Engineering Materials and Personal Spaces in Public Repositories: The Case of the MERLOT Digital Library

Natalia Muñoz-Rujas
Universidad de Burgos

Jennifer Baptiste
University of Trinidad and Tobago

Ana Pavani
Pontifícia Universidade Católica do Rio de Janeiro

Aly El-Iraki
California National University

Eduardo A. Montero
Universidad de Burgos

The open educational resources are learning, teaching and research materials available in open sites for free access, and are frequently grouped into personal collections by users. MERLOT, the well-known online repository, includes amongst its materials Bookmark Collections (BC) created by its contributors. This article evaluates, from the point of view of users other than the creators, the usefulness of the MERLOT personal collections in engineering education. There are at least 895 Bookmark Collections in the Engineering collection of MERLOT. The main assessment criteria are the potential of shareability and reusability of the collection in terms of the engineering content and description, and the coherence of materials and collection with the respective engineering discipline and sub-discipline. Results show that the quality of these collections could be improved if the assignment of the collection would be declared, as the title and description, during the BC creation. The improvement of the BC title and most especially its description would be also a good improvement that will guide the searcher more precisely.

Keywords: Open Educational Resources, Engineering Education, MERLOT, e-portfolio

SUMMARY

The development of open educational resources is a very active trend of research and innovation in open education. The development and promotion of open educational resources is often motivated by a desire to provide an alternate or enhanced educational paradigm. However, its implementation in educational institutions faces barriers and is relatively slow. Well-structured and peer-reviewed online

repositories covering a broad range of topics, when made available, can overcome these barriers and will be highly appreciated.

The use of open educational resources in engineering education has been an interesting topic of research during the last decade. When allocated in online repositories, the use, share and reuse of these materials is highly improved. As many engineering courses worldwide often share well-known core contents, the potential for the integration of available open educational resources into personal collections is quite high. MERLOT is an online repository where available existing online learning resources in a range of academic disciplines, including engineering, can be found for use by higher education faculty and students. The analysis of the Bookmark Collections in the Engineering discipline of the MERLOT digital repository performed from the point of view of external users, reveals that faculty and students demonstrate interest in creating personal collections. Some difficulties for the external user arise when searching through personal collections labeled as engineering if the content does not correspond to engineering topics. Title and precise description of the respective Bookmark Collection is found to be a key factor for its shareability and reusability.

INTRODUCTION. PERSONAL SPACES IN DIGITAL REPOSITORIES

Nowadays education and training are overcoming the constraints of the traditional classroom environment, and the increased availability of online repositories and educational digital libraries have a major influence factors on these changes. As expected, teachers are the primary intended audience of educational digital libraries. Teachers use digital libraries and web resources in many ways, including looking for interactive materials, lesson planning, curricula development, and looking for examples, activities as well as videos and animations to complement textbook materials. The present global trends of sharing, using and reusing Open Educational Resources (OER) provides an enormous opportunity to improve the quality of education in many education levels (Hilton et al., 2010).

A well-known and accepted definition of OER was established by UNESCO (UNESCO, 2002), which declares that OER are " teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions.” There exist more OER definitions provided by other authors and institutions (Atkins, Brown & Hammond, 2007; Cape Town Declaration, 2007; OECD, 2007), but they all refer to educational resources that are freely available over the Internet for use by educators and learners without an accompanying need to pay royalties or license fees (Butcher & Hoosen, 2012).

The development of OER is an open field of research and innovation as open education is broadening its scope of application (D’Antoni, 2009; Chicaiza, et al., 2017). Sometimes, OER are seen as the potential solution to worldwide problems of education in the future, and as an alternative to the traditional educational paradigm. Nevertheless, their adoption in educational institutions into common teaching practices remains quite low (De Liddo, 2010; Murphy, 2013; Mishra, 2017). The OER development is the topic of study by researchers with the objective of highlighting the strengths and weaknesses of its use (Saeed, Yang & Sinnappan, 2009; Xu & Recker, 2012; Farrow et al., 2015; Weller et al., 2015; Miao, Mishra & McGreal, 2016; Tlili et al., 2020).

