

Makerspaces in school libraries: a bibliometric analysis

Deise L. Jesus¹ and Ana Novo²

¹Instituto Federal de Brasília, Brasil

²Universidade Aberta, Portugal/CIDEHUS-UE*

Abstract: This paper is focused on the use of makerspaces in school libraries. The main objective was to identify, through a bibliometric analysis, the approach given in the scientific literature to the makerspace in school libraries. Using “Publish or Perish” software, 979 articles in English language and 108 articles in Portuguese and Spanish language were retrieved. The results obtained show that the Bradford’s Law is confirmed over this subject, the results are consistent with Lotka's Law but they couldn’t be confirmed with exactness. The theme presented an H index of 31; G index of 58. In the altmetric analysis the social media most used was Twitter followed by Facebook. The country with most mentions was the USA followed by the UK and Australia. In Portuguese and Spanish the results are much lower than in English, both in bibliometric and altmetric analysis.

Keywords: Makerspace, School library, Bibliometrics, Altmetrics.

1. Introduction

School libraries, while fulfilling their mission to promote reading, have gained a prominent role and are responsible for several actions within the school in order to improve the quality of teaching. Several studies show that some of the benefits of the presence of makerspaces in libraries are: engagement of the participating community, access to new technologies, opportunities for new learning for users and a visibility of a good future for the organization (Slatter & Howard, 2013:276).

In the school environment, in addition to the benefits cited other can stand out, such as: development of psychopedagogy and creativity of children, improvement of the interaction between students, between teachers and within the library, between the school and the library community and thus providing a more participatory and collaborative school. Another point that deserves attention is the inspiration, the chance of new discoveries that cause excitement giving more motivation to students to do more research and expand their knowledge. In this sense, through a bibliometric analysis, this paper presents a panorama of the makerspaces in an attempt to demonstrate their potential impact in school libraries.

Quantitative methods of evaluating scientific articles have gained space in the academic environment since the proposition of bibliometrics by Pritchard in 1969. The author proposed the application of mathematical and statistical methods for the analysis of books and other means of communication. The

* This work is funded by national funds through the Foundation for Science and Technology and by the European Regional Development Fund (ERDF) through the Competitiveness and Internationalization Operational Program (POCI) and PT2020, under the project UID/HIS/ 00057/2019

premise of this proposition is that the generation of knowledge about a given subject is corroborated in the same proportion that scientific material about it is produced (Chueke & Amatucci, 2015).

2. Literature Review

The definition of makerspace includes not only an idea, but a new philosophy, which seeks to introduce in libraries a notion of an innovative creative space, aggregator of people and content and that interacts with the community that is served by it.

The first author who attempted to define the concept of makerspace was Britton (2012:1, our translation): "A place where people gather to create and collaborate, to share resources, knowledge and tools". This author explains that much of the conception of makerspace derives from the Do-It-Yourself (DIY) culture. This idea is also corroborated by Willingham & De Boer (2015) who understand that makerspaces are more similar to the DIY movement than with the hackerspaces. For these authors, this type of laboratory, understood as a creative space, is a kind of an oriented-DIY.

Kroski (2014:1, our translation) argues that makerspaces are spaces directly linked to the DIY movement:

"Makerspaces are creative DIY spaces where people gather to create, invent and learn. They usually have 3D printers, electronic equipment, some machinery for metal, wood and traditional equipment for arts and crafts. They are also used by schools and libraries to provide valuable skills in mathematics and engineering for children and users of all ages."

Moorefield-Lang (2015:107), tries to add the idea of a creation place with the educational possibilities, "Makerspaces are new and exciting services offered in school, public and university libraries. These services create an atmosphere of engagement for learning and experimentation but also present their challenges and successes." Kroski (2014) uses the educational potential of makerspaces for its definition. It is important to take into account that, in the case of creative spaces, the library has played an important role, incorporating within its structure a place of creation that can serve its students, in the case of school or university libraries or the community, in the case of public libraries. Although each of these libraries has its own specific users, there are convergence points when you have the makerspace as a space that gathers these users together for the creation of shared knowledge.

