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Self-Regulated Learning in Massive Online Open Courses: A State-of-the-Art Review

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ABSTRACT Self-regulated learning (SRL) is a cyclical process through which individuals plan their objectives, execute them and self-evaluate their own behavior so as to obtain their proposed goals. SRL has been investigated by different authors such as Zimmerman, Boekaerts, Winne and Hadwin, Pintrich, Efklides and Hadwin, Järvelä and Miller and it's being applied in learning environments. This systematic review describes the current state of the art in terms of the support for SRL in Massive Online Open courses (MOOC) using technologies based on psychological models. 66 studies conducted between 2010 and 2020 were analyzed by searching three multidisciplinary databases: Scopus, Web of Science and Google Scholar. The review methodology steps were the review planning, the search, literature analysis and the results report. Results show SRL in MOOCs is an emerging study area incentivized by the high dropout rate of the participants in MOOC. Regarding models of SRL, the most representative author reported was identified as Zimmerman. The most prominent self-regulation strategies used by MOOCs participants are: Goal setting, Help Seeking, Time management, Self-evaluation and Strategic planning. The platforms with research on SRL in MOOCs that stand out are Coursera, Edx, Open Edx and Moodle. We identified tools which have been developed to support SRL in MOOC and a set of good practices useful to support SLR that can be used by MOOC designers and tutors. Finally, a series of open problems and challenges that could lead to new research on the topic of SRL in MOOCs have been identified.

INDEX TERMS Educational technology, MOOC, self-regulated learning, SRL strategies, systematic review.

I. INTRODUCTION

The word MOOC was coined by Dave Cormier in 2008 [1] and represents the acronym of Massive Open Online Courses. As the name implies, MOOCs are open, participatory, distributed courses with a publicly shared curriculum and that support learning in networks under the connectivism approach [2], [3].

Among the difficulties that arise in the context of carrying out these courses, it is possible to highlight the great dropout rate that occurs when they are supposed to be executed, due to different causes such as: the poor quality of the courses, poor time management on the part of the participants, the lack of basic digital knowledge and skills, unsatisfactory learning experiences with the courses, lack of interaction with the instructor, lack of motivation, little attention to the diverse needs of the participants in the design of the courses, or the lack of strategies on the part of the participants of these courses in self-regulating their learning process [4].

As a result of the aforementioned, various lines of research in the field of MOOCs have been created as an object of study, among which the following stand out: specification of the MOOCs creation processes [5]–[7], gamification as a didactic strategy in MOOCs [8], conversational agents in MOOCs [9]–[11], the evaluation of the quality of MOOCs [12], the analysis of various types of interaction of the participants [13]–[15], accessibility in the contents

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of the MOOCs [16], as well as support for self-regulated learning [17]–[19].

The main focus of the literature review reported in this document is the work that has been developed in supporting self-regulated learning as a process that must be endorsed in the context of MOOCs, so that participants can conclude satisfactorily their learning progress in these massive online courses [20], [21].

Self-regulated learning is defined by Zimmerman [22] as the ''process formed by self-generated thoughts, emotions and actions that are cyclically planned and adapted to achieve personal goals'' (p. 14). When a student cannot self-regulate their learning, it is very likely that they will abandon the activity they are developing due to different factors or situations that they may be faced with, such as not having an adequate work environment or not having created or planned the objectives, in addition to the poor distribution of time and the lack of monitoring and self-evaluation of the activities carried out.

Such is the level of importance of self-regulation in the learning process of a human being, that in time, several models have been created from psychology and psycho-pedagogy that explain, from different perspectives, how the process of self-regulation is conceived. Among these models we can highlight the ones proposed by Zimmerman [23], Boekaerts [24], Winne and Hadwin [25], Pintrich [26], Efklides and Hadwin [27], Järvelä and Miller [28] and which have been characterized and systematized by Panadero [29].

Information and communication technologies are being used to support learning self-regulation through software tools such as NoteMyProgress [30], Learning Tracker [31], Mylearningmentor [32], which help the student to focus on the task and its objectives and provide scenarios for achieving them. In general, the available developments focus on supporting students in activities such as creating and planning objectives, specifying the temporary planning of activities, carrying out follow-ups and supporting the entire process in order to complete the task.

The objective of this systematic literature review is to describe the current state of the support offered in the Massive Open Online Courses so that participants can self-regulate their learning in these contexts, as well as advance knowledge on how to support self-regulated learning in the context of massive online courses identifying open questions and challenges in this line of research.

In this study, 66 studies reporting on self-regulated learning in MOOCs from 2010 to 2020 were analyzed. The search sources for the studies included in the review are the following databases: Web of Science, Scopus and Google Scholar, deeply recognized as the most relevant source of research studies by the academic community. Different keywords were used in searches in the three databases, the results were then crossed to discard repeated documents, therefore obtaining those that met the inclusion criteria defined for the review. Then, the method that will be described in later sections was applied.

This document is organized as follows. The first section presents the works related to this study, those that include self-regulated learning in MOOCs. The second section details the systematic literature review method. The third section details the analysis of the literature found. The fourth section describes the results and finally the fifth section presents the conclusions, challenges and future work.

II. RELATED WORKS

This section presents an analysis of the recently reported literature studies that address self-regulated learning in Massive Open and Online Courses from three relevant lines of research in the area of self-regulated learning research in MOOC such as: the software tools that support SRL, self-reports or surveys and data analysis. Additionally, the different literature reviews developed in the area of self-regulated learning in MOOC and the differences with the review of the present study are addressed.