OER are often stored, used, mixed and shared within learning object repositories, which reside in an open and public space. Learning Object Repositories (LOR) are systems that enable the storage and retrieval of OER metadata. More specifically, a LOR is a system that manages access to reusable learning content and can present a great variety in size and scope, supported by individuals or institutions. The digital content may be stored at the author web server or accessed remotely via computer networks. Learning materials and repositories are growing very fast, hence the challenge is how to find the best quality resources that are most relevant for teachers and learners. Several authors (Atenas & Havemann, 2014; Romero-Pelaez et al., 2019) have developed quality criteria for the assessment of LOR. The literature review reported in Romero-Pelaez et al. (2019). reveals that the objective of the LOR is “to support educators in searching for content, sharing their own resources, reusing and evaluating materials, and adapting materials made by or in

collaboration with other members of the community." Two categories of oriented quality indicators, social and technical, should be considered when creating LOR. Concerning the social issues, it is of value to mention the highlighting of resources, the user evaluation tools, the peer review policy and the authorship recognition. In relation to the technical issues, some indicators are the retrieval keywords, the OER metadata, and the resource Creative Commons license.

Personal spaces in LOR allow users to build, store and present knowledge in a way suited to their unique individual patterns of use by using technological tools (tags, bookmark collections, etc.) to mark selected materials. Users interested users in developing self-made learning processes can use materials developed by others and include them in their personal spaces within the repository. At the same time, they may transfer learning materials from their personal spaces and into the public space and thus share them with others. A personal space can be used, for example, to save a set of selected learning materials concerning a topic in a course. In addition, if the LOR allows the definition of key elements of a course (e.g., prerequisites, approach and outcomes, assessment, etc.), then the collection becomes a course e-portfolio. The usefulness of personal collections and e-portfolios is evident for the respective author, but there is a concern when evaluating if the collection is useful also by other users. Shareability is also an objective of the repository's supporting institution.

MERLOT is one of the most reputed OER repositories and is a portal connected to multiple digital LOR (MERLOT, 2020). MERLOT stands for Multimedia Education Resource for Learning and Online Teaching, and is a LOR devoted to identifying, peer reviewing, organizing and making available existing online learning resources in a wide range of academic disciplines. MERLOT membership is for free. Only MERLOT members can add learning materials to the MERLOT collection. This means adding the metadata for a material to describe the item and provide a URL. The personal data (authorship, affiliation and professional profile) are always shown in the resource description when uploading any material. There exist an editorial board for the respective domain of knowledge. The materials are classified into nine main categories: Academic Support Services, Arts, Business, Education, Humanities, Mathematics and Statistics, Science and Technology, Social Sciences and Workforce Development.

The MERLOT repository provides access to learning materials, learning exercises, comments, personal spaces, (Bookmark Collections), and Content Builder Web pages, all designed to enhance the teaching experience of online learning material. The OER are classified into 18 different learning material types. A large selection of materials in MERLOT has also assignments and comments attached to them.

As mentioned above, MERLOT includes amongst its materials Bookmark Collections as well as Course e-Portfolios created by its users. Cohen, Reisman and Sperling (2015) studied the Bookmark Collection of MERLOT as a facilitator for adoption of OER into teaching practices and to gain more insight into different types of OER user behaviors by analyzing the users' behaviors. In addition, using the data mining methodology applied to the MERLOT server Weblogs, most active Bookmark Collection contributors were classified into clusters of users with the same patterns of activity. The work deals with any scientific field contained in MERLOT and the results are discussed from a general perspective. To the extent we know, this study of Cohen, Reisman and Sperling (2015) is the only review of the MERLOT repository found in the literature.

CASE STUDY AIM AND METHODOLOGY

MERLOT members create personal collections for several uses with diverse goals:

(i) for their own teaching use (e.g. my tools, my resources), while allowing others to view and copy;
(ii) for other users, such as the students in their courses and other students; for teachers of their discipline; for their professional community, etc.

The work of Cohen, Reisman and Sperling (2015) describes in a general form the most frequent uses of MERLOT BC. They stated that the most common usage of BC was the assemblage of resources and tools, which support the learning of a particular domain skills. The creator uses materials (OER) which are developed by others and includes them in his/her personal space within the repository. The materials remain

in the public domain, yet the construction of the new process takes place in a personal space. Another common use of BC is as a stage for the presentation of resources and outcomes for the community, for creating and displaying open textbooks, or for displaying online courses. Examples and contributor's comments are extensively cited.

