SYSTEMATIC MAPPING STUDY 2012-2017: QUALITY AND EFFECTIVENESS MEASUREMENT IN MOOC

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Received Date: 25/03/2018 **Accepted Date:** 05/09/2018

ABSTRACT

Massive Open Online Courses (MOOCs) concentrate an important number of students and are set up as an alternative for acquiring knowledge and continuing education. The objective of this article is to analyze how the quality and effectiveness of the MOOCs were measured in empirical studies between 2012 and 2017. For which a systematic mapping study of articles was performed by using databases of Scopus and Web of Science. These articles were analyzed according to the: (1) context of the publication, (2) type of developing institutions and distribution platforms of the MOOC, and (3) characteristics of the empirical studies. It was identified that 54% of the developing institutions were universities and that 31% of the platforms that distributed the MOOC are of Coursera. These articles were also analyzed by type of study, the more frequently used indicators to measure the effectiveness, and the more frequently used focus points (approaches) to measure quality. The results of this study are useful because it allows having a general view of the most frequently utilized methodologies to measure quality and effectiveness in MOOCs.

Keywords: Systematic Mapping Study, Massive Open Online Courses, MOOCs, quality, effectiveness, measurement.

INTRODUCTION

Massive Open Online Courses (MOOCs) are an educational innovation both in technology and in didactic strategies. These new forms of delivering massive, open, and, distance education within reach of any human, in whatever place they are at, and most importantly, free of charge, also require measuring their quality and effectiveness. Analyzing the previous literature on MOOCs, it was found that this line of research needed a study that synthesized how quality and effectiveness have been measured in these courses (more details in the previous literature section below). For such reason, this article had the objective of identifying how quality and effectiveness were measured in the MOOCs between the years 2012-2017. The results of this study are useful because they provide a general view of the most frequently utilized methods to measure quality and effectiveness in MOOCs.

The Massive Open Online Courses (MOOCs) have become an important teaching and learning alternative which is reflected by its fast growth (Ruiz Bras, 2016). The latter can be demonstrated in the coverage of some platforms like Coursera (2017), which stated, that by 2016, it had at least 18 million students in different parts of the world and that also some countries informed a 70% or above growth in these platforms. On the other hand, UNESCO (2017) published the document: "Making sense of MOOCs; A Guide for Policy-Makers in Developing Countries", where it recognizes the great potential of MOOCs and promotes their development as a strategy in the frame of the plan "Education 2030: Quality and Inclusive Education". Likewise, Isaksson, Garvare, Johnson, Kuttainen, and Pareigis (2015) inform them as an alternative to a growing and unsatisfied demand of continuous education, despite their lack of acknowledgment to the official value of most of these (Law, 2015).

Having this overview in mind, an important increase of investigations about MOOCs is observed, which encompass different aspects and note different challenges as an effort to search parameters, methodologies, and procedures that allow them to be an alternative that contributes towards formal education. The latter can be demonstrated in the Scopus database, where a constant increase of the studies about MOOCs and their connections with quality, effectiveness, and measurements are observed. In Table 1 it is seen that from the year 2012 to November 2017, 2010 articles have been published. From 2009 to 2017, a tendency towards an increase in publications on this subject is observed (see first line of the table), where from the total, since 2009, 28% are articles referring to either quality, effectiveness, achievement and/or success (see the second line of the table) and 24% to measurement and/or evaluation (see the third line). The review of the literature is up-to-date, comprehensive and addresses the need for the manuscript.

Table 1. All the publications about MOOCs, quality, effectiveness and measurement in SCOPUS (January 2009-November 2017)

Search	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	%
Massive Open Online Course* (Massive Open Online Course*)	2	0	9	12	169	362	485	506	476	2021	100
AND (quality OR effectiveness OR achievement OR success) (Massive Open Online Course*)	1	0	1	2	39	101	134	138	151	567	28
AND (measure or assessment OR evaluation OR appraisal)	0	0	2	2	32	84	117	126	123	486	24

Note. Source: Build with SCOPUS data. Until November 2017

Massive Open Online Courses

According to Patru and Balaji (2016), MOOCs are online courses designed for a massive number of participants (thousands), which can be accessed by any person with an Internet connection from any place in the world and do not require any entry requirement, meaning they are free of charge. The MOOCs are developed under the concept of Open Learning or Open Education, where it is expected to resume the academic characteristic of interaction, access to debate, trading of knowledge and transparency beyond only the provision of contents, which can approach the democratization of knowledge (Cormier and Siemens, 2010). According to Baturay (2015), the fundamental characteristics of MOOCs are:

- Open. To anyone who wishes to enroll, free of charge and the products resulting from the course must also be freely available (investigations, essays, etc.).
- Participative. The MOOCs' basis of learning is the participation, contribution, exchange and willing interaction from the students.
- Distributed. MOOCs are based on the connectivism approach, so knowledge must be distributed in a network of participants. The course is generally carried out in social learning environments, where the participants interact with the material.

MOOCs have less than 20 years of history, these began between the years 2000-2007 within the Open Education movement. The first MOOC appeared in 2008 and was named "Connectivism and Connected Knowledge". Their originators were George Siemens and Stephen Downes and it was offered through the University of Manitoba, Canada. By 2011, Stanford University offered a course on artificial intelligence which enrolled 160 000 students. In 2012 the MOOCs distribution platforms appeared: Audicitu, Coursera, MITEDX which today conglomerate thousands of courses and millions of students (El Ahrache, Hassan, Tabaa, and Medouri, 2013; Greene, Oswald, and Pomerantz, 2015). This evolution is observed graphically in Figure 1.

