
Open educational resources: inquiring into author use and reuse

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Abstract: For teachers and learners, the proliferation of Open Educational Resources (OER) in combination with advances in information technologies has meant centralised access to materials and the possibility of creating, using, and reusing OER globally, collaboratively, and across multiple disciplines. Through an examination of a community of author users of the OER portal Connexions, this article explores individual and group authorship, OER use and reuse and the factors contributing to and hindering these practices. As such, the paper sheds light on how OER can be sustained and continuously improved, with an emphasis on the use and reuse of dynamic, relevant, and high quality materials over time.

Keywords: OER; open educational resources; author use; author reuse; peer production; collaboration; content creation; CNX; connexions; sustainability; mixed method study; log file analysis; interviews.

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1 Introduction

Open Educational Resources (OER) have gained increased attention for their potential to obviate demographic, economic, and geographic educational boundaries – in short, for their ability to serve as an equitable and accessible alternative to the rising costs and increased commercialisation and privatisation of education (Ishii and Lutterbeck, 2001). Pushed along by early initiatives such as the Massachusetts Institute of Technology's open courseware collection and by advocacy for other institutions and organisations to follow suit, the internet now is home to numerous repositories and aggregators, all offering freely available open educational resources. For educators and students, the proliferation of OER has meant centralised access to materials that meet unique teaching and learning needs, and the possibility of collaborating with peers to create, use and reuse OER globally and across multiple disciplines.

But the question remains as to how much and in what ways the promise and potential of OER is being realised. As evidenced by the open source software movement, the sustainability of open, peer-driven models is contingent upon continuous user contribution, collaboration, open exchange, and ongoing modification of content (Benkler, 2005). However, recent research into the use of OER has indicated that while educators and learners are accessing and using OER materials (Massachusetts Institute of Technology, 2006; Harley et al., 2006; Hylén, 2006), the sharing of one's own OER and the reuse of others' OER is less expansive (Collis and Strijker, 2003; Harley et al., 2006; Petrides et al., 2008). Other studies have begun to address the issue of collaborative content creation, highlighting that it is through interactive, interested users that the necessary critical mass of content is created and hence through which OER is sustained (Benkler, 2005; Stephenson, 2006). Few of these studies, however, have empirically

addressed author use and collaborative authorship, and therefore, our understanding of the extent to which it occurs and the incentives and factors supporting it are limited.

In an effort to build on existing studies and address issues of sustainable OER use and reuse, this paper examines how and to what extent OER are created, adapted, augmented, and 'remixed' by both individuals and communities of author users. Specifically, through an examination of those who have created open education materials within the repository called Connexions (www.cnx.org), this study explores the extent and nature of author use and reuse practices. In doing so, the study seeks to shed light on how OER collections and repositories can create a user-driven infrastructure that supports the continuous addition and modification of content and which in turn can help in the effort to create ongoing advancements in the creation of materials that are freely available.

2 Literature

OER are defined as web-based materials that are free and open for use and reuse in teaching, learning and research (UNESCO, 2006). Examples of OER include course materials such as syllabi, lecture notes, and educational games; primary and secondary research materials such as historical documents and reports; and pedagogical tools for creating lesson plans, worksheets and exercises. With roots in the open source software movement, where users continuously review, critique and develop openly available source code, OER serves to facilitate – through accessible technology and alternative licensing – a community of users who collaborate, discuss, critique, use, reuse¹ and improve educational content. Thus, for educators and students, OER translates into centralised access to materials to supplement their local teaching and learning needs, as well as the possibility of sharing materials, collaborating to improve upon existing materials, and creating new OER globally and across disciplines (Petrides and Jimes, 2006).

Recent research into OER use and reuse has provided evidence that some of this promise and potential is in fact being realised. In a survey of 452 college instructors, Petrides et al. (2008)² found that 92% had searched for course-related materials on the internet. Reasons cited by the participants included their desire to integrate new materials into their courses, to improve their teaching methods and knowledge, and to connect with colleagues who have similar teaching interests. Likewise, MIT's recent evaluation report of its OCW collection revealed that educators are accessing OER to support their course planning and preparation and to enhance their personal knowledge (Massachusetts Institute of Technology, 2006). Ninety-six percent of these educators indicated that MIT's OCW collection has improved or will help to improve their courses.

Additional research has indicated that while educators are accessing and using OER materials, the sharing of one's own educational material and the reuse of others' is less expansive (Collis and Strijker, 2003; Harley et al., 2006; Petrides et al., 2008). Specifically, Petrides et al.'s (2008) study of online instructors found that while 67% of those surveyed were willing to share their course materials with others over the internet, only 25% were actually making their course materials available. Similarly, Harley et al.'s (2006) study of online practices revealed that while instructors maintained private digital collections on their personal computers, and were willing to share those materials, they were doing so to only a minimal degree.