This work is limited to the MERLOT Bookmark Collections in engineering education. The aim is to analyze the usefulness of the engineering Bookmark Collections (BC) for users other than the authors. The methodology applied is the extraction of open data directly from the MERLOT website. The contribution presents a review of the engineering materials from the point of view of external users. Three review criteria were used: (i) first, the evaluation of BC creators as active members of MERLOT; (ii) second, the correct assignment of the BC with the respective engineering discipline and sub-discipline; (iii) third, the potential reuse of the available BC because of its engineering content.

DESCRIPTION OF THE ENGINEERING MATERIALS IN THE MERLOT BOOKMARK COLLECTIONS AND E-PORTFOLIOS

Several authors have paid attention to the use of OER in engineering education (Tovar & Piedra, 2014; Muñoz-Rujas et al., 2021). The reusability of the OER, that is to say, the ability to reuse and simply create personalized courses by means of collections or e-portfolios, is one of the most important recommendations. BC may offer the stimulating possibility of personalizing public learning object repositories, with the emphasis on the individual. Even though they add a strong element of personalization to the system, they still retain the many institutional benefits of learning object repositories.

The benefit of the integration of available OER into personalized courses is quite high, because the production of OER can be time and resources consuming. It is a matter of fact that well-known core contents are shared by many engineering courses worldwide, though the learning contexts and learning styles are more specific. The reusability of OER is highly improved if the LOR allows the creation of material collections and e-portfolios through the corresponding facility. To boost this reusability even more, the collections and e-portfolios created by any user should also be reusable by any other user. The owner of the BC can describe its aims and contents to more easily explain its purpose. Then, the BC are discoverable and shareable by other MERLOT users. As an indicator of the popularity or value of any material, MERLOT records the frequency with which a certain material item is stored in a BC. For this reason, MERLOT displays the number of Bookmark Collections in which each material item has been placed. A Course e-Portfolio (eP), an extension of a Bookmark Collection, provides MERLOT members with the opportunity to also define strategic elements of a course. Through the definition of prerequisites to online resources and assessment, the MERLOT eP allows the user to build an entire course, and then share the eP with colleagues and students, or download it into a Word document and create a course syllabus. The eP and BC are expandable – if new materials are submitted to MERLOT, the authors of the eP and BC can add them to their collections.

By December 2020, the engineering community of MERLOT (Figure 1) is formed by approximately 4,900 members and presents more than 7,800 learning materials distributed into nineteen disciplines of engineering selected by MERLOT, ranging from aerospace engineering to petroleum engineering. Concerning the activity of engineering members, 22.1% of them have used the MERLOT website at least once in the last 5 years, while 5.4 % of them have created at least one BC and 0.5% created eP. Selecting the appropriate items from the list of engineering materials, MERLOT users have created at least 895 BC and 83 eP by August of 2020, as shown in Table 1.

FIGURE 1
MERLOT. THE ENGINEERING COMMUNITY PORTAL

With respect to the BC, the most numerous are mechanical (193) and electrical engineering (152), followed by computer engineering (90) and civil engineering (75). On the other hand, disciplines such as biomedical, geological, mining, ocean and nuclear engineering are well under 10 items each.

It seems that there exists a great opportunity for users, other than BC creators, to search inside these collections and decide if they can profit from their colleague's selection and to reuse in their own courses. The main question to answer is to what extent these collections are really useful and shareable with anyone.

TABLE 1
ENGINEERING BOOKMARK COLLECTIONS AND COURSE E-PORTFOLIOS AT THE MERLOT REPOSITORY

Engineering discipline	Bookmark Collections	ePortolios
Aerospace and Aeronautical Engineering	55	12
Agricultural and Biological Engineering	11	1
Biomedical Engineering	7	1
Chemical Engineering	64	1
Civil Engineering	75	6
Computer Engineering	90	2
Electrical Engineering	152	19
Engineering Science	23	1
Environmental Engineering	53	17
Geological Engineering	5	0
Industrial and Systems	61	5
Manufacturing Engineering	35	2
Materials Science and Engineering	41	4
Mechanical Engineering	193	8
Mining Engineering	1	0
Nuclear Engineering	21	0
Ocean Engineering	2	4
Petroleum Engineering	6	0
Total	895	83

THE ENGINEERING BOOKMARK COLLECTIONS: ANALYSIS AND RESULTS

In this section we will analyze only the records of those disciplines with more than 40 BC, in order to describe enough material in the discipline for the aim of this work. As declared, the main objective of this work is to assess to which extent the BC created by an author are reusable and shareable by a different user. We would present first a separate analysis of authorship features for faculty and students, as we can expect that faculty and students could have diverse interests when searching for OER materials.