A. RESEARCH LINES ASSOCIATED WITH SRL TOOLS IN MOOC

In the line of research associated with tools to support self-regulation in MOOC contexts Alonso-Mencía *et al.* [33] comment that research on SRL in MOOCs is still scarce, especially in support of interventions. In this sense, in their study they present MOOCnager, a Chrome plug-in to help students improve their SRL skills. Specifically, this work focuses on 3 areas: goal setting, time management and self-assessment. Each area is included in one of the 3 phases that make up the Zimmerman SRL cyclical model. The results were not conclusive, since the use of the plug-in by the participants was very low. However, students seem to prefer a tool built into the MOOC platform.

Robal *et al.* [34] meanwhile, argue that many of the MOOCs currently available focus on video conferencing. In this sense, they designed a privacy system called IntelliEye, which makes use of the students' web cameras to determine, in real time, the moments the students are not paying attention during these video-conferences, notifying them of the situation. IntelliEye makes students aware of their moments of inattention, through visual and auditory cues. The authors implemented IntelliEye in a MOOC, over a period of 74 days, and explored to what extent MOOC students accepted the intervention as part of their learning and to what extent the use of this tool influenced student behavior. They found that the majority of students (67%) are reluctant to allow the use of webcam-based tracking techniques because they pose privacy concerns.

Continuing with the line of research regarding tools that support SRL, Pérez Álvarez *et al.* [21] analyzed existing software tools to support self-regulation in MOOCs. According to them, it is concluded that there are very few and that they do not provide enough SRL features for students to self-regulate. Based on their findings, the aforementioned authors developed an application called NoteMyProgress, which was evaluated by 4 experts from different countries and

18 students. The results obtained indicated that the experts positively evaluated the application as a tool to support SRL. Meanwhile, students considered that the included features were useful in managing their time and organizing their learning process. However, the tool was tested by very few users due to the short study duration of only two weeks. On the other hand, another limitation of the study was that the only instrument used was a concept evaluation test, which fails to fully measure the self-regulation process achieved by students with respect to their learning.

On the other hand, Onah *et al.* [35] carried out a study that reveals the effectiveness of virtual and traditional teaching for an undergraduate course. eLDa was used, which is a platform for the delivery of computer concepts used in the Python MOOC course. In the research, an online self-regulated learning questionnaire (OSLQ) was applied to 107 people as an instrument to measure students' self-regulated learning skills. The results of this study reveal the effectiveness of mixed teaching in the classroom for an undergraduate course and recommend consistently providing combined online and traditional exercises to increase student academic achievement.

Finally, based on the fact that weakness in self-regulation skills is one of the key factors that contributes to dropping out of a MOOC course, Sambe *et al.* [36] created a conceptual framework generic enough to be seen as a tool to promote self-regulated learning in a MOOC. This framework is intended to serve as the basis for working with a virtual partner to provide metacognitive cues and a display of indicators all focused on collaborating in self-regulated learning. They leave as a future work the creation and implementation of a virtual partner in a MOOC, based on the self-regulation literature and evaluate the impact of the companion on the learning skills of self-regulation in MOOCs.

B. LINES OF RESEARCH ASSOCIATED WITH SELF-REPORTS (SURVEYS OR QUESTIONNAIRES)

In the line of research on self-reports, Zalli *et al.* [37] found that there is no self-regulated online learning (SRL) measurement model compared to traditional face-to-face context. Data collection was performed by applying the online self-regulation questionnaire (OSLQ) and using a sample of 384 students in three MOOCs operated under the open-learning.com platform. The results demonstrated that the measurement model and proposed data fit well after performing the model modification procedures. Therefore, the model is suitable for measuring SRL online in the MOOC learning environment.

In research by Sands *et al.* [38] explored the differences in self-regulated learning between high school students enrolled in the traditional Computer Science course and students in a MOOC. The sample in which it was used was 72 participants, with 31 participants learning traditionally and 41 from the MOOC course applying the motivated learning strategies questionnaire (MSLQ). The results showed that help seeking was more frequent in traditional learning and was also the only SRL strategy that was significantly related to MOOC students' scores on programming tasks.

Meanwhile, Kseniia A. Vilkova [39] conducted research using an online survey as a method of data collection, the purpose of which was to examine whether SRL skills such as foresight, performance, and self-reflection affect students' educational outcomes. A total of 2,815 students participated in the study and completed the survey, which consisted of demographic questions and self-assessment, in addition to the regulated learning questionnaire. According to the research results, SRL sub-processes such as goal setting, self-efficacy, and task value are most useful for MOOC completion.

Along this same line of research regarding SRL self-reports in the context of MOOCs, Martínez López *et al.* [40] reported the results of the application of the Online Self-Regulated Learning Questionnaire (OLSQ), translated by experts into the Russian language, with 45 students who participated in a MOOC offered by the Samara National Research University. The results showed that the self-regulated learning skills of Russian Engineering students in MOOCs are moderate, with high levels in terms of ''Structuring the environment'' and ''Setting goals'', but low in ''Search for help''. Self-regulated learning variables did not indicate differences in results with respect to gender.

Meanwhile, Alario-Hoyos *et al.* [41] analyze in their study the motivation and learning strategies of students in MOOCs. Six thousand three hundred and thirty-five students from 160 countries responded to a self-report based on the Motivated Learning Strategies Questionnaire (MSLQ) (7-point Likert-type questionnaire), which was included in the MOOC activities entitled Introduction to Programming with Java created on the Edx platform. The results indicated that the students were highly motivated and confident that they would do well in the course. However, the authors indicated that there was a need to provide support for some self-regulating learning strategies, especially with regard to time management.

In this same line of the self-reports, in 2016, Littlejohn *et al.* [42] conducted a study to investigate self-regulated learning with the participation of 788 members of a MOOC. The objective of the study focused on analyzing how the participants' motivations can influence their behavior and the use of self-regulation strategies. For this, a survey called Self-Regulated Learning in MOOCs Questionnaire SRLMQ (Milligan & Littlejohn, 2014a) was used as an instrument. The study's conclusions indicate that the motivations and objectives of the students shaped the way they conceptualized the purpose of the MOOC, which in turn affected their perception of the learning process.