In terms of reuse of other's OER materials, a key concern is the viability of OER as related to issues of contextualisation. Specifically, it has been noted that highly de-contextualised OER are reusable in the greatest number of learning situations, but this means that they can be the most expensive and difficult to reuse, localise, and personalise. This is because such resources, by nature of their high level of granularity, are devoid of the context that may be needed to make them comprehensible on their own (Wiley, 1999; Calverley and Shephard, 2003). For example, a visual representation of a particular social science theory created in English with accompanying labels and text may be reusable for instructors in English classrooms, but may not be for those who instruct, e.g., within purely Russian-language classrooms. Removing the contextual labels and accompanying text allows the visual to be reused by multiple instructors who wish to add foreign language labels and context; however, it may also render the visual representation incomprehensible. Given that ease of incorporation into instructional activities has been identified as a central facilitator of reuse (Recker et al., 2004), the ability to contextualise OER across various teaching and learning situations becomes central.

Perhaps a more challenging barrier to reuse cited within the literature, however, stems from the proprietary, hierarchical nature of educational content. That is, given the educational context, wherein individual proprietary knowledge is incorporated into classroom instruction (Collis and Strijker, 2004), and where the roles of professors, teachers, administrators, and students are distinct and embedded, users may lack the confidence, capacity, or willingness to contribute changes to OER. In short, such an environment, in serving as the backdrop to OER creation, brings with it assumptions and structures that can hinder OER sharing, reuse, and collaboration across roles, disciplines, and contexts.

In mitigating these barriers, much of the discussion around OER use and reuse calls for a focus on the role of communities. Stemming from the success of open source software, communities are deemed as central to OER sustainability – for they encourage participation, responsibility and commitment by members to evaluate, augment, improve upon and republish materials (Collis and Moonen, 2001; Collis and Strijker, 2002; Stephenson, 2006). Stephenson (2006) notes that community is also central to OER adoption by new users, for community members evaluate, comment, and help new and potential users locate and become involved in relevant OER. In other words, community can be said to play an important role in the future of OER, for it is by way of interactive, interested users that new users are attracted, and that the necessary critical mass of content is created and continuously improved upon.

Empirical studies have underscored and expanded upon the role of community, specifically focusing on the role of collaboration within online content creation communities. Huberman and Wilkinson's (2007) study revealed how collaboration among community members contributes to sustainability of online resources. Specifically, their analysis of Wikipedia content revealed that an increase in the number of collaborators on (and edits of) articles impacted article quality – with quality being defined in terms of those articles that were featured and selected by the Wikipedia community as being the best.

Other studies have focused on the process of online collaboration within OER or digital resource communities, and on how through that process new users are inspired to participate in resource creation, use and reuse. Metros and Bennett's (2002) work points to the notion that online digital resource environments can facilitate role shifts and bring new, non-traditional users into the content creation process. Specifically, their informal

web-based survey of digital resource practices at 97 higher education institutions revealed that instructors have begun to assign their students the role of co-producers of digital content. In this sense, the creation of content becomes a process whereby instructors are no longer the sole creators and purveyors of knowledge; instead they become facilitators of the content creation process, and students become co-authors. Furthermore, Lin's (2006) analysis of an online language translation community shows how the collaborative content creation process can be structured to facilitate division of work activities within a group, as well as invite use by non-group members. Through examination of community members' online discussion threads and the technological, organisational, and ontological structures surrounding the community, Lin found that collaborative content creation necessitates a governance structure to support decision making and responsibility sharing; however, at the same time, it requires a loosely coupled system to encourage use by members outside of the community. Richmond (2006) underscores these findings, pointing to the necessity of 'coherent anarchy', wherein OER portals and collections facilitate the removal of traditional hierarchical roles to inspire information sharing and reuse, while offering structures to help organise activities in the absence of those roles.

Despite the emergence of literature that has begun to address central obstacles and issues of OER use and reuse, several gaps remain. That is, while studies reveal how OER content is being used and illuminate the issues surrounding OER sustainability in terms of continued use and reuse, they have only scratched the surface of our understanding of the OER process. For example, we know little about users and what inspires reuse, and even less about what motivates OER creators to republish content that they have reused and augmented or how communities of OER users form, operate, and collaboratively create content. Given the emergence of OER repositories and aggregators that support the re-contextualisation of OER, the time is ripe to further address issues of author use, collaborative content creation and reuse, the focal point of this article.

3 Methodology and source of data

As part of the selection process for participation in this study's investigation into OER use and reuse, over a dozen open education collections and repositories were examined – from subject-specific university collections to cross-disciplinary open content repositories. Selection criteria included the amount and type of content that comprised the collection or repository, the user groups that it targeted (instructors, students, and self-learners), and the features and functions it offered. As the focus of the study was on author use and reuse, the criteria for selection were that the source be a robust collection or repository that emphasised instructor use and that it enabled users to create and augment content individually and in groups within an online environment. Another central criterion was whether the collection or repository tracked user behaviours and actions by way of log files³ – as this would facilitate an analysis of use practices over time.