As MERLOT could allocate the BC in several disciplines, independent of the declared discipline of the individual materials enclosed in them, the first issue to analyze is whether the reported BC in an engineering discipline are really coherent with their category. As any registered member in MERLOT has to declare his or her primary discipline, it can be expected that the majority of the BC created by an author would correspond with this primary discipline. If this hypothesis was right, then an external user looking for BC could also find those materials not only by browsing materials, but also by searching through the membership of MERLOT (for example, applying filters by discipline, or affiliation, faculty, student…), thus widening the options to find an interesting material. The percentage of engineering BC created by engineering members of MERLOT for each discipline will be reported, as well as the coherent correspondence between the BC assignment with the disciplines of the materials enclosed.

Concerning the reusability of BC, when the external user opens a certain BC, the observation of the OER enclosed is the most suitable way to decide if it is useful or not for his or her learning or teaching aim. In this analysis we will report the total number of OER included and the percentage of engineering content. And finally, the last step is to evaluate the correspondence of the title and description of the content of the BC. This will reduce the time spent by the external user when looking for the BC of his or her interest.

Authorship Distribution of Engineering Bookmark Collections

The authorship of the selected 784 BC by member type is presented in Table 2. Of the considered BC, 53% were created by faculty, showing a centered distribution over the various engineering disciplines, as

dispersion over 10% or more from the average is limited to 63% in chemical engineering and 37% in materials science and engineering. Students created 19% of the BC, which can be considered a good contribution. As remarkable cases we can mention that the students' contribution to electrical engineering BC is well under the average (7%), while materials science (32%) and civil engineering (28%) are at a high level. In relation to the rest of categories, other authors contributed 28% of BC, being the teachers' K-12 contribution quite small (5%, which means that the MERLOT repository is more addressed to high schools and universities) and 23% to a miscellaneous set of MERLOT members (administrators, librarian, staff, consultants…)

TABLE 2
AUTHORSHIP OF ENGINEERING BOOKMARK COLLECTIONS BY MEMBER TYPE

Bookmark Collection	Total items	Student		Faculty		Other	
		items	%	items	%	items	%
Aerospace and Aeronautical Engineering	55	14	25%	31	56%	10	18%
Chemical Engineering	64	8	13%	40	63%	16	25%
Civil Engineering	75	21	28%	37	49%	17	23%
Computer Engineering	90	12	13%	51	57%	27	30%
Electrical Engineering	152	11	7%	78	51%	63	41%
Environmental Engineering	53	9	17%	30	57%	14	26%
Industrial and Systems	61	9	15%	33	54%	19	31%
Materials Science and Engineering	41	13	32%	15	37%	13	32%
Mechanical Engineering	193	39	20%	100	52%	54	28%
Engineering BC, Total	784	*Avg*	19%	*Avg*	53%	*Avg*	28%
*General BC, Total**	9802	*2835*	29%	*4482*	46%	*2485*	25%
MERLOT Engineering members	4836	2051	42%	1714	35%	1071	22%

*Data from Cohen, Reisman and Sperling (2015).

The study of Cohen, Reisman and Sperling (2015), concerning the authorship categories of disciplines of MERLOT, reported 46% of BC faculty authorship, a lower percentage than in the engineering case, 53%. On the other hand, for students, the general BC authorship was 29%, greater than the corresponding 19% of this work. Data show that authorship of engineering BC is skewed towards faculty with respect to the general case.

Comparison of engineering BC authorship distribution with the total engineering member type distribution (last row of Table 2) reveals that, as expected, faculty (35% of members) are the major contributors (53% of engineering BC, 46% of general BC), while students (42% of members) are more searchers of single materials than creators (19% of engineering BC, 29% of general BC).

Though, in its present form, all the BC could be still useful both for the author and other users, it is of value to examine the continuity of the students and faculty as active members of MERLOT and their BC contributions. The work of Cohen, Reisman and Sperling (2015) reported some additional data of the BC creators as active members of MERLOT. In this study, by using the data mining methodology applied to the MERLOT server Weblogs, they found that 13% of those who created collections were active members that have also contributed materials and peer reviews to the repository, written comments and submitted learning exercises.