Another investigation regarding self-report systems or questionnaires was the one applied by Phithak *et al.* [43] from a MOOC where they examined self-regulated learning behaviors in the pre-learning, learning and post-learning phases. The results showed that MOOC participants took online courses to improve their job performance.

C. RESEARCH LINES ASSOCIATED WITH DATA ANALYSIS

In the line of research associated with data analysis in the context of MOOCs, in relation to self-regulated learning, Cerezo *et al.* 2019 [44] investigated in their studies, using the process mining technique, how students self-regulate their learning by identifying the SRL skills of students during the development of the MOOC. For the analysis of the information they reported the use of the Inductive Miner algorithm on the interaction traces of 101 university students. The team concluded that, although the students who passed did not exactly follow the instructors' suggestions, they did follow the logic of a successful self-regulated learning process. In the future, they suggest that it would be very interesting to include other variables in the study such as the timestamp variable or access time record, and they also say that other mining techniques that take into account the time dimension could be used as well.

Continuing along the lines of data analysis, Won *et al.* 2019 [45] conducted a study on how MOOC students make use of SRL support, by exploring sequences of student activities. In the MOOC, videos explaining and inviting self-regulation were made available to the participants. In total, 103 active learners (that is, learners who completed at least one activity) participated in this research. For the analysis of the information, sequential pattern mining algorithms were used. The results report that the students who followed the directions of SRL also followed the structure of the course better than those who did not, and that the students who saw more messages about SRL interacted with more elements of the course.

In this same area of data analysis, the team of Maldonado *et al.* [46] investigated about predicting the success of learners in a MOOC through the identification of self-regulated learning sequence patterns; For this they used a sample of 2,035 students who performed a MOOC in Coursera's platform. Among the contributions found, the following are highlighted: the identification of self-regulated and self-reported learning strategies by students, as well as the identification of patterns of sequence of activities in MOOCs. They identified two groups of students: first, the comprehensive ones, who follow the path of the course designed by the teacher, and secondly, those who were looking for the information required to pass evaluations.

Finally, in this line of data analysis, Kizilcec *et al.* [47] indicate, as a result of their research, that it is not just about training students to use a support system for self-regulated learning, nor about being actively supported with suggestions and activities. Instead, for there to be an effective implementation of support systems in MOOCs, it is necessary to understand which SRL strategies are most effective and how these strategies are manifested in the online behavior of the participants. The research, which had a sample of 4,831 students enrolled in 6 MOOCs, aimed to identify the student's weakest SRL strategies. This was based on the analysis of individual records of general achievements in a course, interactions with course content, and responses to surveys. The results obtained, considering the number of people and their diversity, demonstrated multiple individual differences in self-regulation strategies, and may inform the usefulness of specific interventions, such as the adaptive problem-solving strategy.

D. LITERATURE REVIEWS CONCERNING SRL IN MOOCS

To date, different literature reviews have been developed in the field of self-regulated learning in MOOCs for various purposes. The review carried out by Alonso *et al.* [48] states that research in MOOCs and its relationship with self-regulated learning is still scarce and there is a tendency not to specify which SRL model is used; This review was carried out from 2008 to 2017 and one of the inclusion criteria is actual experience with at least one MOOC. For their part, Lee *et al.* [17] carried out a literature review from 2008 to 2016 in which they identified SRL strategies as motivational regulation strategies, specifically self-efficacy, task value, and goal setting, and they also concluded that the understanding of self-regulation in MOOCs is still limited. Meanwhile, in the review by Perez-Alvarez *et al.* [18], [49] between 2008 and 2018, they analyzed tools to support self-regulation in MOOCs, concluding that most of the tools that support the SRL in MOOCs do not evaluate the effect and impact of student strategies. Finally, the review reported by Wong *et al.* [50] from studies conducted between 2006 and 2016 on SRL meant to effectively support students' self-regulated learning online. It concluded that each student benefits differently from the support offered by the tools, for example: messages, comments, and integrated support system.

Although progress has been made in analyzing the state of the art of self-regulated learning in MOOCs, and considering existing reviews that also identify trends and challenges in this area of research, there are still several issues that deserve to be studied. In particular, this review will introduce the analysis of categories not considered in other reviews such as: the self-regulation models most used in studies reported in the literature, the methodological solutions supported in ICT that help the self-regulation of students in the context of MOOC, the different data analysis software focused on establishing relationships between interactions of the participants in the MOOCs and the self-regulation strategies used by them. On the other hand, with respect to other reviews, this review reports a greater number of self-regulation strategies analyzed in the selected studies, more self-regulation support tools have been identified in MOOC, as well as more instruments for the identification of self-regulation strategies used by the participants. Likewise, and opposed to other reviews, this review included analysis categories that describe the community that works in this line of research, describing authors, conferences and journals which published the works considered in the review, as well as the number of articles reported in each conference and journal.

The research question that guides this study is: What is the current status of the support offered in the Massive Open Online Courses so that participants can self-regulate their learning in these contexts?

Next, the method followed to carry out the review will be described.

III. METHOD

To carry out the literature review object of this study, we considered the guidelines and steps proposed by Mathias *et al.* [51], as well as those of Kitchenham [52].

Specifically, the steps followed for the development of the literature review were as follows:

A. Planning the review

1. Defining the question and sub-questions that will guide the review.

2. Defining preliminary categories of analysis.

B. Search

3. Defining the sources of literature search.

4. Defining the inclusion criteria of the literature.

5. Defining the exclusion criteria of the literature.

6. Keywords definition to search

7. Searching and final literature selection.

C. Literature analysis

8. Reading selected literature.

D. Report of results

In the following sections, each of the steps followed for the review is described in detail.