The collection/repository that best met the selection criteria was Connexions (CNX). The reason for choosing the CNX repository, which includes a range of both small and large chunks of scholarly content spanning multiple subjects in K-12, higher education, self-learner and professional needs alike, was the following: First, in operating as a multi-functional OER repository platform, it encompassed a wide range of possible user

activities from searching and viewing content, to creating, augmenting and publishing OER. Furthermore, because CNX enables members to create online content individually as well as collaboratively, it also allowed for the analysis of the role of groups in creating content. Additionally, and perhaps most importantly for this study, CNX not only actively tracks and archives user behaviours through log files, they were also willing to share these files for the purpose of this study. These files included several types of data, such as if a piece of content had been augmented or published, the date that this occurred, and whether or not a piece of content originated from a pre-existing item within the system. The log files also provided author reuse data by way of an open-ended field within the CNX system in which author users could report how and why they had augmented, remixed, or otherwise changed a piece of existing content, as well as their perceptions of and experiences with the technical functions that facilitated their reuse activities.

The study of OER author use and reuse within the CNX environment occurred by way of the log file analysis, as well as interviews with a selection of CNX users. CNX log file data were analysed from the period of April 2000 to July 2005.⁴ Examination of these data – in the form of frequencies, correlations, probability and qualitative analyses – allowed for the quantification and qualification of OER use and reuse behaviours and provided insight into the factors that support OER use and reuse. Also, because CNX allows author users to enter comments about why they augmented and published OER content, these data allowed for the analysis of the reasons for creating content, and user perceptions of that process.

Because the focus of this study is to better understand aspects of author use and reuse that center around content creation, augmentation, and collaboration, the analysis was confined to CNX users who have created, augmented and contributed OER content to CNX. These users are referred to in this study as ‘author users’. Thus, users who simply search, access, view and download content were not included in the study.

After the log file analysis was completed, eleven follow-up phone interviews were conducted in order to contextualise the findings from the log file analysis from the perspective of specific CNX author users. The goal of the interviews was to understand obstacles to and incentives for content creation, use, and reuse. The interviewees were selected based upon the frequency and type of CNX activities that they participated in – the objective being to have a diverse mix of participants with varying levels of use and types of activities. The questions posed to the eleven participants centered on why they chose to use CNX, their typical activities within CNX, and their prior experiences with creating and using OER. Thus, while the quantitative data provided insight into use and reuse practices as well as into some of their determinants, the interviews conducted with the selection of CNX author users added depth to these findings by delving into the why and how behind use and reuse practices, as well as into the discontinuation of use and reuse by some users.

The findings below are categorised as follows:

- the extent to which OER is being used and created
- factors supporting authorship
- the nature of reuse
- incentives and disincentives to use, reuse and collaborative authorship.

It is important to note that this study does not attempt to provide a comprehensive assessment of OER use, reuse and authorship; instead it aims to explore some of the ways a particular community of OER authors – i.e., those participating in the CNX community from April 2000 to July 2005 – create, work with, and collaborate around open educational resources.

4 Findings

4.1 Growth in author users and content

The CNX log file analysis revealed a significant growth in author users over time. Table 1 shows the number of new, returning, and total author users from April 2000 to July 2005. In calculating the compounded annual growth rate specifically from April 2000 to December 2004,⁵ the number of new author users joining each year increased at a rate of 93% – from seven new author users in 2000 to 83 in 2004. Furthermore, even when accounting for the loss of author users who did not return each year, the number of active author users grew at a compounded annual rate of 127% – from seven author users in 2000 to 151 in 2004.

Table 1 Number of new, returning, and total author users by year

<i>Year</i>	<i>New author users</i>	<i>Returning author users</i>	<i>Total active author users</i>
2000 (from 4/2000)	7	0	7
2001	32	7	39
2002	37	33	70
2003	64	54	118
2004	83	68	151
2005 (to 7/2005)	24	93	117
<i>Total</i>	<i>247</i>	<i>n/a</i>	<i>n/a</i>

The table also shows a total of 247 authors having participated or continuing to participate in CNX over the five year period. As Table 2 illustrates, in terms of the amount of content created by these 247 CNX author users, the analysis likewise revealed significant growth over time.

All content within CNX is organised into modules, and multiple modules can be grouped to form courses. All modules potentially undergo a series of iterations as users edit and modify them, which creates versions. Table 2 shows the number of new modules created each year and the corresponding quantity of versions.⁶ As can be seen, the collection grew from 199 modules in 2000 to 2,514 modules in 2005. Concomitantly, the number of versions grew from 199 in 2000 to a total of 12,993 in 2005. Expressed as average yearly growth, the modules grew at a compounded annual rate of 76%, and the versions at an annual rate of 153%.⁷ The figures thus reveal growth in both the creation of original modules or content that is remixed or broken down into new modules, and in the reuse and augmentation of those modules by way of versions.