In our case, extracting open data directly from MERLOT website, we have performed an evaluation of the BC creators as active members by using several dates: member last login, membership date and BC creation date. The hypothesis is that, once the BC is created, its updating and curating will be an indicator of its long-term usefulness for the author. If an author does not update the BC, it would mean that it was created for a short-term purpose or merely like a test of the MERLOT facilities. We found that 64% of students and 38% of faculty created the BC and never logged back into MERLOT (i.e., the difference

between the last login date of the author in MERLOT and the date of the BC creation is 0 days). When, instead of 0 days, the period evaluated for the same indicator is 1 month (column B), the averages reach 72% and 49%, respectively. This means that a significant percentage of students created the BC as a trial and not for as a true learning tool. Even for faculty, the figures are quite high.

Moreover, 55% of students and 34% of faculty created the BC the same day they became members of MERLOT. And, as a summary, 38% of students created the BC and did not log in MERLOT for more than 3 years, and for faculty the same indicator reaches 24%. The whole set of data described points out that some authors created BC but never used it again.

Coherence of the Engineering Content of the Bookmark Collections

The whole selected BC in this work are allocated in the website, www.merlot.org>materials>bookmarkcollections>science&tecnology>engineering. However, it can be observed that some of the BC content does not correspond to the engineering disciplines. Table 3 presents the correspondence between the expected engineering discipline of the BC and the declared disciplines of the materials included. As MERLOT does not assign discipline to the BC during its creation procedure, the authors of this work have assigned to every BC the most representative discipline, taking into consideration the most frequent discipline of the materials included in the BC.

Of course, it is possible that an author whose primary discipline is engineering can create a BC in another discipline, but it would be expected that this case is the exception, not the rule. However, Table 3 shows that, on average, only 28% of the engineering BC found through the search corresponds with authors with an engineering profile, which is a quite low result. The distribution ranges from a minimum contribution of 11% in Industrial and Systems Engineering to a maximum of 41% in Materials Science and Engineering

TABLE 3
COHERENT ENGINEERING DISCIPLINE ALLOCATION OF THE BOOKMARK COLLECTIONS

Bookmark Collection	Total items	Author discipline				Topic discipline			
		Engineering	%	Other	%	Engineering	%	Other	%
Aerospace and Aeronautical Engineering	55	20	36%	35	64%	17	31%	38	69%
Chemical Engineering	64	14	22%	50	78%	29	45%	35	55%
Civil Engineering	75	24	32%	51	68%	42	56%	33	44%
Computer Engineering	90	22	24%	68	76%	26	29%	64	71%
Electrical Engineering	152	44	29%	108	71%	103	68%	49	32%
Environmental Engineering	53	11	21%	42	79%	10	19%	43	81%
Industrial and Systems	61	7	11%	54	89%	37	61%	24	39%
Materials Science and Engineering	41	17	41%	24	59%	21	51%	20	49%
Mechanical Engineering	193	73	38%	120	62%	162	84%	31	16%
Total	784	*Avg*	28%	*Avg*	72%	*Avg*	49%	*Avg*	51%

When looking at the topic discipline, only 49% of the BC analyzed corresponds to engineering disciplines, ranging from the minimum of 32% in electrical engineering to the maximum of 81% in environmental engineering. But it remains 51% of the BC whose materials do not belong to the engineering disciplines.

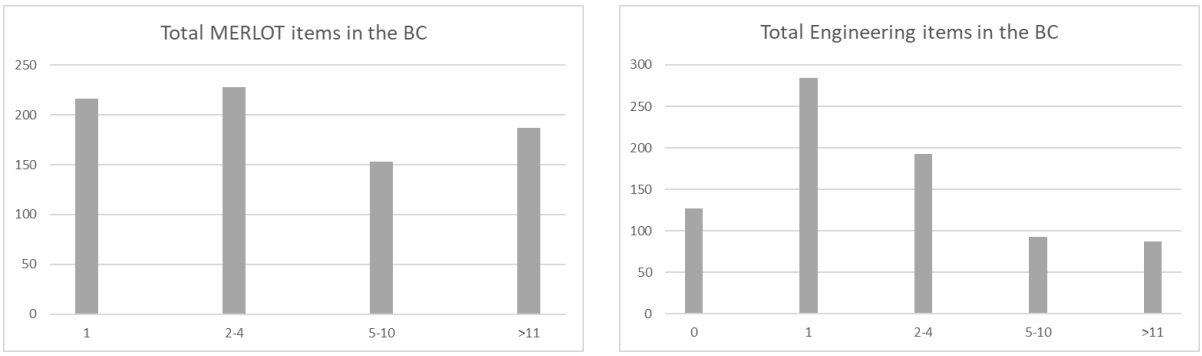
Certainly, some engineering disciplines could have diffuse boundaries when assigning discipline. For instance, many of the materials in computer engineering could be also assigned to the categories of