A. PLANNING THE REVIEW

1) DEFINING THE QUESTION AND SUB-QUESTIONS THAT WILL GUIDE THE REVIEW

The main research question addressed by this literature review is:

What is the current status of the support offered in the Massive Open Online Courses so that participants can self-regulate their learning in these contexts?

According to this main research question, a series of research questions were defined:

RQ.1) How is the academic community that investigates self-regulation in the context of MOOCs shaped and what are their research interests?

RQ.2) According to the reported literature what is understood by self-regulation?

RQ.3) What are the strategies that students use to self-regulated learning their learning in the context of MOOC?

RQ.4) What methodologies supported by ICT have been designed so as to support student self-regulation in the context of MOOC?

RQ.5) What are the software technologies that support SRL in the context of MOOCs and on which platform are they used?

RQ.6) How could the reported research on the use of SRL support in MOOCs be described?

RQ.7) What instruments are used in the collection of information on self-regulated learning shown by participants in MOOCs?

RQ.8) How can self-regulation learning and its strategies collaborate in the different aspects of the design, teaching and learning of a MOOC?

Once the research questions were defined, preliminary analysis categories were established for each sub-question, which could be reviewed during the execution of the review.

2) DEFINING PRELIMINARY CATEGORIES OF ANALYSIS

The defined categories are shown below.

RQ.1) How is the academic community that investigates self-regulation in MOOCs shaped and what are its interests?

- Journals and conferences interested in the topic of self-regulated learning in MOOCs according to the review carried out
- Most outstanding researchers in self-regulated learning in the context of MOOCs.

RQ.2) According to the reported literature what is understood by self-regulation?

To answer this question, the following were identified:

- The different definitions of SRL according to the most representative authors

RQ.3) What are the strategies that students use to self-regulated learning their learning in the context of MOOC?

- Self-regulated learning strategies that are extracted from the different articles analyzed.

RQ.4) What methodologies supported by ICT have been designed to aid student self-regulation in the context of MOOC?

- Methodologies or methodological supports and their impact on SRL in MOOCs

RQ.5) What are the software technologies that have been created to support SRL in the context of MOOCs and on which platform have they been developed?

- Tools that contribute to the self-regulation of participant learning in a MOOC.
- Data analysis software used to perform massive data analytics.
- Platforms that stand out in hosting MOOC courses.

RQ.6) How would you describe the reported research on the use of SRL support in MOOCs?

- MOOC research areas
- Type of population linked to the study
- Number of participants
- Research approach
- Data collection method

RQ.7) What instruments are used in collecting information on self-regulated learning shown by participants in MOOCs?

- Data collection instruments with which the respective self-reports are carried out.

RQ.8) How can self-regulation learning and its strategies support the different aspects of the design, teaching and learning of a MOOC?

- The different actions that support MOOCs in aspects such as design, teaching and learning.

B. SEARCH

1) DEFINING THE SOURCES OF LITERATURE SEARCH

As research sources, three (3) databases were selected for their multidisciplinary aspect and academic recognition: Scopus, Google Scholar and Web of Science. Scopus is ''the largest database of citations and summaries of peer-reviewed literature and high-quality sources on the web'' [53]; it covers scientific literature that is peer-reviewed. On the other hand, Web of Science is recognized as one of the important sources of scientific consultation [54]. Finally, Google Scholar is also multidisciplinary, offering access to more than 220,000 documents regarding MOOCs.

2) DEFINING THE INCLUSION CRITERIA OF THE LITERATURE

General criteria:

- Studies published between January 2010 and May 2020.
- Studies describing applications, models or conceptual frameworks used to support self-regulated learning in Massive Open Online Courses.

Specific criteria in relation to the research questions:

- Studies that report methodological solutions supported by ICT to aid student self-regulated learning in the context of MOOC, in addition to the definitions referring to what is understood as self-regulated learning.
- Studies that report methodological solutions supported by ICTs to help the self-regulation of student learning in the context of MOOC, in addition to the definitions regarding what is understood as self-regulation of learning.
- Studies that describe the self-regulation learning strategies used by students to achieve the objectives proposed in the context of MOOC.
- Studies that inform the research designs that have been considered to evaluate the mechanisms of support for self-regulation in MOOCs.
- Studies that report software technologies to support self-regulation in the context of MOOCs, as well as the platforms used.
- Studies that report on instruments used in the collection of information on SRL in MOOCs.
- Studies written in English and Spanish.

3) DEFINING THE EXCLUSION CRITERIA OF THE LITERATURE

The following exclusion criteria were defined and, therefore, studies with these problems were discarded:

- Studies or publications that don't mention the term ''MOOC'' or ''Massive Open Online Course''.
- Studies that claim to be about MOOCs, but are about other types of online courses.
- MOOC studies that are not geared towards self-regulated learning, or that mention the term only anecdotally.
- Studies not identified as articles, book chapters or conference articles, in the context of self-regulated learning in MOOCs.
- Studies written in languages other than English or Spanish.

4) KEYWORDS DEFINITION TO SEARCH

A preliminary document was carried out analyzing the keywords reported by the authors and verifying that many studies between 2010 and 2020 in the area of self-regulation in MOOC have been published using generally the following keywords: MOOC (Massive Open Online Course), CEMA (Curso en Línea Masivo y Abierto - Massive and Open Online Course), CAEM (Curso Abierto En línea Masivo - Massive Open Online Course), COMA (Curso Online Masivo y Abierto - Massive and Open Online Course), CALGE (Curso Abierto en Línea a Gran Escala - Large Scale Open Online Course), SRL, Self-regulated learning, Autorregulación del aprendizaje (Self-regulated learning). The correspondence of the terms was verified using the UNESCO Thesaurus. After verification, the following keywords were established that would be used as query criteria: (MOOC AND SRL), (MOOCS AND SRL), (MOOC AND Self-regulated learning), (Massive open online course + SRL), (Massive open online course + self-regulated learning); all with an additional term PUBYEAR> 2009.