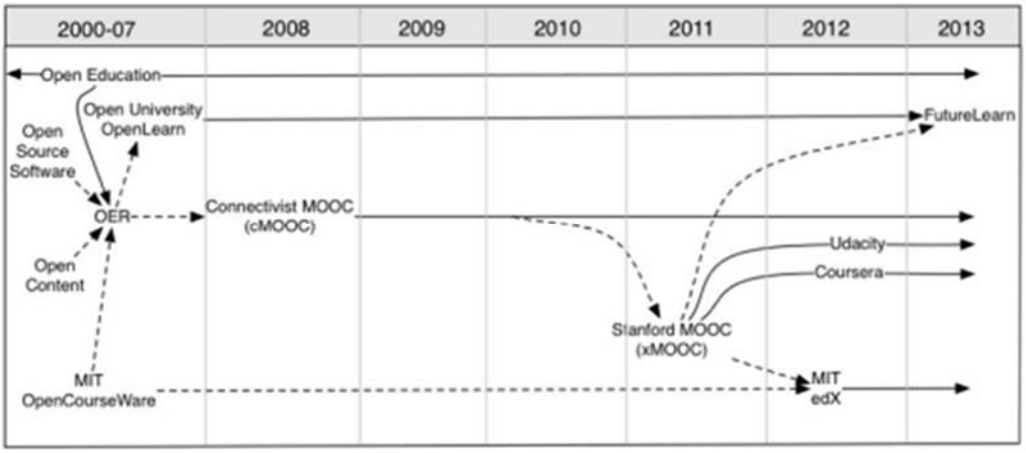

Figure 1. Timeline of MOOC evolution. Source: El Ahrache et al. (2013)

It is important to mention that the amount of reported studies in Scopus (Table 1) is coherent with the evolution of MOOCs in time (Figure 1), where it is observed that these courses were made massive in 2012 through various platforms and a year later, in 2013 the production of articles increased by 1300% (from 12 to 169 articles, first line of the table).

LITERATURE REVIEW

The previous literature reviews on MOOC began to appear in the literature since 2013. Between 2013 and 2018 ten relevant literature reviews about MOOCs were published (Liyanagunawardena et al., 2013; Yousef et al., 2014; Sa'Don et al., 2015; Chiappe-Laverde et al., 2015; Bozkurt et al., 2016; Veletsianos & Shepherdson, 2016; Bozkurt et al., 2017; Cabero-Almenara et al., 2017; Zawacki-Richter et al., 2018; Zhu et al., 2018). The first literature reviews (Liyanagunawardena et al., 2013; Yousef et al., 2014; Sa'Don et al., 2015) identified the most researched topics. For example, Sa'Don, Alias, & Ohshima (2015) reviewed the research trends of higher education MOOCs in 164 articles between the years 2008-2014; they identified that the ten most studied topics in order of importance were: Pedagogy, Evaluation and Accreditation, Commitment or Motivation, Knowledge Exchange, Cultural Diversity, Technology, Social Interaction, Retention of participants, Learning Analytics, and Policy and instructional design.

Between 2016 and 2018, three literature review works are relevant (Bozkurt et al., 2016; Bozkurt et al., 2017; Zawacki-Richter et al., 2018). Given the importance of these studies, a summary of the main results of the two latter studies follows. Bozkurt et al. (2017) conducted an important review of 362 empirical articles from 2008 to 2015. The authors identified three main research areas: theories and models (27%), learner characteristics (15.7%), and instructional design (11%). Additionally, they found that: the related literature is dominated by research on xMOOCs, the discourse in MOOC articles takes a mostly neutral standpoint, and theoretical or conceptual studies are preferred by researchers. Zhu et al. (2018) studied the research paradigms and topics of MOOCs analyzing 146 empirical studies from 2014 to 2016. The authors found five main results: most studies used quantitative research methods, the most frequently adopted data collection method was the survey, more than half of the collected studies used at least two data collection methods, the majority of researchers used descriptive statistics to analyze data, and the research focus was mainly on students. The current state of art summarized above shows different important issues about MOOCs. However, the present article will be focused only on the effectiveness and quality measurement of MOOCs; this will be shown below.

The Quality of Massive Open Online Courses

The quality in education is a complex topic to address. For Wittek and Kvernbekk (2011), there is no accurate definition of quality in education since it can change under the perspective of the educator, student, authority, employer or parent. On the other hand, and after reviewing scientific literature, it is seen that quality must be understood by the level of education being either early, basic or higher education. For these reasons, and considering the purpose of this article, the parameters of quality of MOOCs in various theoretical studies are presented.

Patru and Balaji (2016) propose to frame the quality of MOOCs from the most general approach to quality, where two factors are met: 1. A profound understanding of the expectations and needs of the users, and 2. That the MOOC adapts to or satisfies these aspects. For the abovementioned, they propose two reference parameters: 1. The E-xcellence Framework, which verifies the strategy of the management, design of the curriculum, design of the course, delivery form, support staff for the resources and support for the student and 2. OpenupEd Quality Label (which results from the first parameter) and which verifies aspects at an institutional level (with the same evaluation criteria of the E-xcellence Framework) and also, from the course. The latter combines diverse criteria such as clarity of the learning results, coherence between the results and the contents, learning strategies, relevance and pertinence among other aspects.

In scientific empirical and theoretical literature, three parameters of quality evaluation of MOOCs are observed, which are adaptations of evaluations of online courses. These are:

- Arias Masa Proposal (2007): The author proposes the evaluation of quality of virtual courses by means of the following dimensions, each with its own indicators: pedagogical quality (10 indicators), technical quality (4 indicators), management (3 indicators), usability (3 indicators) and general assessment (2 indicators). This proposal has been adapted for some empirical studies such as those of Mengual-Andrés, Lloret Catala, and Roig Vila (2015) and Roig-Vila, Mengual Andrés and Suarez Guerrero (2014).
- ADECUR Proposal by Cabero Almenara and López Meneses (2009). Its acronym means Description of a Didactic Instrument for the Analysis of Models and Teaching Strategies of Online University Courses. Here the authors propose two dimensions, each with a progression axis. The dimensions are: 1) Psycho-didactic dimension with the following axis: virtual environment, type of promoted learning, goals, contents, activities and their sequencing, the assessment, and the tutorial action; 2) Dimension of technical aspects with the axis: technical aspects and resources. This instrument was adapted for the evaluation of MOOCs in the article by Baldomero Ramírez-Fernandez, Salmerón Silvera and López Meneses (2015).