Table 2 Number of modules and versions created by year

<i>Year</i>	<i>Modules</i>	<i>Versions</i>
2000 (from 4/2000)	199	199
2001	292	2,937
2002	389	3,050
2003	692	3,107
2004	692	2,502
2005 (to 7/14/05)	250	1,198
<i>Total</i>	<i>2,514</i>	<i>12,993</i>

A calculation of the ratio of versions to modules shows that on average, authors created four versions per module. However, some author users were more active than others: the maximum number of modules or versions published by an author user was 94 and the minimum was one.⁸ The discussion below turns to factors that were found to contribute to higher levels involvement on the part of author users and thus sheds light on the conditions that might support the creation of content.

5 Factors contributing to content creation

CNX author users create content individually and in groups. When creating content individually, author users work within their online private work areas and the versions and modules created and augmented in these areas are only visible to others when published at the author's discretion. To work on content collaboratively, author users can create an online shared workgroup around content and invite other author users to join, or conversely, they can become a member of a pre-existing workgroup through invitation by that workgroup's members.

The creator of any given workgroup is assigned three roles by default:

- original author of the content
- maintainer, who is responsible for editing and publishing new versions of the content
- copyright holder, who has the sole right to license the content.

CNX allows workgroup creators to change their own role and to assign new roles to invited group members. This facilitates the collaborative process and the delegation of tasks, as it, e.g., allows for the addition of co-author roles to a given piece of content by the author, and for specific group members to take over the maintainer role in the place of the author.

As revealed below, analysis of the content created over time by both individual authors and authors working in groups allowed for the identification of two factors as central to the amount of content created: consistent, long term use and author group size.

5.1 Consistent use

Analysis of the number of versions created in relation to author users revealed that their level of use was a determinant of the amount of overall content they created. The level

of use demonstrated by author users was assessed by way of yearly participation and non-participation (i.e., version creation) in the CNX system, and was disaggregated into three groups: consistent use, intermittent use, and eventual non-use. Consistent use was defined in terms of those author users who demonstrated activity in CNX for one or more consecutive years and were also active in 2005. Intermittent use was defined in terms of those who were involved with CNX intermittently, and who thus demonstrated activity for non-consecutive years. Eventual non-use was defined in terms of those who did not demonstrate any activity after a specific point in time and who eventually left CNX.

In examining the log files of the 247 members that joined CNX over the five-year period, 38% demonstrated consistent and consecutive yearly participation. Eleven percent was involved with CNX for intermittent periods of time, with distinct years of non-use. Fifty-one percent were classified as eventual non-users, as they had left the system at some point and did not demonstrate any activity as of July 2005. Table 3 expresses these percentages and the number of author users they represent.

Table 3 Breakdown of author users by level of use

<i>Level of use</i>	<i>Number of author users (%)</i>
Consistent use	93 (38%)
Intermittent use	27 (11%)
Eventual non-use	127 (51%)
<i>Total</i>	<i>247 (100%)</i>

Examining these author user groups in terms of the amount of versions they created over the five-year period revealed that consistent author users generated more content than the other two groups. As revealed in Table 4, consistent author users, on average, created 166 versions each, while intermittent author users averaged 51 versions and eventual non-users averaged 18 versions.

Table 4 Author user group and version creation

<i>Author user group</i>	<i>Average number of versions created per author</i>
Consistent users	166
Intermittent users	51
Eventual non-users	18
All user groups combined	78

Looking more closely at the behaviours of consistent author users allowed for the identification of a smaller subset of early adopters. A cohort analysis was conducted, wherein consistent author users were disaggregated into groups, based on the year that they joined CNX. As shown in Table 5, those who joined CNX at the nascent stages of the collection were more likely to be consistent users than those who joined in later years.

Thus, of the seven users who joined in 2000, 86% were consistent users. As the years progress, the consistent users as a percentage of the total user cohort continues to drop (with the exception of those who joined in 2005, because all users in this cohort were deemed as consistent users by definition).

Table 5 Consistent author users by annual cohort

<i>Year joined</i>	<i>Total author users</i>	<i>Consistent author users (%)</i>
2000	7	6 (86%)
2001	32	17 (53%)
2002	37	14 (38%)
2003	64	12 (19%)
2004	83	20 (24%)
2005	24	24 (100%)
<i>Total</i>	<i>247</i>	<i>93 (38%)</i>

Although ‘early adopters’ do not represent the wider population of author users, this niche group was found to play an important role in the overall development and growth in content: The six author users who stayed with CNX for all five years created a total of 737 versions of content. An additional analysis of the correlation between the number of years author users have stayed with CNX and the number of versions they have published shows a positive, statistically significant correlation ($p < 000$).

The importance of early adopters as part of the consistent user group is further demonstrated through examination of patterns of behaviour over a two-year period, starting from the time an author user joined CNX. This two-year cohort analysis reveals that those users who joined at a later date were less likely to be active in the collection the following year. Table 6 details these findings.