5) SEARCHING AND FINAL LITERATURE SELECTION

Initially, a search was performed for the keywords defined. The entire document was searched, obtaining the following results: 616 hits in Scopus, 24 hits on the Web of Science and 2,680 hits on Google Scholar. After the search, a first review of the title, the abstract and the keywords defined by the authors was carried out, evidencing within the documents a large number of false positives that only stated the terms, but did not refer to studies of interest to the review. The review carried out permitted to discard the false positives found. In this way, 57 hits were obtained in Scopus, 19 hits in Web of Science and 19 hits in Google Scholar. Accordingly, a potential of 95 studies were identified.

The 95 identified studies were further evaluated by reading the document of each study in full, and applying the inclusion and exclusion criteria again. At the end of the evaluation, a total of 66 studies were selected to be included in the literature review.

TABLE 1. List of reported studies of self-regulated learning in MOOCS.

Type	Quantity
Journal articles	39
Conference articles *B*	27
Total studies	66

Table 1 shows the number of scientific journals and conference articles identified.

TABLE 2. List of journals and number of studies found.

Journal	Publication year	Studies
Computers and Education	2015, 2017, 2019	8
International Review of Research in Open and Distance Learning	2014, 2017, 2019	3
Education and Information Technologies	2017, 2019, 2020	3
Internet and Higher Education	2016	2
Computers in Human Behavior	2017	2
Journal of Computing in Higher Education	2017, 2019	2
IEEE Transactions on Learning Technologies	2020	1
International Journal of Educational Technology in Higher Education	2019	1
Transactions on Internet and Information Systems	2019	1
Online Learning Journal	2019	1
Turkish Online Journal of Distance Education	2019	1
Research Publishing	2019	1
Journal of Interactive Media in Education	2019	1
Research and Practice in Technology Enhanced Learning	2020	1
International Journal of Emerging Technologies in Learning (iJET)	2020	1
eLearning Papers	2015	1
International Journal of Distance Education Technologies	2015	1
Educational Technology International	2016	1
American Journal of Distance Education	2016	1
International Journal of Human–Computer Interaction	2018	1
Journal of Universal Computer Science	2018	1
Australasian Journal of Educational Technology	2018	1
European Journal of Dental Education	2019	1
Educational Review	2019	1
International Journal of Innovative Technology and Exploring Engineering	2019	1

C. LITERATURE ANALYSIS

1) READING SELECTED LITERATURE

Once defined the specific papers to be included in the review, each study was deeply analyzed by reading the document study in full two time at least by two different readers, who as well, acted as coders. As mentioned by Hsu et al, [55] content analysis allows to find the research trends of a topic by analyzing the articles' content and grouping them according to the shared characteristics. Two authors carried out separately a content analysis to classify the studies according to the categories and sub-categories coding manually the studies according to their characteristics and the previous analysis. In case of discrepancy, the coders resolved it through discussion.

D. REPORT OF RESULTS

Results report are detailed presented in next section.

IV. RESULTS

This section describes the findings organized according to each research question, showing the results obtained from the coding performed, considering the categories established in the planning section of the review with respect to each research sub-question (RQ).

RQ.1) HOW IS THE ACADEMIC COMMUNITY THAT INVESTIGATES SELF-REGULATION IN MOOCS SHAPED AND WHAT ARE ITS INTERESTS?

- JOURNALS AND CONFERENCES INTERESTED IN THE TOPIC OF SELF-REGULATED LEARNING IN MOOCS ACCORDING TO THE REVIEW CARRIED OUT

Table 2 shows the classification of the 39 articles found according to the journals where they were published, with their corresponding year of publication. Computer and

TABLE 3. Conference classification.

Conference	Publication year	Studies
EC-TEL - European Conference on Technology Enhanced Learning	2016, 2017, 2018	6
ACM - International Conference Proceeding Series	2019, 2020	3
EMOOCs - European MOOCs Stakeholders Summit	2014, 2019	3
L@S - Learning at Scale	2014, 2016	2
CLEI - Latin American Computing Conference	2016	2
ACM Hypertext - Conference on Hypertext and Social Media	2018	1
ACM Technical - ACM Technical Symposium on Computer Science Education	2020	1
CEUR Workshop Proceedings	2017	1
COL - Commonwealth of Learning	2019	1
CSEDU - International Conference on Computer Supported Education	2020	1
ICL - International Conference on Interactive Collaborative Learning	2017	1
IMCL - International Conference on Interactive Mobile Communication, Technologies and Learning	2019	1
ICIET - International Conference on Information and Education Technology	2019	1
Intersol - Innovation and Interdisciplinary Solutions for Underserved Areas	2018	1
IST-Africa 2019 Conference Proceedings	2019	1
Koli Calling	2015	1

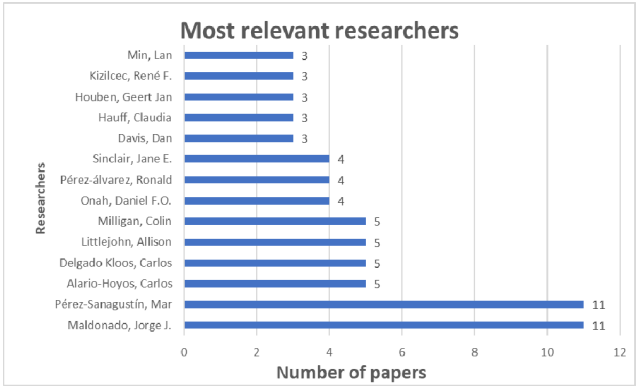

FIGURE 1. Most relevant researchers.

