain our relationship and trust with existing authors/users. Another compromise was that though we require all content to be publicly visible, we don't mandate the license that content must be released under. So, we suggest CC BY, but people can choose any license they like, provided that they acknowledge the minimum expectation of allowing free access."		

TABLE 3. Design Decisions in EdTech Books Version 2.1.

Authors were given the ability to publish chapter content selectively within their books and to share direct links to this content with anyone (much like a Google Doc). However, content was not indexed by search engines, and books were not included in site-level features until after the book had been vetted by site administrators. This gatekeeping functionality was further extended to domain administrators for institution-specific sites so that they could determine what would be published under their brand and take ownership of the quality assurance mechanisms.

Version 3.0 The Future of EdTech Books: Released 10 April 2023

In the more mature platform, the developer turned his attention from the problem-solving of the 5Rs and OER publishing to more fine-grained issues, including situation-specific usability issues, code complexity, and user perceptions (see Table 4).

Unnecessary Complexity

For the purposes of A/B testing on content, different versions or variants of content, known as *flights*, were presented to readers, allowing authors to study the effects of making changes; however, the analysis is difficult. The feature added considerable complexity to the platform code, and few authors were using it.

In Version 3.0, the feature was removed to simplify options to authors. Though A/B testing will still be implemented at the site- or system-level, it was found that the benefit to authors at the book level did not justify the complexity in the code and that it also introduced additional complexity for authorship and management.

Methodologically, Kimmons (2021) found that the feasibility of doing A/B tests at the content level was difficult, because it required content to be highly trafficked and for adjustments to be discrete and focused, thereby only allowing for

FOCUS	DESCRIPTION	DESIGN DECISION
Unnecessary Complexity	A/B Testing at the book level was too complicated and didn't bring significant benefit to authors.	Book-level A/B testing was removed, while platform-level A/B testing will be expanded.
Streamlining Presentations	Presenters displaying the web version of a book found navigation difficult	"Big navigation" was added.
Streamlining Editing (not detailed in text)	Editing still required switching back and forth between "edit" mode and "view" mode. Some things didn't appear the same in "edit" mode.	A more intuitive inline editor was added and editing and navigation were made more seamless and user-friendly.
Including More Content Types (not detailed in text)	Many open resources are not text-based, or do not fit into a textbook format. As a result, some content creators are hesitant to publish their content on ETB.	The developer expresses interest in changing ETB terminology to make it more encouraging of publications that don't fit the textbook format (e.g., a "playlist" allows users to compile resources like that of a course reader).
GOAL: Eliminate waste and fine-tune features that are most important **DESIGNER'S VIEWPOINT:** "We're still doing some new things in V 3.0, but I think we're at a place now where we deeply understand our users' needs, interests, skills, etc. in ways that we didn't before. This means that we are cutting back on some unnecessary or problematic things while streamlining the heart of the system that is valuable to folks. I feel like this lands us in a place where we now have a firm foundation for moving forward and add new features, but these features are wisely based now on a true understanding of the user base."		

TABLE 4. Design Decisions in EdTech Books Version 3.

marginal improvements. Because the effectiveness of A/B testing practically relies upon the aggregation of marginal gains, it is more appropriately applied as a method for system-wide UX adjustments than content adjustments. As a result, future iterations of the platform are expected to implement A/B testing for system-wide testing but not for individual content.

In particular, the developer plans to explore bandit algorithms in future iterations. Bandit algorithms attempt to balance the use of resources between exploring possible improvements and exploiting known improvements. Such algorithms might be used to guide sitewide continuous improvement in a semi-autonomous manner, such as by automatically assigning users to randomized experimental groups to test the effect of font size on readability, learning, and persistence with content.

Overall, since the A/B feature was not widely used, its absence in this version was rarely noticed, and the few instances where authors relied on it typically did not involve uses that attempted to test a feature but rather provided different experiences to different groups (like having an alternative form of a chapter for students enrolled in a semester class vs. the general public). Such needs were better addressed by using the copying and synching feature, so removal of the feature ultimately had little effect on authors or readers.

Streamlining Presentations

As some users began moving from using static PDFs to teach about their subjects to the web version, they found that navigating the web version required more clicks than a full PDF of the entire book. This slowed down their efficiency in jumping between topics when lecturing as they pointed to textbook-based examples of their topics or as they answered in-class questions.

To address this, an additional "big navigation" feature was added to every book. This navigation showed the entire structure of the textbook in a pop-out, collapsible outline that could alternatively be pinned in place if the instructor wanted to keep the outline open while they navigated through the book or would auto-hide when elements were clicked.

To support new development and to maintain a strong product, much of the back-end code was restructured and rewritten using more recent versions of its underlying software tools. With such extensive changes being introduced so quickly, the developer attempted to maintain visual consistency with version 2.1, so that even though the system was operating entirely differently behind the scenes, the user experience was not drastically altered.