- Proposal of Quality of Virtual Education (AENOR, 2012), from the Management of Quality of the Spanish Regulation UNE 66181:2012. It proposes three levels of evaluation: acknowledgment for the employability formation, learning methodology, and accessibility. This regulation has a strong component for the analysis of the users' needs for the development of its proposal and was adapted for the study by Baldomero Ramírez-Fernandez and Salmerón Silvera (2015).

By the end of this section is noted that the quality standards of MOOCs are still in a construction process. There are various proposals with some points in common mainly on the pedagogical design, as well as in the technical aspect and accessibility, however, there are also strong differences and scopes.

Effectiveness in the Massive Open Online Courses

According to the reviewed literature, unlike quality which requires parameters for an evaluation, the effectiveness of MOOCs is measured by various variables and indicators that can be expressed in: retention (given the high number of students' dropout), certification of completion of the course, fulfillment of achievements, change in knowledge or attitude, student's experience, among others (Adam, Young-Wolff, Konar, and Winkleby, 2015; MacKay, Langford, and Waran, 2016; Masanet, Chang, Yao, Briam, and Huang, 2014; Tiejun, 2016). It is important to mention that considering that MOOCs are not official studies, there are no formal statistics which allow having comparison parameters, beyond the results obtained in the published studies.

Previous Literature Review on MOOCs' Quality and Effectiveness

There are two previous revisions of literature about the quality and effectiveness of MOOCs: (1) The study of Gamage, Fernando and Perera (2015), and the study of Duart, Roig-Vila, Mengual-Andrés and Maseda (2017). In the first study, Gamage et al. (2015) performed a review of the quality of MOOCs with the objective of identifying quality metrics that would allow them to evaluate MOOCs between 2012-2015 and to analyze 26 articles. Their results yielded that only three empirical articles provided dimensions for the quality of a MOOC and seven articles on parameters of quality that propose to evaluate MOOCs. Finally, they mention that it is necessary to fill the significant gap in the investigation related to producing and evaluating quality MOOCs.

On the other hand, in the second study, Duart et al. (2017) made a systematic revision of literature in the JCR and Scopus databases with the objective of determining aspects relating to the pedagogical quality of MOOCs. The authors developed an analysis based on seven categories: planning of the course, contents, methodology, resources and activities, motivation, communication and evaluation, and certification. The results show that the assessments of MOOCs yielded a quality average slightly higher than the mean. Furthermore, they warn about the lack of studies directly related with the pedagogical quality of MOOCs, so that it is deemed necessary to develop further studies that, from methodological rigor, tend to obtain conclusive results.

Both revisions of previous literature coincide in underlining the little existence of empirical articles that evaluate the quality and effectiveness of MOOCs. It also must be noted that the main difference between our study and these two previous studies (Gamage et al. (2015) and Duart et al (2017) lies in the depth of our analysis and in the larger period of years considered in our study. It must also be noted that the two studies only analyze the articles until 2015 and the second study focuses solely on the theme of quality. This allows generating a knowledge basis in order to evaluate MOOCs with quality and effectiveness strategies with theoretical and empirical support.

METHODOLOGY

Systematic reviews are, according to Gisbert and Bonfill (2004), scientific investigations with prefigured methods that synthesize the results of the original studies. For these authors, these reviews have four basic characteristics: (1) they are synthesis of information with a practical approach, (2) they are based on available scientific evidence, (3) they formulate clearly defined questions, and (4) they use systematic and explicit methods to identify and analyze the studies. These reviews can drive future research studies (i.e. Russell, 2012). One of these systematic reviews is the systematic mapping of literature (Grant & Booth, 2009), which offers a broad review of primary studies in a specific area with the purpose of identifying the available evidence on the subject (Kitchenham and Charters, 2007).

The current systematic mapping of literature was performed following the steps established by Peterson et al. (2008), for which: only empirical articles indexed in Scopus or Web of Science were considered, the articles published between the years 2012 and 2017 and where quality, effectiveness or both as a set were evaluated or measured. Peterson et al. (2008) established five steps that guide systematic mappings: (1) Definition of research questions, (2) Conduct search for primary studies, (3) Screening of papers for inclusion and exclusion, (4) Classification scheme, and (5) Data extraction and mapping of studies. Next, we describe how each of these steps is followed in the present study.

Step 1: Definition of Research Questions

According to Petersen et al. (2008), the reviews of literature begin with the definition of the research questions. The research questions that guided this systematic review of the literature were the following:

(RQ1) Context of the publication

1. How are the publications distributed by country of publication?
2. How are the publications distributed by year of publication?
3. How are the publications distributed by the most frequent magazines of publication?
4. How are the publications distributed by country of affiliation of the first author?

(RQ2) Type of developing institutions and distributing platforms of MOOCs

1. How are the publications distributed by the type of institution that develops the MOOC?
2. How are the publications distributed by the platform that distributes the MOOC?

(RQ3) Characteristics of the empiric studies

1. How are the publications distributed by type of study?
2. How are the empirical studies distributed according to the most frequent indicators to measure effectiveness?
3. How are the empirical studies distributed according to the most frequent approaches to measure quality?

Steps 2 & 3: Conduct Search for Primary Studies and Screening of Papers for Inclusion and Exclusion

For the search strategy, the keywords obtained from the research objective were used and their equivalents or synonyms were considered based on the Thesaurus of the UNESCO and on the articles of Duart et al. (2017) and Gamage et al. (2015). The keywords used were:

- Massive Open Online Course OR MOOC* (The asterisk is used to develop a dashed search)
- Quality
- Effectiveness OR achievement OR success
- Measure OR assessment OR evaluation OR appraisal

The following general conditions were also considered equally for both databases: 1) The search was made in English in the boxes for title, keywords and in the case of Scopus the summary was included; and 2) Filters for type of documents and years were applied, and only "articles" and the period "2012-2017" were selected respectively. Table 2 shows the results of the search and the process of exclusion. In the results of the first search, 115 articles were found in both databases (Scopus and Web of Science): 54 about quality measurement, 52 about effectiveness measurement and 9 about both quality and effectiveness measurement.