2.1 Makerspaces in school libraries

In schools, makerspaces have the potential to be great auxiliaries in the educational process and pedagogical development of students. Stimulating creativity is always a tool of great value for education. Libraries that seek innovation and invest in this type of collaborative spaces can function as laboratories and have the possibility of providing teachers with assistance and support in teaching activities.

The lack of information literacy and tools that provide access to knowledge through new technologies are some of the reasons pointed out by Kuhlthau (2003) for this lapse in 21st century's education. Bringing the author's approach to a more current perspective, and among the tools that could help students to

develop information competencies, crucial for lifelong learning and the resolution of everyday problems, there is the makerspace. The author cites, among others, collaboration as one of the processes of development of information competencies. The type of experiences provided by an innovative space, which provides technological tools, stimulating creativity, can be a major driver for the development of these competencies so required for students. This can be a way to solve the problem, pointed out by Kuhlthau still in 2003, related to the lack of resources and competences among students from the first school levels to those of university level.

Hamilton (2012) also defends makerspaces as spaces that develop informational competencies. The author identifies some aspects, observed during her research, which point to the potentiality of makerspaces as tools for developing literacy skills:

- Increased motivation and new forms of involvement through meaningful play games and experimentation;
- Learning that students consider relevant according to their personalities and interests;
- Opportunities to create using a variety of media, tools and practices;
- Co-configured experience where educators and students pool their skills and knowledge together and participate in teaching and learning tasks;
- An integrated learning system where connections between home, school, community and world are made possible and encouraged.

Hamilton (2012) believes that makerspaces can provide students and teachers with opportunities to engage in participatory learning: collaborating, adjusting, learning, playing, chatting, experimenting, asking, solving problems together.

In this context, Johnson (2018) points out the skills required for a student in the 21st century, among which are the skills to learn and be creative, which may also be associated with communication skills, technology and media, which are media literacy characteristics, that can be acquired or developed in media centers.

The ideas of Johnson (2018), Hamilton (2012) and Kuhlthau (2003) put makerspaces within the school environment, very close to teaching activities, proposing specific roles, including teachers who, according to the author, should encourage students for experimentation in these spaces.

Regarding makerspaces, specifically in school libraries, Burke (2018:29) addresses the space as being generally geared towards manual interaction, not so focused on technology as makerspaces in public or university libraries. The activities are focused on the STEM, an acronym in English for the areas that should be encouraged by the library in the school: Science, Technology, Engineering and Mathematics. In this sense, daily and curricular demands of schools are equally focused on these disciplines, in addition to others as literature and arts. Thus, the time available for students to have extra class activities is reduced and this factor should be taken into consideration by teacher librarians when promoting activities that are consistent with the school curriculum. In appropriate moments, it may be necessary to perform group activities outside the school period.

From what could be observed, makerspaces are still incipient spaces within the school libraries but of recognized potential. What does not still exist is an exact formula of what to do, what materials to adopt, what space to use. These questions should be analysed on a case-by-case basis by teacher librarians. Nevertheless, the results of the implementation of makerspaces in school libraries appears to be quite positive.

Since 2012, the School Library 2.0 has taken on new dimensions, adding the concept of makerspace to its territory. The most current articles on the SL 2.0 consider the makerspace as the new technological movement of school libraries. This concept is what motivated the theme of this work and will be approached in the bibliometric analysis.

3. Methodology

In this work we chose to use bibliometrics as a method of investigation of the theme makerspaces in school libraries. Bibliometrics is a quantitative method that analyzes publications and authors of the area or theme in question evaluating various aspects, such as publication index, frequency of publication, most used terms, among others.

Bibliometrics can be used to understand the path that a given area is taking within the academic and scientific context. Thus, the methodology of this research sought, by means of quantitative methods, to analyze the movement around the adoption of makerspaces in school libraries. Both the analysis of the texts published in the area and the main authors cited seeks to give an objective form to the context and analyze, from the results, the main points observed.