Table 6 Two-year cohort analysis of author users

<i>Year joined</i>	<i>First year: number of author users who joined CNX</i>	<i>Second year: number of author users who left CNX (%)</i>	<i>Total active author users</i>
2000	7	0 (0%)	7
2001	32	6 (19%)	39
2002	37	13 (35%)	70
2003	64	47 (73%)	118
2004	83	63 (76%)	151
2005	24	n/a	117

As shown, a higher percentage of author users from the 2000 and 2001 cohorts have demonstrated activity in the subsequent year than those users who joined at a later time. This raises an interesting issue moving forward as more niche-oriented collections and repositories are beginning to be used by a group of non-vanguard users – specifically around how to simplify barriers to entry and to encourage participation as added-value to them. So while in the case of CNX, the increasing number of author users who discontinue their activity over time may point to the need to develop alternative strategies to engage a more mainstream group of authors, the following section reveals that group authorship may serve as one way of mitigating this issue.

5.2 Author group size

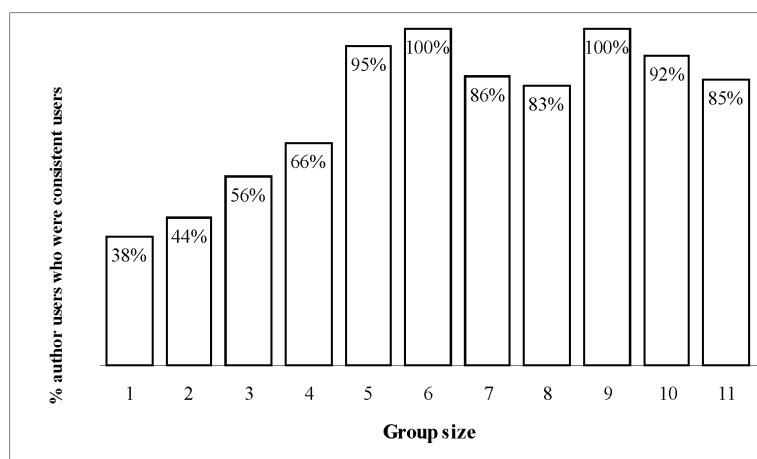
Examination of authorship of the 12,993 versions created during the five-year period revealed that the vast majority (78%) of these versions were created and published by individual members, working in private work areas. Thirteen percent of the versions were created and published by workgroups consisting of two members and the remaining 10% were created by groups of three or larger (the largest author group identified in the study consisted of 11 users). Table 7 details these findings.

Table 7 Author collaboration across versions

<i>Number of author users per version</i>	<i>Versions created (%)</i>
1	10,151 (78%)
2	1,694 (13%)
3	487 (4%)
4	298 (2%)
5	52 (<1%)
6	51 (<1%)
7	8 (<1%)
8	5 (<1%)
9	209 (2%)
10	6 (<1%)
11	32 (<1%)
<i>Total</i>	<i>12,993 (100%)</i>

Figure 1 provides a more detailed look at author group size alongside consistency of use, and revealed a positive relationship between the two. Analyses of author users who demonstrated consistent use, by the size of the groups they participated in, revealed that groups of two or more demonstrated a higher probability of consistent use than individual author users. As user group size increased, the percentage of consistent users also increased. For example, the analysis revealed that 95% of author users who participated in a group of five members were consistent users, while only a 38% of author users who worked alone were consistent users.

The above finding is underscored when juxtaposed with an additional analysis of the relationship between eventual non-use and group size. Again, eventual non-use was defined in terms of author users who stopped using CNX and eventually left the system. The analysis revealed that 53% of author users who worked alone eventually left CNX, but that a lower percentage (45%) left if they worked in a group of two. The percentage of author users who left continued to decrease as group size was increased. In sum, this suggests that as group size increases, author users are more likely to continue creating content on a consistent and consecutive yearly basis; in short, it suggests that group support and community play a role in sustaining the creation of content.

Figure 1 Author group size and consistent use

6 Author reuse behaviours

As part of CNX's version and module submission process, authors were asked to provide an open-ended reason (or reasons) for why they were publishing the content.⁹ There were a total of 14,429 reasons¹⁰ provided by the author users. For the analysis that follows, we did not include the 3,174 reasons that were related to new versions, that is, first time publishing activities or reasons related to the testing of the CNX publishing function. The remaining 11,255 reasons were related to reuse activities – that is, activities that involve the remixing or adaptation of content for new and/or local purposes. From this data, an analysis was conducted, which looked at the nature of reuse activities and the extent to which they occurred. After addressing the categories of reuse behaviours that surfaced from the analysis of the reasons, this section concludes with a discussion of the extent to which the behaviours were conducted by authors who reused others' content.

6.1 Types of author reuse

In examining the reasons that authors provided for changing content, the analysis revealed seven main categories of author reuse: visual and technical changes, general editing, collaboration-related changes, metadata changes, modularisation, language translations, and other miscellaneous reuse behaviours. Table 8 provides an overview of the extent to which these behaviours occurred.

As displayed in the table, the creation of new versions through visual and technical changes to content surfaced as the most prevalent author reuse behaviour. This category of reuse encompassed 51% of the reasons for augmenting or changing versions. It included uploading visual files (graphics, figures, tables, etc.) and changing and improving content layout and display. The latter of these entailed fixing bugs and editing or writing display code in cases where users were technically proficient enough to do so.