Table 2. Strategy, search results and process of exclusion in Scopus and Wos.

Search	Number of Search	Search strategy	Articles found in WOS and Scopus	Excluded Articles	Analyzed Articles
MOOC Quality Measurement	4	(MOOC* OR Massive open online courses) AND (measure OR assessment OR evaluation OR appraisal) AND (quality))	54	41	13
MOOC Effectiveness measurement	5	(MOOC* OR Massive open online courses) AND (measure OR assessment OR evaluation OR appraisal) AND effectiveness OR achievement OR success)	52	44	8
MOOC Quality and effectiveness measurement	4 and 5	They coincided in both searches	9	4	5
Total articles			115	89	26

Afterward, each article was reviewed (in three rounds, to diminish bias) and 89 articles were excluded for the following two reasons: 1) It only measured an aspect of the MOOC, not the MOOC as a whole; and 2) It was not an empirical study of measurement or assessment. Table 3 shows the classification of the excluded articles according to these two reasons.

Table 3. Classification of the 89 excluded articles.

Reasons for exclusion	It only measured an aspect of the MOOC, not the MOOC as a whole			It was not an empirical study of measurement or assessment		
Themes of studies	Teaching methodologies, instructional design, and learning objects	Focus on the students	Focus on learning assessment	Conceptual study	Predictive study	Literature review
Number of studies	36	16	14	18	3	2

As shown in Table 3, 66 articles were excluded because they only measured an aspect of the MOOC, not the MOOC as a whole. Of these articles, 36 focused on topics related to the MOOCs' teaching methodologies (for example, Chen, Xu, Xu, Peng, & Xing, 2017; Inventado & Scupelli, 2017; Muñoz-Merino et al., 2017; Torres-Coronas & Vidal-Blasco, 2017), instructional design (for example, Margaryan, Bianco, & Littlejohn, 2015) and learning objects (for example, Farhan & Aslam, 2017). Sixteen articles focused on characteristics of the students enrolled in the MOOCs: commitment to sign up and conclude the course (Goldberg et al., 2015; Gray, 2015; Sinclair & Kalvala, 2016), behavior during the course (Campbell, Gibbs, Najafi, & Severinski, 2014; Kahan, Soffer, & Nachmias, 2017; Leach & Hadi, 2017) and emotions (Bae, Moon, & Morrison, 2017; Leony, Muñoz-Merino, Ruipérez-Valiente, Pardo, & Kloos, 2015; Liu et al., 2016). Finally, 14 articles focused on learning assessment; two major topics were identified: peer review (Chiou & Shih, 2015; Estévez-Ayres, Crespo-García, Fisteus, & Kloos, 2013; Meek, Blakemore, & Marks, 2017) and appropriate assessment of learning (Christoforaki & Ipeirotis, 2015; Hills & Hughes, 2016; Ruipérez-Valiente, Muñoz-Merino, Pijeira, Ruiz, & Kloos, 2017).

Also, as shown in Table 3, 23 articles were excluded because they were not an empirical study of measurement or assessment. Of these studies, 18 were conceptual studies that reflected on different aspects of the MOOCs, for example, the quality criteria (Baldomero et al., 2015; Ghislandi, 2016); 3 were predictive studies that identified factors to foresee if a MOOC would be successful (Bonafini, Chae, Park, & Jablokow, 2017, Greene, Oswald, & Pomerantz, 2015, Smith, 2015), and 2 were literature review studies.

After the exclusion process, 26 articles remained. Table 4 shows the quote, the title, the type of study and the measured variables of the 26 selected articles.

Table 4. Quote, title, type of study, and measured variables in the 26 selected articles.

Quote	Article	Type of study	What is measured
Chapman, Goodman, Jawitz, and Deacon (2016)	A strategy for monitoring and evaluating massive open online courses	Qualitative case study	Quality and effectiveness
Sinclair, Boyatt, Foss, and Rocks (2016)	A study of user participation across different delivery modes of a massive open online course	Mixed descriptive	Effectiveness
Yousef, Chatti, Schroeder, and Wosnitza (2015)	A usability evaluation of a blended MOOC environment: An experimental case study	Quantitative descriptive	Effectiveness
(Zhuo & Xiaoming, 2017)	An applicable way of teaching quality evaluation based on MOOC platform	Quantitative descriptive	Quality
Alcock, Dufton, and Durusu-Tanrıover (2016)	Archaeology and the MOOC: Massive, open, online, and opportunistic	Qualitative case study	Effectiveness
Roig-Vila et al. (2014)	Assessment the pedagogical quality of the MOOC	Quantitative descriptive	Quality
Eranki and Moudgalya (2016)	Comparing the effectiveness of self-learning Java workshops with traditional classrooms	Quantitative quasi experimental post test	Effectiveness