Besides the bibliometric analysis performed, a complementary altmetric analysis was done using the platform *altmetric.com* with the 50 most cited articles about makerspaces in school libraries.

3.1 Research parameters

The following criteria were established in order to choose the articles that would be analyzed:

- Needed to have in the title the expression: “makerspace + school librar*” (library or libraries);
- Needed to have in the title the expression: “makerspace + biblioteca escolar”;
- Needed to have anywhere in the text: “makerspace + school librar*” (library or libraries);
- Needed to have anywhere in the text: “makerspace + biblioteca escolar”;
- Needed to be within the 2011 to 2018 time span;
- Needed to be published in English, Spanish or Portuguese languages.

3.2 Research universe

The software chosen to analyze the data has a limitation of 999 articles for research, therefore the universe for this research is contemplated by the 999 results in English terms, and the 109 results in Spanish and Portuguese terms combined, totalizing 1108 documents.

3.3 Software

The data was analyzed using the free software Publish or Perish (PoP) from Harzing company. The most current version of the software until the date

when the research was done was version 6.34.6288.6798 released on August 11, 2018.

4. Data analysis

According with the results of the research and parameters used to choose the articles, data was analyzed with bibliometric principles, using Bradford's Law to analyze the main journals, the Lotka's Law to analyze the main authors and the Zipf's Law to analyze the main articles. Besides the most common laws other parameters were also used such as H-index and G-index.

4.1 Main journals

The magazines "Teacher Librarian" and "Knowledge Quest" stood out for having published on the theme makerspace and school libraries, between 2011 and 2018, 99 and 48 articles, respectively.

As for Bradford's law, the result obtained shows coherence with that proposed by the law, since 25% of the journals published 48% of the articles on the subject, while the other 75% published 52% of the articles on the subject, that is, practically half of the scientific literature production on the subject is produced by less than one third of the journals of the sample, which confirms, to a certain extent, Bradford's theory.

In the Portuguese and Spanish languages, scientific production is much less expressive, having been returned in the same period from 2011 to 2018, only 108 articles with 106 different journals publishing these articles. In this case, it is not possible to confirm Bradford's law, because the number of journals and articles on the theme of makerspace in school libraries is very dispersed, and only three journals have two or more publications on the subject.

In the main journals, the quantity of articles and the amount of citations are: Teacher Librarian (99 articles) (254 citations), Knowledge Quest (48) (137), Public Library Quarterly (11) (57), Texas Library Journal (11) (14), Library Hi Tech (10) (191), American Libraries (10) (13), Young and Adult Library Services (9) (25), Society for Information Technology & Teacher Education (9) (1), Makeology (8) (17), Reference & User Services Quarterly (8) (10), Children & Libraries (7) (13), others with fewer than 7 articles published (769) (3834).

4.2 Main authors

In relation to the authors published in English, 29 authors were detected with three or more publications on the subject, with emphasis on two in particular: David Loertscher and Kristin Fontichiaro, the first with 36 articles and the second with 11 articles published. Other authors also demonstrated a certain activity in the area with three or more published articles.

The authors with the greatest impact, that is, with more citations, are Halverson and Sheridan with 604 citations and Johnson, Becker, Estrada and Freeman with 433 citations, followed by Dougherty with 386. These figures show that there is not necessarily a direct relationship between the number of articles published by the author and its level of impact in the scientific community.