Table 8 Type and quantification of reuse behaviours

<i>Type of reuse</i>	<i>Number of reuse reasons (%)</i>
Visual and technical changes	5,694 (51%)
General editing	2,657 (24%)
Collaboration-related changes	1,201 (11%)
Metadata changes	880 (8%)
Modularisation	100 (1%)
Language translations	91 (1%)
Miscellaneous reuse behaviours	632 (6%)
<i>Total</i>	<i>11,255 (100%)</i>

A second category of author reuse behaviours was general editing of content, which accounted for 24% of the reasons for augmenting or changing versions. It included correcting typos, spelling, punctuation, and grammar, refining and rewriting text, and revising versions from the bottom up. It also included updating out-of-date portions of content, and adding or removing content sections.¹¹

Furthermore, 11% of the reasons for version changes were attributed to group collaboration activities. Examples of this category of reuse include making changes requested by a group member or the primary author, accepting edits from a group member, and modifying a group member's role.

Eight percent of the reasons for version changes were attributed to metadata changes. Metadata changes included cases where author users added, deleted or modified the version title, abstract, and/or keywords. Metadata changes also occurred when author users fixed typos in author names or in other metadata components.

Modularisation encompassed activities in which author users separated modules into smaller units or combined or remixed various sub-units to form entirely new modules. Although only 1% (100) of the reasons fell into this category of reuse by author users,¹² it is noted here due to the fact that it diverges from the other behaviours. The analysis revealed that breaking existing modules into smaller units to create several new modules was a prevalent type of modularisation (69 of the 100 reasons in this category). To a lesser degree, modularisation encompassed activities wherein author users combined pre-existing modules to form larger modules or courses (27 of the reasons) or where authors redistributed and passed content from one pre-existing module to another (four of the reasons).

A final category of reuse behaviour was language translation, which was cited for only one percent of the reasons for version changes. Language translations occurred in the form of author users posting, for example, a Spanish version of an existing module or changing a module title to include Japanese fonts.

Additional, miscellaneous author behaviours surfaced in the analysis that included changes to personal contact information (email addresses) and cases where author users indicated fixes or changes they would like to make in the future. This category of author behaviours combined accounted for 6% of the reasons for version changes.

6.2 *Reuse of other's content*

Due to the ability to create 'derived' modules without attributing the original author, we were able to identify only 80 modules with their original authors. An analysis of these 80 derived modules revealed that 88% (70) of them involved author users manipulating their own content. The remaining 12% (10) of the derived modules were published by authors who were not the original authors. This suggests a hesitancy to reuse other's content, especially with regard to modularisation activities.

For versions, however, reuse of other's content was more likely. The log files contained authorship documentation on 7,016 versions, of which 3,578 (57%) were published by individuals who were not the original author (nor were they part of the original author's workgroup). Although the sample for the derived modules is too small to generalise, the data provide some indication that reuse of other's content involving, e.g., general editing and visual changes is more likely to occur than more the expansive reuse activities such as remixing and new module creation.

7 **Incentives and disincentives: author use, reuse and collaboration**

Beyond providing an indication of how and why authors augmented content, the reasons analysis provided an indication of author users' perceptions about the process of publishing versions and modules. That is, 149 author users submitted comments about the user-friendliness of the CNX publishing process or about the structure and role assignment process of the shared workspaces. Examining these comments facilitated, to some degree, an understanding of the incentives and disincentives to use and reuse and provided insight into the functionality of collaborative content creation within CNX. Interviews with a selection of consistent users, intermittent users, and eventual non-users added depth to these findings and brought forth additional understanding of the incentives and disincentives to use, reuse, and collaboration.

7.1 *Use and reuse*

Interviews with intermittent users and eventual non-users revealed technical barriers that prevented members' ability to augment content. Within the interviews, the technical barriers were said to stem from coding and markup errors or to the lack of technical skills on behalf of the author users. Some of the less technically skilled members emphasised technical barriers as an overall disincentive to OER use, as the CNX site represented a "steep learning curve" and was said to be too time consuming.

Conversely, consistent author users cited – within the interviews – their technological know-how and prior experience publishing online content as facilitators of their continued use and reuse. Examination of the author comments in the reasons analysis included examples of successfully expedited edits and technical changes, and revealed exclamations such as 'Done!' and "Eureka! I got one of the equations to work!". Occasionally, author users expressed excitement and provided a brief explanation of how to execute a particular action – for example, "Yay! .png will look fine if you double the resolution instead of changing height/width".

Another incentive mentioned by consistent author users was that it enhanced their professional lives, which helped to create a continuous need for publishing, using and

re-using content. That is, consistent users explained that as teaching professionals they had a heightened need for timely content for their students and colleagues. Interestingly, however, intermittent and eventual non-users – some of whom were also teachers – identified the lack of relevant content on CNX as a disincentive to use.