Castaño, Maíz, y Garay (2015)	Design, Motivation and Performance in a Cooperative MOOC Course	Quantitative ex post facto prospective	Effectiveness
Loftis and Martínez Wormser (2016)	Developing Online Information Literacy Instruction for the Undergraduate Art Student: A Collaborative Approach in the Context of the Framework for Information Literacy	Qualitative case study	Quality
Baldomero Ramírez-Fernandez and Salmerón Silvera (2015)	Edutool®: A tool for evaluating and accrediting the quality of MOOCs	Quantitative instrumental	Quality
Tiejun (2016)	Empirical research on the effectiveness of MOOCs in developing design students on sino-foreign cooperation university programs	Qualitative case study	Effectiveness
Moskal, Thompson, and Futch (2015)	Enrollment, engagement, and satisfaction in the Blendkit faculty development open, online course	Qualitative case study	Effectiveness
Khalil, Brunner, and Ebner (2015)	Evaluation grid for xMOOCs	Quantitative instrumental	Quality
Aleman De la Garza, Sancho-Vinuesa, and Gómez Zermeño (2015)	Indicators of pedagogical quality for the design of a massive open online course for teacher training	Quantitative instrumental	Quality
MacKay et al. (2016)	Massive open online courses as a tool for global animal welfare education	Quantitative quasi experimental pre-post-test	Effectiveness
Adam et al. (2015)	Massive open online nutrition and cooking course for improved eating behaviors and meal composition	Quantitative quasi experimental pre-post-test	Effectiveness
Baldomero Ramírez-Fernandez (2015)	MOOC appraisal: A quality perspective	Quantitative descriptive	Quality
Frick and Dagli (2016)	MOOCs for Research: The Case of the Indiana University Plagiarism Tutorials and Tests	Qualitative case study	Quality and Effectiveness
Hsieh, M.-Y. (2016)	Online learning era: Exploring the most decisive determinants of MOOCs in Taiwanese higher education	Quantitative instrumental	Quality
(Rieber, 2017)	Participation patterns in a massive open online course (MOOC) about statistics	Quantitative descriptive	Quality
Baldomero Ramírez-Fernandez (2015b)	Proposal quality certification of educational Spanish MOOC courses offer conducted by the National Institute of Educational Technologies and Teacher Training.	Quantitative descriptive	Quality
Yepes-Baldó et al. (2016)	Quality indicators: developing “MOOCs” in the European Higher Education Area	Quantitative instrumental	Quality
Gómez Hernandez, Monge López, and Sebastian Heredero (2016)	Quality of a MOOC inclusion on education: implementation of various instruments and indicators	Qualitative case study	Quality
(Henderikx, Kreijins & Kalz, 2017)	Refining success and dropout in massive open online courses based on the intention-behavior gap	Quantitative ex post facto prospective	Effectiveness

Masanet et al. (2014)	Reflections on a massive open online life cycle assessment course	Quantitative quasi experimental pre-post-test	Effectiveness
(Mengual-Andrés, Lloret Catala, & Roig Vila, 2015)	Validation of the Questionnaire of Quality Assessment of Online Courses adapted to MOOC	Quantitative instrumental	Quality

Steps 4 & 5. Classification Scheme, Data Extraction and Mapping of Studies

For the data analysis, from the first two sets of research questions (RQ1 and RQ2), a tabulation was decided and then a percentile analysis performed. For the third set of research questions (RQ3) the articles were classified by types of study, based on the proposal by Montero and León (2007), and then were described in comparative tables for each item. The search, the gathering and the analysis of data for the systematic mapping study were concluded with these procedures.

RESULTS

In this section are presented the obtained results when performing the review of the literature for this mapping divided into the three groups of research questions.

(RQ1): Context of the Publication

In this subsection are presented the obtained results related to the first set of research questions referring to the context of the publication. The distribution of the publications is analyzed by: (1) country of publication, (2) year of publication, (3) magazines of publication with more frequency, and (4) by country of affiliation of the first author. With respect to the country of publication (see Table 5), it was found that the published work is only distributed in seven countries. The country that concentrated the most amount of publications was Spain with 27%, followed by the United States with 23%, the United Kingdom with 19%, and Germany with 15%. Also, it is observed that the three other countries concentrate only 4% of the publications respectively (Brazil, Canada, Switzerland and Turkey). It should be noted that the majority of articles are developed first in Europe, then in North America and in a minimum proportion in South America.

Table 5. Countries by articles publication.

Country	%
Spain	27%
United States	23%
United Kingdom	19%
Germany	15%
Brazil	4%
Canada	4%
Switzerland	4%
Turkey	4%

The search of articles was performed in the 2012-2017 period. When analyzing the publications by year of publication (see Figure 2), it was found that there were no publications about quality and effectiveness between the years of 2012 and 2013. This could be because, in 2012, MOOCs were massified as it was previously mentioned when analyzing Figure 1. Besides, it can be observed in Figure 2 that in 2014, 8% of the studies were published, 38% in 2015, 42% in 2016, and 12% in 2017. This distribution of articles

justifies the value of our study. As mentioned before, the revisions of previous literature analyze only until 2015. According to our search, 52% of the articles with the specific characteristics established in the Methodology section were published in 2016-2017. This is half of the empirical articles about the measurement of quality and effectiveness in the MOOCs.

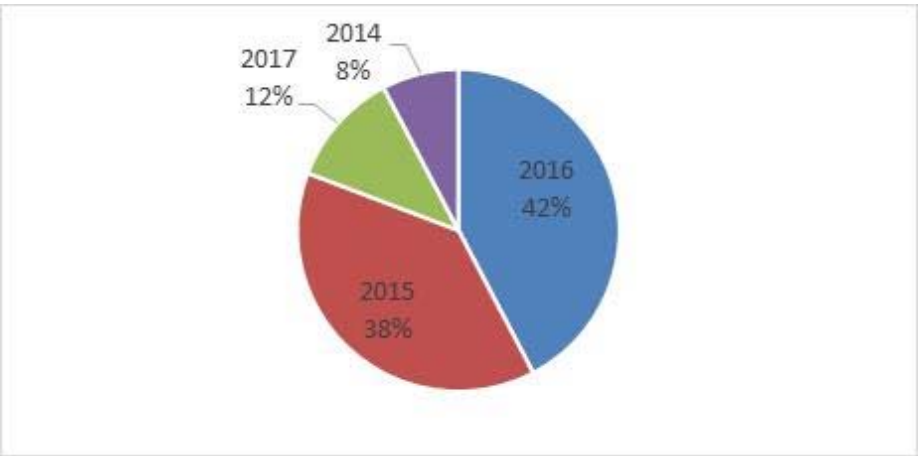

Figure 2. Distribution of publications by year

In relation to the magazines, it was identified that "La Revista Iberoamericana de Educación a Distancia" and "the International Journal of Emerging Technologies in Learning", are the ones that concentrate the higher number of articles with two publications in each. Additionally, other characteristics of the magazines are reported such as that 32% of the studies were published in magazines that were in the Q1 and 36% between Q2 and Q3 of the Rankings: Scimago Journal Rank or Journal Citation Report and that 60% of these articles are open access.

Finally, in relation to the places where the studies were developed, which were measured through the filiation of the principal researcher, it was found that 31% of them were held in Spain and 27% in the United States (Table 6, Figure 3). It is observed here, as in the country of publication case, that Europe concentrates the highest amount of publications, followed by North America and Asia.