With regard to the Lotka's law, on the productivity of the authors and in the case of the theme 'makerspace in school libraries', the results demonstrate some coherence but cannot be confirmed accurately. In numerical terms Lotka

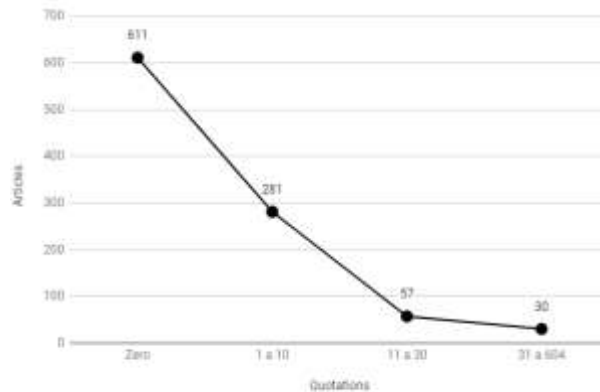
states that the number of authors who make two contributions is the fourth part of those who make a contribution. In the case of the sample of this study, 767 authors with a contribution and 42 authors with two contributions, representing an 18-fold greater number of authors with only one contribution. Shortly thereafter, 14 authors appear with three contributions and then 12 authors with four or more contributions.

The data obtained confirm, in part, the Lotka's law in the sense that there is a small number of authors who contribute with expressiveness to a given area. Lotka's assumption also states that the number of authors who make only one contribution is approximately 60%. In the case of the sample studied in this study, the number of authors with only one contribution corresponds to 76%.

In Portuguese and Spanish languages it was possible to confirm the trend presented in the analysis of the journals in item 4.1, that is, little expressiveness of the theme in these languages: 104 authors were found for the 109 articles retrieved by the PoP software. From this result, one author has 3 contributions and 3 authors have two contributions. The other 100 authors have only 1 contribution.

4.3 Main articles

The analysis of the main articles contributes to the understanding of the theme as a whole. By detecting the most cited articles, it is possible to understand what aspects the researchers and those interested in the area are most interested in reading and reproducing that content through citations in their publications.

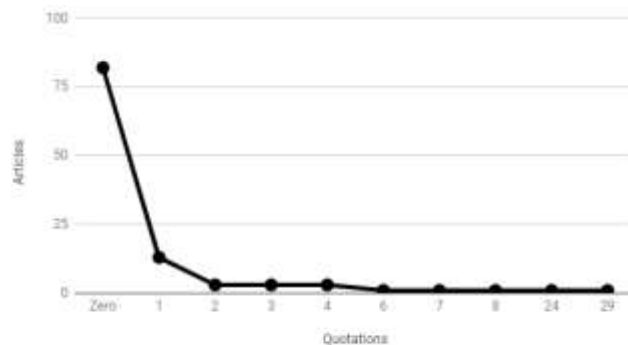


Graph 1 - Articles x Quotations (English)
Source: Research data, 2018

We detected 979 articles, as shown in Graph 1. There is a sharp drop in the number of articles that have 10 quotes or more. From the sample of 979 articles, 630 contained no citations, and 99 had one citation. At the other extreme, articles with 31 or more citations are much less frequent, representing only 3% of the articles.

There was a certain preference among the readers of the theme for documents that have a broader approach, contemplating panoramic analyzes on the theme of the makerspace, with both practical and theoretical views. The theoretical view stands out among the most cited articles and, precisely because they are

theoretical works, it is possible that they have a high number of citations as they serve as a basis for the other authors in their works. Practical views of the use of creative spaces are more frequent in results from articles with 30 citations or less.



Graph 2 - Articles x Quotations (Portuguese and Spanish)
Source: Research data, 2018

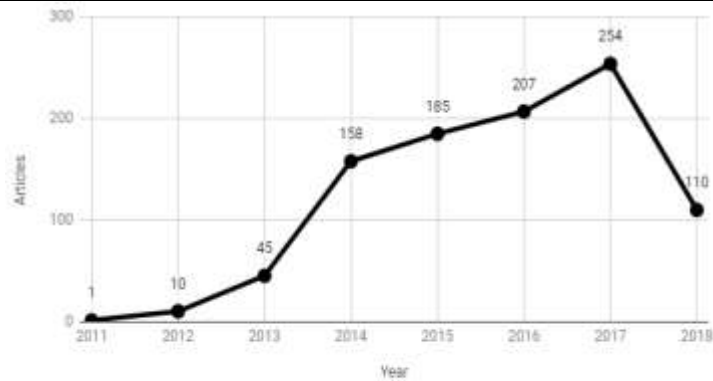
In Portuguese and Spanish, the results show a similar curve to the results found in English, but with a more pronounced curve in the decrease of the proportion between articles and citations, possibly due to the lower number of documents found, 109 in total.