7.2 Collaborative content creation

As discussed previously, although CNX author users can create content both individually and in groups, most content was created by individual author users in their private work areas. However, the findings also revealed the existence of author groups and their importance to content creation.

Interviews with author users indicated how author groups were formed and operated, which in turn elucidated how CNX's built-in group structures and group processes facilitated or in some cases hindered group authorship. Several respondents, for example, described how they, as teaching professionals, were spurred by a desire to make their work available across geographic and language boundaries. In facilitating this effort, they often invited multiple author users to join their workgroup. Importantly, these workgroup members cited the overreaching structure of the work groups as important factor in maintaining their group publishing efforts, as the role assignment function allowed for a means through which content was regularly maintained, kept up-to-date and accurate, and published in a timely fashion. The author users further explained how within their author groups, individuals were assigned informal roles – as the maintainer role was, e.g., sometimes split into content editor, uploader, bug fixer, and translator. In this manner, the four roles that the CNX system allows for (author, co-author, maintainer, publisher and licensor) were further disaggregated within the author groups. This can be said to have facilitated collaborative efforts as it enhanced and further stretched the division of labor function built into CNX.

However, the interviews revealed the existence of some disincentives to group authorship. Because the editor and publisher roles are assigned by the content authors, and because changes must be filtered through the individuals occupying these roles, several author users expressed frustrations around editing group content. These frustrations were evident in the user-generated documentation; for example, one of the author users, who was waiting to be formally assigned the role of editor, wrote “[I] just couldn't wait for [Author User A] or his partner to accept roles”. As a result, this particular author user made changes without the permission of the content author. Another user who authored a piece of content that was changed without his or her permission stated, “[Author User B] made some changes behind my back”. Activities such as these very obviously involve cases where author users circumvent the proprietary and permission constraints set up by CNX. In doing so, these users, instead of creating new versions with the permission of the author, created new modules and did not document where these modules were derived from.

8 Discussion

In extrapolating the CNX findings to the wider OER context, this study reveals that the creation of OER, while still a nascent phenomenon, has developed and grown. In line with previous studies (MIT, 2006; Harley et al., 2005), this study indicates a 70% annual

growth in new CNX authors over the nearly five-year period, showing that momentum is building. These OER author users are creating and augmenting more content, as the data revealed that modules and versions are increasing at an annual percentage rate of 76% and 153%, respectively. Interestingly, as the growth of versions has been faster than that of modules, author users are editing and augmenting existing content to a greater extent than they are creating new content.

Despite this consistent and prolific growth, however, some users discontinue their use after initial use – and those leaving are primarily those who have joined the CNX space at the latter stages of its existence. In light of this potentially increasing loss in users, understanding the drivers, as well as the incentives and disincentives to OER content creation, use, and reuse become extremely relevant.

This study found that central to retaining active, consistent users and hence to the sustainability of OER use and reuse, was that of author group size. Specifically, as group size increased beyond one author user, the probability that users stayed with the OER collection increased with it. Thus in line with previous studies on OER, facilitating OER group authorship and collaboration becomes an important force in use and reuse sustainability. However, given that the majority of the OER content within this study was created individually as opposed to in groups, the issue becomes how OER repositories can facilitate more group authorship (or participation). Furthermore, given that new content creation and modularisation of other's content are less prevalent than version creation, the issue also becomes how OER repositories inspire users to cross boundaries, interact, collaborate, and create new knowledge and content. Certainly, the mere presence of modularisation as an author user behaviour suggests that flexibility, adaptability, and interchangeability of content are in fact promising facilitators of new OER creation. That is, users are breaking apart, combining, and redistributing portions of existing content to form entirely new OER when given the tools and capability to do so. The next potential step is to inspire more of this behaviour, and to facilitate the process of modularising content outside of their own author groups.

In facilitating group authorship, group role structures play an important part. In one sense, the CNX author group roles support content use and reuse by way of giving individuals distinct and collaborative roles for maintaining the content. On the other hand, the fact that some members within these groups operate as gatekeepers (i.e., content editors and authors) serves to dissuade other members outside of the group from altering existing content. This can be said to counter the very nature of OER, with its promise of obviating demographic, geographic, economic boundaries. And in line with Lin's (2006) work on OER communities, it points to the potential necessity of community role structures that lie somewhere between loosely coupled systems and strictly governed ones.

9 Recommendations

On a pragmatic level, because consistent users and early, long term adopters of OER appear to play an important role in sustaining use and reuse, instilling incentives to attract and retain such users will become increasingly important as OER supporters move forward with new OER solutions and initiatives. In light of the findings presented in this paper, these incentives might include, for example, decreasing technical barriers to editing, visual augmentation, and modularisation activities. Importantly, however, they

could also include structures that support group collaboration – preferably those where boundaries can be crossed but also where group tasks are delegated and managed.