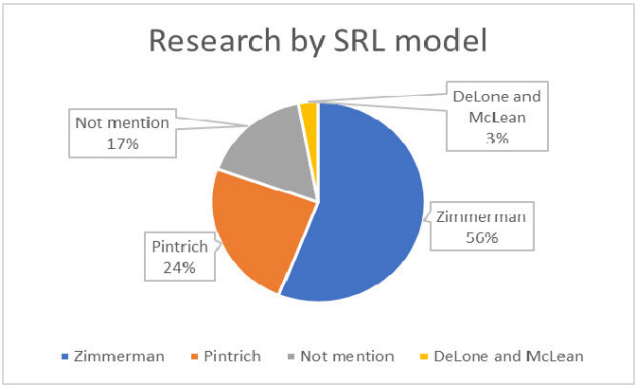

FIGURE 2. Research by SRL model.

Education is the journal with the highest number of articles on the subject with 8 studies.

Table 3 presents a classification of the conferences in which the 19 identified articles have been published for review.

- MOST OUTSTANDING RESEARCHERS OF SELF-REGULATED LEARNING IN THE CONTEXT OF MOOCS.

The researchers who have published most papers on the subject of MOOCs with self-regulated learning are: Jorge Maldonado with 11 papers, followed by Mar Pérez Sanagustín with 11 paper and researchers Alario-Hoyos, Delgado-Kloos, Littlejohn and Milligan with 5 papers each. Meanwhile, Onah, Pérez Álvarez, Sinclair have 4 publications on this topic and lastly, Davis, Hauff, Houben, Kizilcec and Min with 3 publications each.

According to the review carried out, it is evident that the most representative authors who have supported the research on self-regulated learning in MOOC from a psychological perspective are Zimmerman and Pintrich. 56,1% of the analyzed studies base their constructions on the Zimmerman self-regulation model, 24,2% of the investigations conceptually adopt the Pintrich model, 3% of investigations the DeLone and McLean model and 16,7% of the studies do not mention the model used. The summary of these data can be seen in Figure 2.

RQ2: ACCORDING TO THE REPORTED LITERATURE, WHAT IS UNDERSTOOD BY SELF-REGULATION?

- THE DIFFERENT DEFINITIONS OF SRL ACCORDING TO THE MOST REPRESENTATIVE AUTHORS

Continuing with the analysis, the different definitions of self-regulated learning were extracted from the two most cited authors in the selected studies, as mentioned before, Zimmerman and Pintrich, by also taking into account the

TABLE 4. Zimmerman's definitions of self-regulated learning.

Autor / Paper	Date	Definition
[60] [61] (p. 2)	1989	SRL is defined as the student's proactive commitment to the learning process through various personal management strategies to control and monitor cognitive and behavioral processes towards a learning result.
[62] [33] (pag.2) [47] (p. 3) [63] (p. 2) [64] (p. 4)	2000	SRL is defined as a process formed by self-generated thoughts, emotions and actions that are planned and adapted cyclically to achieve personal goals.
[65] [41]. (p. 4)	2002	SRL is defined as the student's ability to control and regulate their own learning through the use of cognitive and metacognitive strategies
[66] [19] (p. 2)	2008	SRL refers to the process by which students personally activate and sustain cognitions, as well as the effects and behaviors that are systematically oriented towards the achievement of learning objectives.

TABLE 5. Pintrich definitions.

Author / paper	Date	Definition
[26] [67] [47] (p. 2) [17] (p. 2)	1999 and 2000	SRL is defined as "an active and constructive process whereby students set goals for their learning and then attempt to monitor, regulate, and control their cognition, intentions, and behavior, guided and limited by their goals and contextual characteristics of their environment.

year the definition has been generated. Table 4 and 5 show the identified definitions, indicating author, date and definition.

RQ.3) WHAT ARE THE STRATEGIES THAT STUDENTS USE TO SELF-REGULATED LEARNING THEIR LEARNING IN THE CONTEXT OF MOOC?

- SELF-REGULATED LEARNING STRATEGIES THAT ARE EXTRACTED FROM THE DIFFERENT ARTICLES ANALYZED.

As can be seen in Figure 3., among the self-regulation learning strategies most used by students in MOOCs are: goal setting (15.3%), help seeking (13%), self-evaluation (10.3%), time management (10%), task strategies (8.6%) and strategic planning (8.6%), self-efficacy (6.3 %), environment structuring (6.0%), elaboration (3.3%), organization (3.0%) and self-satisfaction (3.0%), task interest (2.7%) and self-monitoring (2.7%), effort regulation (2%), interest enhancement (1.7%) and critical thinking (1.7%) Finally, self-instruction and self-motivation (a percentage of 1.0% each).

Offering a greater understanding of what each of the self-regulation strategies identified in the studies analyzed consists of, Table 6 describes each of them.

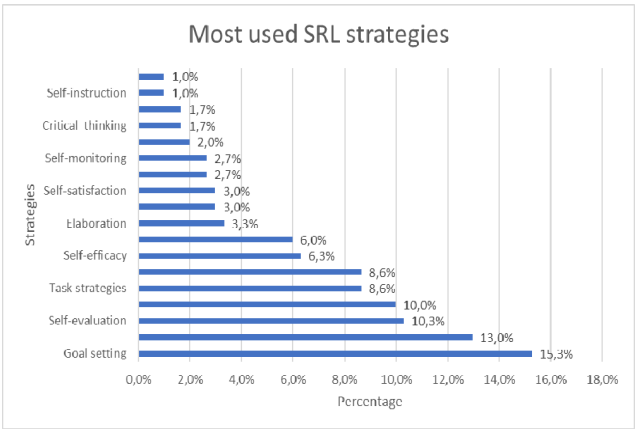

FIGURE 3. SRL strategies most used by students to self-regulate their learning in the context of MOOC.

RQ.4) WHAT METHODOLOGIES SUPPORTED BY ICT HAVE BEEN DESIGNED SO AS TO SUPPORT STUDENT SELF-REGULATION IN THE CONTEXT OF MOOC?