Following the tendency of the results in English, of the 108 documents, 82 have no citations; as the number of citations increases the number of articles decreases; from six quotes only one article is returned, creating a stable line, as Graph 2 shows.

We noticed that in Portuguese and Spanish languages there is a greater dispersion in relation to the focus of articles than we observed in English language. This fact indicates, to some extent, that the topic is still incipient in the Portuguese and Spanish speaking countries or among readers who read in those languages. It is assumed that there is a delay in the literature and in the development of these spaces between the Portuguese and Spanish speaking communities.

4.4 Temporal analysis

The temporal analysis presents data on the growth of the topic in the literature over the years, in the period stipulated in the methodology, from 2011 to 2018, which corresponds to the emergence of the topic in the literature in 2011, until the time of the research, July 2018 (Graph 3).



Graph 3 - Articles per year (English)
Source: Research data, 2018

The temporal analysis indicates a growth in the number of documents published since the first article found in the literature in the year 2011. Growth was exponential in the first three years, from one document in 2011 to 11 in 2012 and 45 in 2013. The explosion of the theme seems to have occurred from 2013 to 2014, when there was an increase from 45 to 160 published documents, three times more publications than the previous year and 16 times more than in 2012. In addition, it continued to grow, but linearly from 2014 to 2017, the year in which it reached its peak with 256 published documents on the subject. In relation to 2018, 110 papers had been published up to July, which indicates that there should be a small decrease in the number of publications, or that it will remain close to the level reached in 2017.

The temporal growth indicates that the documents most cited are those referring to the years of greatest growth of the theme between 2013 and 2017. From the analysis observed among the most cited articles, the exponential growth in the number of articles given between 2011 and 2014 was accompanied by an explosion in the number of citations, especially in the years 2014 with 1,616 citations and 2015 with 1,027 citations. This fact may indicate that the years from 2013 to 2017 were years of maturation of the theme, indicating an increase in the scientific community's interest in the makerspace until its peak, in 2017.

In Portuguese and Spanish languages, the same growing tendency is observed when compared to English language. This growth also had its peak in 2017 with 39 published documents. However, the temporal coverage in these two languages is even more recent, since the first work on the theme dates back to 2014. That same year, four documents with the theme were still widely dispersed and from 2015 we can find articles mainly in Spanish language and which are more focused on makerspaces and libraries.

4.5 H and G-index

Following the search parameters, the PoP software indicated the H-index of 31 and the G-index of 58. In numerical terms, the area can be considered quite prominent, at least in English language. The Portuguese and Spanish languages have an H-index of 5 and a G-index of 9, which only confirms what has already been verified, that is, it is still an incipient subject in the scientific community of these languages but with potential to grow in the

next years.

4.6 Altmetric analysis

In the altmetric analysis we selected and tabulated the 50 most cited articles according to the possibilities of the platform *altmetric.com*. The results are presented as follows: among the 50 articles surveyed, 27, that is, a little more than half of the documents, did not have citations in social networks or no altmetric data returned by the research tool.

The results demonstrates that there is no direct relationship between the most cited articles in scientific area and the most cited articles in social networks and other web 2.0 tools. Of the 50 most scientifically cited articles, 27 were also quoted altmetrically. However, not necessarily, the most cited articles were the most reproduced in Web 2.0. For example, the article with the highest altmetric score (192) is only the 40th of the list of the most cited with 22 citations.