computer science or information technology, which are in MERLOT categories of science and technology other than engineering. But many other BC belonging to humanities, education, business or arts have been found in the list. In our opinion, the cause could be the algorithm MERLOT uses to allocate any BC once created. The assignment criterion to a fixed discipline has not been found on the website. As a result, the user finds difficulty when searching BC and it becomes a drawback of the MERLOT repository that should be improved.

Material Retrieval/Reuse Through the Engineering Bookmark Collections

As stated, the MERLOT repository provides access to thousands of engineering educational materials in varied disciplines and types. Some of them were reused and integrated in the 895 BC. Due to the fact that any material can be integrated in more than one collection, it is interesting to analyze the material's content of the BC. The collections differ in the number of items in them. It can be found that there is a significant number of collections which do include scarce links to materials while others do include links to a large number different materials. Concerning the 784 BC included in the selected nine engineering disciplines, Figure 2(a) describes the total MERLOT materials integrated in the BC. It shows that 216 of 784 BC (27.5%) contain only 1 material. It means that the BC has no added value with respect to the single material, and it could lead to a loss of time in search. It can be also observed that 381 of the BC (48.6%) include materials within the interval 2-10 (the summation of 2-4 and 5-10 intervals) and 187 (23.9%) shows more than 11 materials.

FIGURE 2
MERLOT AND ENGINEERING MATERIALS INCLUDED IN THE BOOKMARK COLLECTIONS



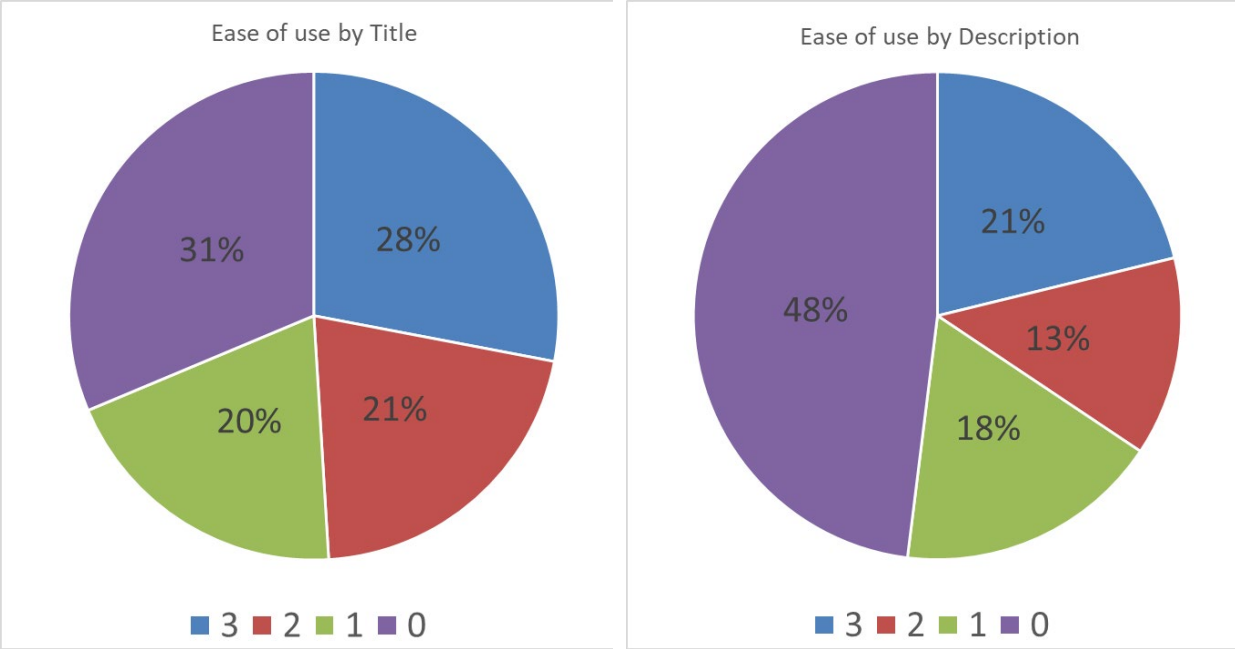
(a) (b)