- METHODOLOGIES OR METHODOLOGICAL SUPPORTS AND THEIR IMPACT ON SRL IN MOOCS

In the literature review, no methodologies supported by ICT were found to facilitate the self-regulation of student

learning. Although ICT tools that support self-regulation were found (Figure 4) and these software tools were considered instrumental in the studies, they fail however, to offer a clear methodological process that transcends the use of the application and which should lead the student to a true understanding of what self-regulation of your own learning is and how you can achieve it. Consequently, the impact that these may have on self-regulated student learning in a MOOC was also not found.

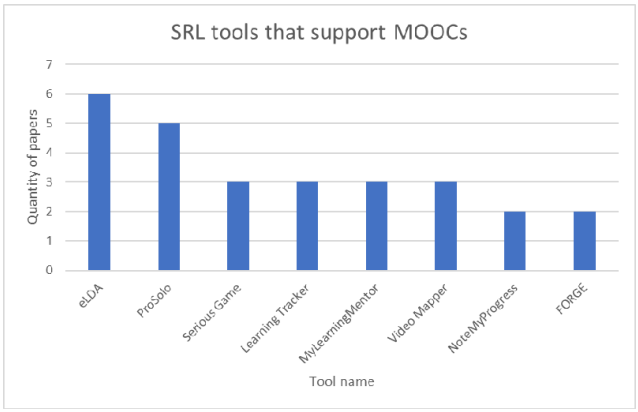

FIGURE 4. SRL tools that support MOOCs.

This shows that research is needed in order to create ICT-based methodologies that support self-regulated student learning in the context of MOOCs.

RQ.5) WHAT ARE THE SOFTWARE TECHNOLOGIES THAT SUPPORT SRL IN THE CONTEXT OF MOOCS AND WHAT PLATFORM ARE THEY USED ON?

- TOOLS THAT CONTRIBUTE TO SELF-REGULATED PARTICIPANT LEARNING IN A MOOC.

According to the systematic review of the literature carried out, the tools that help a student to self-regulate their learning are very few, but the following stand out: eLDa [35], Prosolo [56], Serious game [57], Learning tracker [31], Mylearningmentor [32], Video Mapper [58], NoteMyProgress [21], FORGE [59] as indicated in Figure 4.

In order to describe the relationship between the tools identified in the literature and the most important self-regulation strategies also identified in this study (section RQ3 and RQ5), Figure 5 is introduced.

Convention GS = Goal Setting, HS = Help-seeking, TM = Time Management, SE = Self-evaluation, SP = Strategic Planning, SM = Self-motivation SW = Self-awareness, O = Organization.

As can be seen, the self-regulation strategy supported by the developed software tools are goal setting, self-evaluation, help-seeking, strategic planning and self-motivation. This result confirms the findings of Perez-Alvarez [49], [76].

- DATA ANALYSIS SOFTWARE USED TO PERFORM MASSIVE DATA ANALYTICS

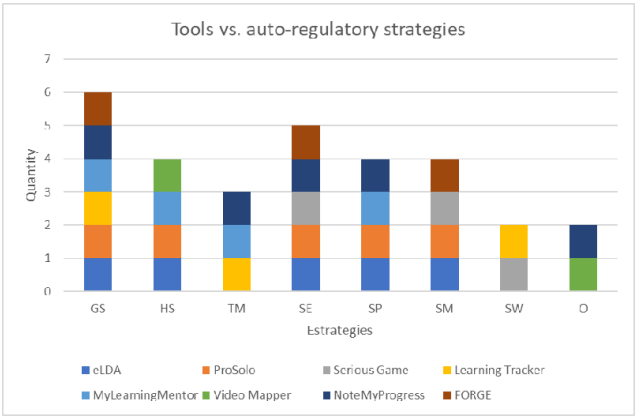

FIGURE 5. Tools vs. auto-regulatory strategies.

In regards to the software used for the most common data analysis in studies on the self-regulated learning in MOOCs, these can be organized into three categories: a) statistical data analysis software that are used for data analysis in the field of MOOCs; In the review, 10 studies were found using SPSS (Statistical Package for the Social Sciences) which is a set of data processing tools for statistical analysis. On the other hand, in category b) process analysis software like Disco Tool used in 7 studies, Celonis was used in 1 study and ProM was used in another one; These tools can graphically represent student behavior within the MOOC and thus identify patterns of interaction. Finally, in category c) click analysis software, a software called Clickstream was used in 4 studies. This allows reviewing the route that a user follows during his/her visit to the different pages visited and during registration, in addition to monitoring the patterns of navigation. Figure 6 shows the Data Analysis Software used in the reviewed studies.

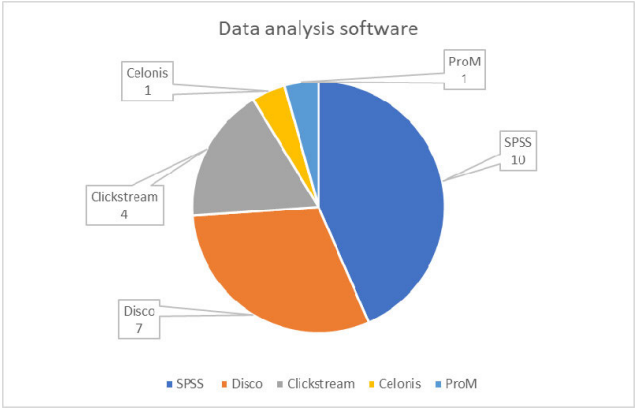

FIGURE 6. Data analysis software.

- PLATFORMS THAT STAND OUT IN HOSTING MOOC COURSES.

The platforms that were most used to carry out research on self-regulated learning in MOOCs were: 1) Coursera (54%), used in the research by Alonso-Mencía *et al.*,

TABLE 6. Description of self-regulated learning strategies.