Table 6. Country of filiation of the principal researcher.

Country	%
Spain	31%
United States	27%
China	12%
United Kingdom	8%
Germany	4%
Austria	4%
India	4%
Mexico	4%
South Africa	4%
Netherlands	4%

Figure 3. Country of filiation of the principal researcher.

(RQ2) Type of Developing Institutions and Distributing Platforms of MOOCs

This section analyzes the type of developing institutions and distributing platforms of MOOCs in the studied publications. According to MOOC developing institutions, (see Figure 4), it was identified that 54% were universities, 8% government institutions, and 4% independent associations. Furthermore, 34% of the studies do not mention the source of the MOOCs. This is usually because these studies were generally made in a group of MOOCs where the main interest was the topic or some common characteristic among them independently from their or its origin.

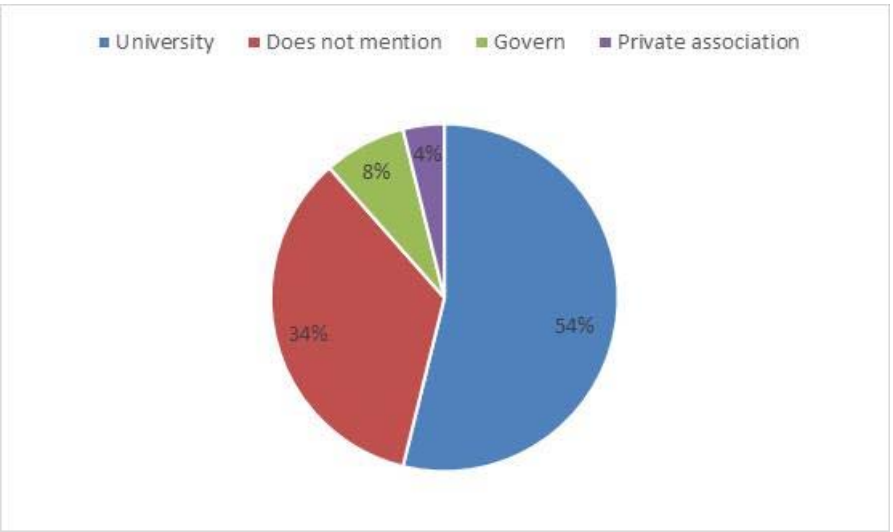

Figure 4. Developing Institutions of MOOCs

Regarding the distributing platforms of the MOOC (Table 7), the following is reported: 31% were by Coursera, Edx with 14%, and Udacity and Canvas with 7% each one. Another important figure is that 9% corresponds to studies performed with the own institutions' platforms.

Table 7. Percentage of studied platforms.

Plataform	%
Coursera	31%
EdX	14%
Does not report	14%
University´s own	9%
Canvas Network	7%
Udacity	7%
Miríada X	6%
L2P-bMOOC	3%
Lynda.com	3%
FutureLearn	3%
UNX	3%

(RQ3) Characteristics of the Empirical Studies

This section analyzes the distribution of the publications by type of study, the more frequently used indicators to measure the effectiveness, and the more frequently used focus points (approaches) to measure quality.

Types of Studies

Each publication was classified, using as reference the article from Montero and León (2007), with the purpose of systematizing the results about the type of studies. Table 8 shows the distribution of publications that measure quality, effectiveness, and both (quality and effectiveness as a set), by type of study.

About the distribution of publications by measured variable, it is observed that 50% of the articles measure the quality variable, another 42% the effectiveness, and 8% quality and effectiveness as a set. In respect to the distribution of publications by type of study, it can be observed that 27% of the articles are qualitative (first row), 69% are quantitative (from the second to the sixth row), and that 4% of the articles are mixed studies (seventh row).

Table 8. Classification by types and object of studies.

Types of study	Types of study and definition	Quality	Effectiveness	Quality and, effectiveness	Total, genera l
Qualitative case study	Describes strategies referred to a single element: a person, a group, an organization.	2	3	2	7 (27%)
Quantitative quasi experimental post-test with two groups	One treated group and another of non-equivalent control; both measured at the same time (only post-test).	0	1	0	1 (4%)

Quantitative quasi experimental pre-post-test	Measures the dependent variable before and after the intervention.	0	3	0	3 (12%)
Quantitative descriptive	Applies systematic observation by using a codified arbitrary system.	4	1	0	5 (19%)
Quantitative ex post facto prospective	Begins by registering the values of an independent variable and then by measuring the dependent one.	0	2	0	2 (8%)
Quantitative instrumental	Notes the development of new procedures, tools, instruments or tests.	7	0	0	7 (27%)
Mixed descriptive	Uses a qualitative method and another quantitative one.	0	1	0	1 (4%)
Total, general		13(%)	11 (42%)	2 (8%)	26 (100%)

By observing Table 8 it can be noted that the most frequent type of study is the qualitative case study (7 publications, 27%), as 2 of these publications measure the quality, 3 measure the effectiveness, and 2 measures jointly quality and effectiveness. It is also observed that the other most frequent study is the quantitative instrumental (7 publications, 27%) and that within this, all publications measure the quality. On the other hand, it is shown that the third most frequent one is the quantitative descriptive (5 publications, 19%), with 4 of them measuring quality and only one measuring effectiveness. Lastly, the fourth most frequent study (3 publications, 12%) is quantitative quasi-experimental pre-post-test, with all of these articles measuring the effectiveness. So, it is observed that the most utilized types of studies to measure quality are quantitative instrumental (7 publications) and quantitative descriptive (4 publications), and qualitative case study (2 publications). Moreover, the most frequent study types to measure effectiveness were quantitative quasi-experimental pre-post-tests (3 publications) and qualitative case study (3 publications) respectively. Finally, the most used type for measuring jointly quality and effectiveness is the qualitative case study (2 publications). This publication distribution is interesting for the researchers because it allows having a general view of the most frequently utilized methodologies.