That said, it should be noted that at this early stage of OER, open content use and reuse can potentially be viewed both as a means to attract and create communities that mirror those in the offline world, but also as a means of inspiring new roles, new definitions of content creation, and new knowledge. Upon first glance, the divisions across educational disciplines and the hierarchical boundaries imply that growth in OER will come from niche communities within specific disciplines who are motivated to publish and distribute content online. However, careful consideration of how we can move beyond these single-discipline communities toward cross-disciplinary and globally-diverse author groups can potentially serve to move OER into the realm of continuous knowledge creation and innovative content.

Thus, on an empirical level, future research might consider the ways in which user groups can expand beyond the current group of vanguards and niche enthusiasts. Future research could also carefully explore the variety of structured and unstructured collaboration groups to better understand the full range of peer-to-peer collaboration. Taking this in conjunction with the interview data suggesting that group roles and formal structures facilitate the activities of author groups, we can conclude that further empirical studies into how to mitigate the potential proprietary and permission constraints that accompany group roles while at the same time stimulating division of labor is important. Furthermore, in moving beyond the scope of the study at hand, future research might also explore the types of role-based collaboration that occur within OER communities in order to understand whether and how, e.g., students and instructors interact around online content. As the use of online materials continues to evolve, further understanding of these key areas can help to incite authorship, use and reuse.

Finally, research will require widespread access to OER user data, so that more generalisable conclusions can be made. Specifically, understanding OER author use and reuse requires looking at detailed and comprehensive data for many more collections and repositories – and log files are one important and fruitful means of obtaining such data. Additionally, log files and in-depth interview data around author users' reasons for augmenting and changing content could serve to inform meaningful categories of author use and reuse. However, in attempting to provide data, repository owners and collections may consider finding ways to encourage users to document their activities and the reasons for them more concretely. Thus, beyond facilitating group authorship, cross-disciplinary collaboration, and enhanced support for new, non-vanguard users, this study calls for the creators of OER repositories and aggregators to collect such data, and in the name of openness and OER sustainability on a global level, to share them.

10 Conclusions

Through the coalescence of technology, organisational capital, goodwill, and individual drive, the burgeoning open educational content movement has the potential to bring about a paradigm shift by way of expanding access to and active participation in the development of educational resources for teachers and instructors across the globe and in hard-to-reach locations. However, realising this shift necessitates an understanding of how we can move beyond existing challenges – for while new developments in OER

have surfaced, more research and discussion must be enacted to address use and reuse sustainability.

Therefore, while this study shows that OER author use and reuse is present and growing, there is still a limited understanding of how to move beyond some of the encumbrances – specifically with regard to creating new content collaboratively and reusing other’s content, as well as to potentially converting users who do not create content into authors who do create content, which this study did not explore. Such an understanding is necessary in order to create the critical mass of content that is needed to support the vision of equitable education, and perhaps more importantly, to inspire a culture of continuous improvement in OER so that we can in turn truly move toward improved teaching and learning.

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Notes

- ¹Reuse is defined as the remixing or adaptation of OER for new and/or local purposes.
- ²This study is titled "An Instructor Perspective on Online Teaching and Learning in Developmental Education", and is pending review.
- ³In general, log files can be used to record and study user behaviours, including how users navigate through a site, what they click on, and what specific actions they take.
- ⁴This date range represents the month and year of CNX inception (April 2000) to the month and year that the data collection was completed (July 2005).
- ⁵Because the figures for 2005 only extend through July of that year (and because author growth spikes may coincide, e.g., with needs of instructors at the beginning of their school terms, i.e., in the fall of each year), the author growth rate calculations are based on the year period from April 2000 to Dec 2004. The formula used for calculating the compounded annual growth rate (CAGR) is as follows: $(\# \text{ author users at ending year} / \# \text{ author users at beginning year})^{(1/\# \text{ of years})} - 1$.
- ⁶Upon the creation of an original module, the CNX system assigns the module two numerical ids: a module identification number and a version identification number. As users create versions of the original module, additional version ids are assigned. Table 2 was created from the counts of total module and version ids within the CNX system. This explains why in 2000 there were 199 modules and also 199 versions – for author users during this first year did not create additional versions of their original modules.
- ⁷Content growth calculations were based upon the entire period of analysis, from April 2000 to July 2005, in order to incorporate the version and module totals.
- ⁸The maximum number of modules or versions published excludes 14 extreme cases, which were defined as cases where a single author user published more than 94 versions or modules.
- ⁹This was not a required field.
- ¹⁰Some versions had more than one reason attached, which is why the number of reasons (14,429) is greater than the total number of versions (12,993). Author users did not provide reasons for 295 of the new versions created.

¹¹The interviews with a selection of author users allowed for additional insight into the reasons behind general editing activities. Several of the instructors were said to use CNX as a distribution tool for their offline courses – i.e., as tool to help distribute information to their students, including course schedules, syllabi, and course content. As the courses progressed throughout the term, these instructors made changes to their materials held in the CNX repository.

¹²While authors create new derivative modules based on previously existing modules, they do not have to formally attribute the original content to the original author. This prevents a complete understanding of the extent to which modularisation occurred.