Concerning the analysis of the engineering material's content, it is also remarkable that 127 of 784 (16.2%) of the BC have 0 item, and 284 (36.2%) have only 1 item (Figure 2(b)). It means that 52.4% of the BC allocated as engineering BC do not contain a significant number of engineering materials. From the point of view of an external user, it could be a little bit disappointing. 36.5% (286 items) include engineering materials within the interval 2-10, and 11.1% (87 items) exhibits more than 11 engineering materials.

Once the user finds the full list of BC in the engineering discipline of interest, the decision of selection will be made easier by the title and description of the BC. MERLOT allows the BC author to freely write a title and description of the BC. Then, it relies on the author to properly describe the BC. Some authors decided to use personal keywords or codes as if they were to be the only users of the BC, making this information useless for a different user. On the other hand, some authors write a more precise title and clear description of the BC, making the decision of selection easier for other users, which is the aim of MERLOT. Figure 3 shows the clarity and precision of the description of the BC using a rating scale ranging from 0 to 3 (3-Excellent; 2-Good; 1-Needs improvement; 0-Unacceptable).

The title could be considered useful in finding a given topic (2-3 in the scale), 49% of the cases on average. In relation to the short description of the features of the BC, this usefulness decreases to 34%. The majority of the BC authors give a very poor description or no description at all. There are two disciplines where this unacceptable characteristic is significant, computer engineering (61%) and materials science engineering (71%).

FIGURE 3
EASE OF SEARCH OF ENGINEERING BOOKMARK COLLECTIONS BY TITLE AND DESCRIPTION. RATING SCALE: 3-EXCELLENT; 2-GOOD; 1-NEEDS IMPROVEMENT; 0-UNACCEPTABLE



CONCLUSION

The Bookmark Collections in the Engineering discipline of the MERLOT digital repository have been reviewed in this contribution. The analysis has been performed from the point of view of external users by extracting open data directly from the MERLOT website. There, 895 Bookmark Collections were reported by July 2020, but the study was limited to those disciplines with more than 40 Bookmark Collections. Faculty members are the majority of BC contributors (53%), as expected, but also students contribute to a significant amount of them, close to 20%.

A significant fraction of the BC identified on the MERLOT website as engineering discipline do not corresponds exactly to engineering topics. Searching in the BC to check the topic discipline demonstrates that only 49% of the BC analyzed corresponds actually to engineering disciplines, probably due to the MERLOT algorithm which decides the assignment. As a result, the external user finds a mix of engineering and non-engineering BC, which could cause difficulties when selecting the appropriate BC. This issue could be improved if, for instance, the creator should declare the discipline category (as well as the title and description) when creating the BC. It will boost the ease of access of the MERLOT digital library.

The title and description given by the contributors to the BC is another issue related to the ease of search. The study shows that 51% of titles and 67% of BC descriptions are of little or no use for users other than the contributors. This result highlights a conflict of interest between the MERLOT aim (to improve the shareability of the repository) and the contributor aim (his or her own courses).

In relation to usefulness of the BC, 36.5% of the BC contain between 2 and 10 engineering materials, and 11.1% include 11 or more items, which is a good feature. On the other hand, 16.2% of the BC have 0 item, and 36.2% have only 1 item, which make them useless.

ACKNOWLEDGEMENTS

The authors acknowledge MERLOT organization for the support of this work.

REFERENCES

Atenas, J., & Havemann, L. (2014). Questions of quality in repositories of open educational resources: A literature review. *Research in Learning Technology*, *22*, 20889.

Atkins, D.E., Brown, J.S., & Hammond, A.L. (2007). *A review of the Open Educational Resources (OER) movement: Achievements, challenges, and new opportunities*. The William and Flora Hewlett Foundation. Retrieved December 16, 2020, from http://www.hewlett.org/uploads/files/ReviewoftheOERMovement.pdf

Butcher, N., & Hoosen, S. (2012). *Exploring the business case for open educational resources.* Commonwealth of Learning, British Columbia: Vancouver. Retrieved December 16, 2020, from http://oasis.col.org/bitstream/handle/11599/57/pub_OER_BusinessCase.pdf?sequence=1&isAllowed=y

Cape Town Open Education Declaration. (2007). *Cape Town Open Education Declaration: Unlocking the promise of open educational resources*. Retrieved December 16, 2020 from https://www.capetowndeclaration.org/

Centre for Educational Research and Innovation, Organization for Economic Co-operation and Development (OECD). (2007*). Giving Knowledge for Free: The Emergence of Open Educational Resources*. Paris, France.