Effectiveness of Indicators

It was identified that investigations can use a combination of indicators that at the end report if the course was effective. These indicators could contemplate:

- Performance, that can be expressed as an achievement of the objectives, change of knowledge or attitude, grades, or as the achievement itself.
- Teaching methodology that includes the design, assessment, and course contents.
- Retention or desertion (dropout) from the course and the commitment. These indicators pretend to measure that students do not drop out from the course.
- Perceptions of motivation/satisfaction, which have to do with the emotions that students feel during or at the end of the course.
- Culmination or certification from the course.

Table 9 shows the frequency of use, of this group of indicators, in the studies that assess effectiveness.

Table 9. Frequency of use of the five groups of indicators in the eleven studies that evaluate the effectiveness.

	Group of indicators to evaluate the effectiveness				
Article	Efficiency	Teaching Methodology	Retention, Commitment or Dropout	Perceptions of motivation/ satisfaction	Course culmination
Eranki and Moudgalya (2016)	1	1	0	0	0
MacKay et al. (2016)	1	0	1	1	1
Adam et al. (2015)	1	0	0	0	0
Masanet et al. (2014)	1	0	1	0	0
Tiejun (2016)	0	0	1	1	0
Alcock et al. (2016)	0	0	0	0	1
Moskal et al. (2015)	0	0	1	0	0
Yousef et al. (2015)	0	1	0	0	0
Castaño et al. (2015)	1	1	0	0	1
Sinclair et al. (2016)	1	1	0	1	0
(Henderikx et al., 2017)	0	0	0	1	1
Percentage	55%	36%	36%	36%	36%

One of the most important results that can be observed in Table 9 is that 54% of the articles used efficiency indicators. On the other hand, another important result is that the other four indicators (Teaching methodology; Retention, Commitment or Dropout; Perceptions of motivation/satisfaction; and Course culmination) have the same percentage: 36% respectively.

Quality Approach

It was identified within the last 26 analyzed articles that in respect to the assessment of quality, more complex models, that contemplate dimensions either with criteria or indicators, were used. Therefore, it can be observed that the study of quality results more complex and profound than the effectiveness study.

Table 10. Frequency of use of the seven criteria in the eleven approaches to assess the quality.

Approach/ Quote	Pedago-gical	Functional from the platform	Platforms or Technological Systems	Time	Intrinsic of the student	Interaction with the professor	Effect
E1: Baldomero Ramírez-Fernandez (2015a, 2015b), Baldomero Ramírez-Fernandez y Salmerón Silvera (2015)	1	1	0	0	0	0	1
E2: Mengual-Andrés et al. (2015), Roig-Vila et al. (2014) based on Arias (2007)	1	1	0	1	1	0	0
E3: Aleman De la Garza et al. (2015), Gómez Hernandez et al. (2016)	1	1	1	1	0	0	0
E4: Khalil et al. (2015)	1	1	1	0	0	1	0
E5: Yepes-Baldó et al. (2016)	1	1	1	0	0	0	0
E6: Zhuo y Xiaoming (2017)	1	0	0	0	0	0	0
E7: Rieber (2017)	1	0	1	1	0	0	1
E8: Loftis y Martínez Wormser (2016)	1	0	0	1	1	0	0
E9: Chapman et al. (2016)	1	0	1	0	0	1	0
E10: Frick and Dagli (2016)	1	0	0	0	1	0	0
E11: Hsieh, M.-Y. (2016).	1	1	0	0	0	1	0
Total	11	6	5	4	3	3	2
Percentage	100%	55%	45%	36%	27%	27%	18%

When analyzing the fifteen studies regarding quality, eleven quality approaches were identified in order to assess them. As seen in the first column of Table 10, the eleven quality approaches are identified and are called E1 to E11 respectively. As it can be observed in the article's quote, in each of the approaches (column two of the table), in approach 1 (E1), three studies from the analyzed group from Baldomero Ramírez-Fernandez (Baldomero Ramírez-Fernandez y Salmerón Silvera, 2015; Baldomero Ramírez-Fernandez, 2015a, 2015b;) are grouped. In approach 2 (E2), it can be observed that two articles from the analyzed studies are found (Mengual-Andrés et al., 2015; Roig-Vila et al., 2014) and that these two take as reference the Arias study (2007). Moreover, two articles of the analyzed studies (Aleman De la Garza et al., 2015; Gómez Hernandez et al., 2016), are grouped in approach E3 while there is just an article in the rest of the

approaches (E4-E10), As it can be seen, the first three approaches (E1-E3) are the ones more used within the 2012-2017 period.

The eleven quality approaches were classified according to seven different groups of appraisal criteria that take into consideration the reach and the objective of the study. As previously mentioned, this type of groupings has not been performed in previous literature revisions. These seven different groups of appraisal criteria are:

- Pedagogical criteria: this groups the criteria that contemplate the teaching methodology, the design of the course from objectives to assessment, the instructional design, the quality and relevance of the contents or of the learning objectives. About this, it was observed that the approaches can deal with all aspects in a general manner or with some of them.
- Functional criteria of the platform: this one groups the criteria that valuate the functions that incorporate the platforms in order to complement the teaching process. For example: the utilization of tools such as video players, chats, forums, mobile applications, etc. Also, in this aspect can be assessed the correct use of these tools.
- Platforms or technological systems criteria: this groups the criteria that evaluate the solidity of the platform, the capacity to be accessible the 24 hours of the 365 days a year, the timely technological support for the student, accessibility, compatibility between technologies, besides other similar topics.
- Time criteria: this group of criteria is associated with two main characteristics: the presentation and the fulfillment with a chronogram and the speed of how doubts are responded and support are given to the student.
- Intrinsic criteria of the student: this criteria group is associated to the valuation of emotions or perceptions that the student manifests before, during, or at the end of the course. These can be: motivation, satisfaction, or commitment.
- Interaction with the teacher criteria: this group of criteria refers to the student finding an opportunity of communication with the professor, which can be through the same MOOC's platform as the timely answer from the student.
- Effect criteria: this group of criteria is geared towards assessing if the MOOC impacted the student in some progress, as in the betterment of the student's knowledge or competences.