REFLECTION

Development of a New Product

The development of ETB illustrates a pattern typical for a new software product, starting with rapid development of a basic solution in Version 1.0, followed by an expansion of the feature set in Version 2.0 and 2.1 and refinement in Version 3.0 based on real-world usage. For ETB, this pattern developed within a framework of needs, goals, and values defined by the challenges and affordances of OER publishing and the 5Rs of openness.

Creation

During the creation period, development was driven by the core unmet needs of OER publishing: practical remixing, platform reliability, and realizing the potential affordances of openly published content. The developer outlined three concepts that he found to be useful during the initial work on the platform: 1) Make things simple for your users. Make the act of remixing as easy as possible. 2) Make things look good. We judge books by their covers. 3) Don't overload users with features. Anticipate their needs and use cases and make their pathways as seamless and obvious as possible.

Expansion

During the expansion period, the initial focus expanded to include all of the 5Rs and challenges of OER publishing. Some changes were bug fixes, but the majority were new designs emerging from an increasing user base with diverse needs, interests, expectations, demands, and skills.

For the most part, these diverse needs were also based on the challenges of OER publishing and the desire to achieve the lofty aspirations of the 5Rs in the real world. Authors wanted more and better tools for revising, remixing, and redistributing their content, and for making it easier for students to retain and reuse. They needed to demonstrate the quality of their work to content adopters and the impact of their work on their department heads.

As usage increased, however, some users wanted the design to adjust to practical uses that didn't align well with ideals of openness. On this point, the developer stated,

Though we should respond and adapt quickly to user feedback, we should have some core vision items that direct what we're doing that are non-negotiable. Without those, we can't maintain trust. So, if we claim to be committed to the 5Rs, we have to do that at some level. Compared to some projects, we are actually very practical and negotiated in how we mandate the 5Rs to others (e.g., we don't require Share-Alike), but the minimum vision is that content is freely available.

Refocusing

In the refocusing period, changes have less surface connection to the 5Rs and the challenges of OER publishing. However, the goals of OER remain the driving force for change, as the platform evolves to improve the user experience with remixing (streamlined editing), reuse (streamlined presentation), redistribution (additional content type) and continuous improvement/demonstration of impact (refinement in the A/B testing process).

Regarding the refinement process, the author referred to a core design principle attributed to Antoine de Saint Exupéry: "Perfection is achieved, not when there is nothing to add, but when there is nothing left to take away." While earlier versions were about adding to the platform, the developer described a shift to refinement by taking away from the platform in Version 3.0:

A key design takeaway here is that intentionality is key, but we only know what to be intentional about sometimes after we have tried lots of things. This applies to OER as well. Many think they're done creating OER once they get their content up, but this is kind of just the beginning. Putting up the OER (or building the basic system in our case) was placing all of the clay we needed on the potter's wheel. Now, we need to shape it, refine it, and streamline it. At the beginning, we 'moved fast and broke things,' but we're at a place now where we cannot break things, because breaking them has real consequences on learners. In Versions 1.0-2.1 we brought in heavy machinery to break up the rocks and till the ground; now, we need to intentionally nurture the seedlings that are coming up and shape the garden around them.

Learning Across Versions

The redesign of A/B testing demonstrates how design can change when a designer has feedback from real users. When it was originally implemented, the developer was personally aware of the need that content creators had to demonstrate impact. He says,

While I was working on this, I was also working toward tenure, which created some tensions in time but also some guidance in developing ways to legitimize the work, such as building in ways of doing research on the content and tracking impact. My chair at the time told me multiple times that the work I was doing was great, but I needed to be sure that I was building in ways of conducting research at the same time, otherwise the effort could be seen as wasted because it wouldn't count toward tenure.

Accordingly, he designed multiple ways of demonstrating impact. Later, however, it became clear that authors weren't using A/B testing at the book level; it was too complicated, it was less effective than system-level A/B testing, and other tools were being used more effectively.

With this real-world data, the correct design choice was to remove book-level A/B testing and enhance system-level testing instead. In each case, the design choice was driven by the same motivation—to simplify the demonstration of impact and continuous improvement—but differing levels of information about real usage. This small change demonstrates the power of design-based research.

CONCLUSION

In this design case, we have described the creation, advancement, and expansion process of EdTech Books - an open textbook platform that has increasingly reached a global audience of learners from diverse cultural, linguistic, and economic backgrounds. Through a timeline of events and a recompilation of the developer's updates, we examined the challenges of customizing the platform to meet the needs of all users—authors, faculty, and students. We used the context of the 5Rs of openness and OER Publishing as a framework to analyze the design decisions made by the developer during creation, expansion, and refinement of the platform.

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