Chicaiza, J., Piedra, N., Lopez-Vargas, J., & Tovar-Caro, E. (2017). Recommendation of Open Educational Resources. An approach based on linked Open Data. In *Proceedings of the 2017 IEEE Global Engineering Education Conference EDUCON* (pp. 1316-1321).

Cohen, A., Reisman, S., & Sperling, B.B. (2015). Personal Spaces in Public Repositories as a Facilitator for Open Educational Resource Usage. *International Review of Research in Open Distributed Learning*, *16*(4), 156-176.

D'Antoni, S. (2009). Open Educational Resources: Reviewing initiatives and issues. *Open Learning: The Journal of Open, Distance and eLearning*, *21*(1), 3-10.

De Liddo, A. (2010). *From open content to open thinking*. World Conference on Educational Multimedia, Hypermedia and Telecommunications (Ed-Media 2010), Canada.

Farrow, R., Pitt, R., de los Arcos, B., Perryman, L.A., Weller, M., & McAndrew, P. (2015). Impact of OER use on teaching and learning: Data from OER Research Hub (2013-2014). *British Journal of Educational Technology*, *46*(5), 972-976.

Hilton J.L., Wiley, D., Stein, J., & Johnson, A. (2010). The four 'R's of openness and ALMS analysis: Frameworks for open educational resources. *Open Learning: The Journal of Open, Distance and e-Learning*, *25*(1), 37-44.

MERLOT. (2020). *Multimedia Education Resource for Learning and Online Teaching*. Retrieved December 16, 2020, from www.merlot.org.

Miao, F. Mishra, S., & McGreal, R. (2016). *Open Educational Resources: Policy, Costs and Transformation*. UNESCO & Commonwealth of Learning (COL). Retrieved December 16, 2020, from https://unesdoc.unesco.org/ark:/48223/pf0000244365

Mishra, S. (2017). Open educational resources: Removing barriers from within. *Distance Education*, *38*(3), 369-380.

Muñoz-Rujas, N., Baptiste, J., Pavani, A., & Montero, E. (2021). Enhancing interactive teaching of engineering topics using digital materials of the MERLOT database. In A. Herrero, C. Cambra,

D. Urda, J. Sedano, H. Quintián, & E. Corchado (Eds.), *The 11th International Conference on EUropean Transnational Educational (ICEUTE 2020)* (AISC Series 1266, pp. 295–306). Cham/Switzerland, Springer.

Murphy, A. (2013). Open educational practices in higher education: Institutional adoption and challenges. *Distance Education*, *34*(2), 201-217.

Romero-Pelaez, A., Segarra-Faggioni, V., Piedra, N., & Tovar, E. (2019). A proposal of quality assessment of OER base on emergent technology. In *Proceedings of the 2019 IEEE Global Engineering Education Conference EDUCON* (pp. 1114-1119).

Saeed, N., Yang, Y., & Sinnappan, S. (2009). Emerging Web Technologies in Higher Education: A Case of Incorporating Blogs, Podcasts and Social Bookmarks in a Web Programming Course based on Students' Learning Styles and Technology Preferences. *Educational Technology & Society*, *12*(4), 98–109.

Tlili, A., Jemni, M., Khribi, M.K., Huang, R., Chang, T.W., & Liu, D. (2020). Current state of open educational resources in the Arab region: an investigation in 22 countries. *Smart Learning Environments*, *7*, 11.

Tovar, E., & Piedra, N. (2014). Guest Editorial: Open Educational Resources in Engineering Education: Various Perspectives Opening the Education of Engineers. *IEEE Transactions on Education*, *57*(4), 213-219.

UNESCO. (2002). *Forum on the impact of Open Courseware for higher education in developing countries. Final report*. Paris. Retrieved December 16, 2020, from https://unesdoc.unesco.org/ark:/48223/pf0000128515

Xu, B., & Recker, M. (2012). Teaching Analytics: A Clustering and Triangulation Study of Digital Library User Data. *Educational Technology & Society*, *15*(3), 103–115.