Table 10 shows the frequency of use of this group of criteria in the eleven approaches to assess quality. The first interesting trend that is observed is that in all approaches (100%), the pedagogical criteria are considered. This seems to be because, in the education field, pedagogical criteria are the base of any type of course development. The second interesting trend is that 55% of the approaches consider the functional criteria of the platform. Finally, it can be observed that the rest of the groups have percentages equal or lower than 45% in the following order: the platforms or technological systems criteria (45%), Time criteria (36%), Intrinsic criteria of the student and Interaction with the teacher criteria (27% respectively), and Effect criteria (18%).

As previously mentioned, the first three approaches (E1-E3) are the more utilized approaches in the 2012-2017 period. Each of these approaches is described next.

- Approach E1: This E1 approach, from Baldomero Ramírez-Fernandez & Salmerón Silvera (2015), presents EduTool®, a registered trademark in the Spanish Office of Trademarks and Patents which proposal is based on Spain's Regulations (Normas Españolas UNE 66181). The valuation categories are: Recognition of the formation of employability, which contains 6 items; Learning methodology, which contains 43 items; and Accessibility with 21 items.

- Approach E2: The E2 approach is based on the Arias Masa doctoral thesis (2007). Its proposal is directed towards the assessment of virtual courses and, even though is not specific for the MOOCs, it has been adapted and taken as reference. The proposed categories are: Pedagogical Quality (Teaching guide, Methodology, Organization of the contents, Quality of the contents, Teaching resources, Capacity to motivate, Multimedia elements, Language style, Discrimination and values, User singularity); Technical Quality (Security of information, Technical compatibility, Integration with other systems, Modular and scalable); Management (System's communication, Interaction among participants, Flows of information); Usability (Surfing ease, Legibility of information, Aesthetic Quality of the interface); and General Assessment (Non-evaluated aspects). What is interesting about this approach is how long it has existed and how, for such reason, it has been used in diverse investigations and the level of assessment detail.
- Approach E3: The E3 approach, from Aleman De la Garza et al. (2015) proposes 50 indicators to assess the pedagogical quality of the design of a MOOC. These are grouped into 4 categories and 15 subcategories. The four assessment categories are: Pedagogical (Contents, pedagogical focus, tutorials, evaluation, adequation and adaptation to the users, ability for motivation, and resources); Functional (Ease of use, autonomy and control from the user, and functionality of the documentation); Technological (Interaction and surfing dialogues, visual environment, design and technology, and versatility; and Time (Presentation of the exams, performing activities, doing exercises, studying topics, calendar, and participation in forums and discussions). The criteria were validated by the Delphi method by 55 experts and the final instrument was applied in 12 MOOCs.

DISCUSSIONS AND CONCLUSION

This article analyzed how quality and effectiveness were measured in MOOCs through empirical studies between 2012 and 2017. A systematic mapping study was performed by using Scopus and Web of Science databases with keywords, and their equivalents, to MOOC, measurement, effectiveness, and quality. The articles were analyzed according to: (1) context of the publication, (2) type of developing institution and distributing platform of the MOOC, and (3) characteristics of the empirical studies.

Within the context of the publication, it was found that the majority of the articles are published in Europe, followed by North America and in a minimum proportion in South America. It was also observed that the country of filiation of the first author is concentrated in Europe followed by North America and Asia. Related to the developing institutions of the MOOC, it was identified that 54% of the developing institutions were universities, 8% government institutions and 4% independent associations and about the platforms that distributed the MOOC, it can be noted that 31% are of Coursera, 14% of Edx, 7% of Canvas Network and the 7% of Udacity.

Many interesting trends were found concerning the characteristics of the empirical studies. Within the type of studies, it can be observed that the most utilized, by frequency order, to measure the quality are quantitative instrumental, quantitative descriptive, and qualitative case study. On the other hand, the most frequent types of study to measure effectiveness are quantitative quasi-experimental, pre-post-tests and qualitative case study. Lastly, the type of study most used in order to measure quality and effectiveness as a set was the qualitative case study. This distribution of publications is interesting for the researchers because it allows having a general view of the most frequently utilized methodologies used.

Regarding the use of indicators in the studies that assess effectiveness, it can be observed that 55% of the articles used efficiency indicators, and that the other four indicators (Teaching methodology; Retention, Commitment or Dropout; Perceptions of motivation/satisfaction; and Course culmination) have the same

percentage of use: 36% respectively. When analyzing the fifteen studies about quality, eleven approaches to evaluate quality were at first identified. The three most used approaches in the period were from Baldomero Ramírez-Fernandez et al. (2015, 2015a, 2015b), from Arias (2007), and the Aleman De la Garza et al. (2015) approach. Also, interesting trends were observed as to the frequency in the use of criteria in these eleven approaches. It was noted that pedagogical criteria are considered in all approaches (100%) while 55% of the approaches consider functional criteria of the platform and 45 % of the criteria of platforms or technological systems, while the remainder of the groups of criteria have percentages lower than 45% in the following order: Time criteria (36%), Intrinsic criteria of the student (27%), Interaction with the teacher criteria (27%) and Effect criteria (18%).

Considering the principal question of this study, which refers to how quality and effectiveness are measured in the MOOCs, it is concluded that effectiveness is measured mainly by indicators at the beginning and the end of the MOOC, which are mostly oriented towards the performance of the student in the classroom. In the case of quality, it is observed that courses are principally assessed in respect to fulfilling certain criteria, which can encompass different aspects, particularly pedagogical and functional criteria of the platform, which are present in all the cases. It is not observed in the literature a close link between quality and effectiveness. This is important in order to understand the quality standards that contribute to courses becoming more effective. On the other hand, on behalf of quality, student evaluations are not observed, the judgments are mainly made by the experts.

Authors' Note: The study has been recorded in the framework of Project 266632 "Binational Laboratory for the Intelligent Management of Energy Sustainability and Technological Training", with financing from the CONACYT-SENER Energy Sustainability Fund (call: S0019¬2014¬01).

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