With regard to social networks, it is possible to notice a predominance of Twitter as the most common means of reproduction, followed by Facebook. Few mentions in blogs, Wikipedia and Google User + were also observed.

Although geographically, there are representatives from all continents, there is a predominance of certain countries, especially the United States (15 mentions), Canada (7) and United Kingdom (6) in relation to the others with a maximum of 2 mentions each, with the exception of Spain with 5 mentions. Developed countries, with in the English language community, that produce and read in English language, are the most active in both scientific and social environments. The presence of other countries such as Brazil, Argentina and Uruguay demonstrates the potential of the topic, which even incipient begins to appear in less active countries in the scientific world.

5. Conclusions

The discussion about the benefits brought about by creative spaces in school environments, has increasingly shown the importance of stimulating manual work, problem solving with day to day tools and teamwork for children and teenagers. The benefits of these activities are noted in the development of this audience in adult life, providing an improvement even in literacy levels. Dougherty (2012) underlines the benefits of the maker movement in education which provides an ecosystem of talent, connections and learning that leads to a truly innovative society and economy. The author, inspired by John Dewey's work, understands that there is virtue in teaching, which is why the brain grasps best when hands are used in the learning process.

It is concluded that the makerspace is a valid space of learning and of social development that can be better observed and exploited by teacher librarians in order to be a greater support in school libraries. It is suggested that more studies and research are needed so teacher librarians have access to practical guides to teach how to develop such spaces on school libraries.

References

Britton, Lauren. (2012) *A fabulous laboratory: the makerspace at Fayetteville Free Library*. Chicago: Public Libraries Online. jul./ago. 2012. Recuperado em

12 outubro 2017, de <http://publiclibrariesonline.org/2012/10/a-fabulous-labaratory-the-makerspace-at-fayetteville-free-library/>.

Burke, John J. (2018) *Makerspaces: a practical guide for librarians*. 2. ed. Lanham: Rowman & Littlefield.

Chueke, Gabriel Vouga e Amatucci, Marcos. (2015). *O que é bibliometria?* uma introdução ao fórum. *Revista Eletrônica de Negócios Internacionais*. São Paulo, v.10, n.2, maio/ago., 1-5.

Dougherty, Dale. (2012). *The maker movement*. *Innovations*, 7(3), p.11-14. Recuperado em 29 outubro 2017 de, http://www.mitpressjournals.org/doi/pdf/10.1162/INOV_a_00135

Hamilton, Buffy J. (2012) *Makerspaces, participatory learning, and libraries*. *The unquiet librarian, blog*. Recuperado em: 8 abril 2018 de, <https://theunquietlibrarian.wordpress.com/2012/06/28/makerspaces-participatory-learning-and-libraries/>.

Johnson, Eric M. D. (2018) *The right place at the right time: creative spaces in libraries*. In: *The future of library space. Advances in library administration and organization*, 36(1), 1-35.

Kroski, E. *The 4 flavors of makerspaces*. *Open Education Database*. Acedido em 10 abril 2018, de <http://oedb.org/ilibrarian/4-flavors-makerspaces/>.

Kuhlthau, Carol. (2003). *Rethinking libraries for the information age school: vital roles in inquiry learning*. *School Libraries in Canada*, 22(4), p. 3-5.

Moorefield-Lang, Heather (2015). *Change in the making: makerspaces and the ever-changing landscape of libraries*. *TechTrends*, 59(3), 107-112.

Pritchard, Alan. (1969). *Documentation notes: Statistical bibliography or bibliometrics?*. *Journal of Documentation*, v.25, n.4, 344-349.

Slatter, Diane e Howard, Zaana. (2013). *A place to make, hack and learn: maker spaces in Australian public libraries*. *The Australian Library Journal*, 62(4), 272-284. Recuperado em 10 fevereiro de 2018 de, <http://dx.doi.org/10.1080/000449670.2013.853335>.

Willingham, Theresa e De Boer, Jeroen. (2015). *Makerspaces in libraries*. Lanham: Rowman & Littlefield.