Strategy	Description	Autor
Goal setting	Goal setting or educational sub-goals to exert the effort required to achieve those goals	[22]
Help seeking	Help seeking: asking for help from other people, such as the instructor or peers, or consulting resources and external help	[68]
Time management	Time management: what is available to carry out an activity.	[69]
Self-evaluation	Self-evaluation: activities are given to monitor the learning process in relation to defined learning objectives	[70]
Strategic planning	Strategic planning: planning the sequence, timing and completion of activities directed at learning objectives	[71]
Self-efficacy	Self-efficacy is defined as the belief that the individual has about his own ability to carry out the task.	[69]
Task strategies	Task strategy: you can organize, plan and transform your own study time (time management) and tasks (that is, time, sequence, rhythm, reorganization of instructional materials)	[72]
Environment structuring	Regarding work environment: where can an environment be created with the least number of distractions and that facilitates the development of the task increasing its effectiveness.	[69]
Task interest	The interest around the task: that is, the preference for and usefulness of the task. Interest can be personal (for what it means to the person) or situational (for the characteristics of the task). It is important for students to know the importance of what they have to do so that their involvement is greater.	[69]
Elaboration	Elaboration: Extend or modify learning materials so as to make them more meaningful and memorable.	[73]
Organization	Organization: It includes strategies such as sketching, taking notes and connecting different aspects of the material studied.	[74]
Self-monitoring	Self-monitoring: Self-control in order to maintain concentration and interest during the task. It requires the use of a series of strategies, which we can classify as metacognitive (to maintain concentration) and motivational (to maintain interest)	[69]
Self-satisfaction	Self-satisfaction: affective and cognitive reactions that students have in regards to the way they judge themselves.	[69]
Critical thinking	Critical thinking: results from the interpretation, analysis, evaluation and explanation of conceptual and methodological actions regarding a judgement.	[75]

[33], [77], [78] 2) Edx (35%) in the works of Davis *et al.*, [39], [79], [80]; 3) Moodle platform (5%) in the research by Sambe [19]. 4) Futurelearn and Open Edx (3%) in studies by Pérez-Álvarez *et al.*, [81] and These findings are summarized in Figure 7.

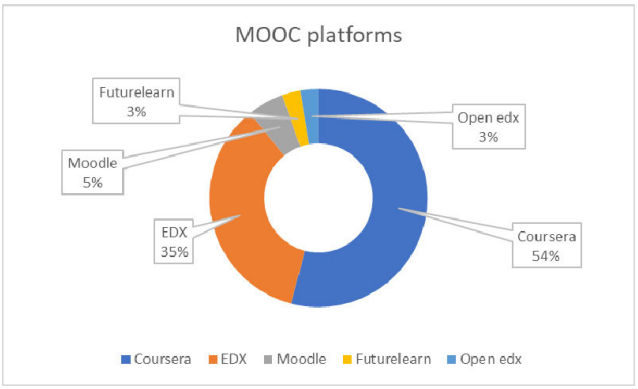

FIGURE 7. MOOC platforms.

RQ.6) HOW COULD THE REPORTED RESEARCH ON THE USE OF SRL SUPPORT IN MOOCS BE DESCRIBED?

- MOOC RESEARCH KNOWLEDGE AREAS

According to the International Standard Classification of education (UNESCO, 2013), the knowledge areas where solutions and research on self-regulated learning in MOOCs are: Education (78.79%), followed by Information and Communication Technologies (12.12%), then we find Humanities and Arts (4.55%), and finally, Health (4.55%). These findings can be seen in Figure 8.

- TYPE OF POPULATION LINKED TO THE STUDIES

It has been shown that people who participated most in a MOOC were those who had completed higher education studies previously [82]. This was verified in the literature review and is shown in Figure 9. The participants in MOOC are: university students (23), followed by professionals (21), individuals with a master's degree (15), individuals with

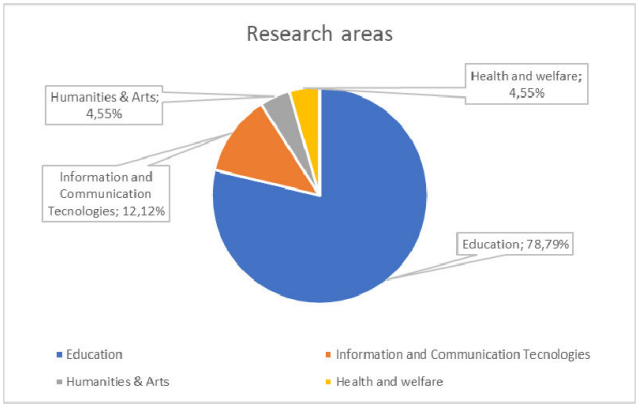

FIGURE 8. Research areas.

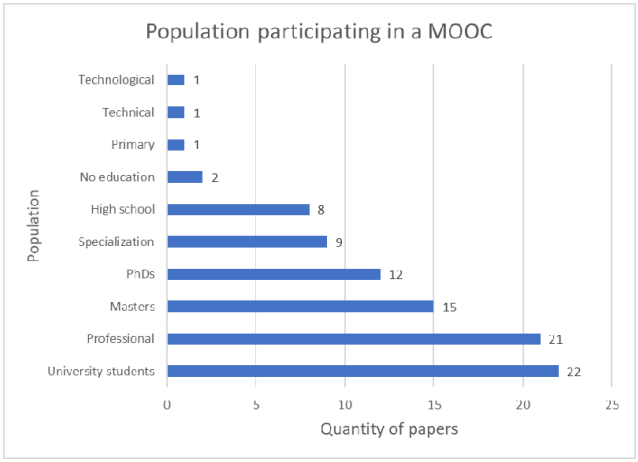

FIGURE 9. Population participating in a MOOC.

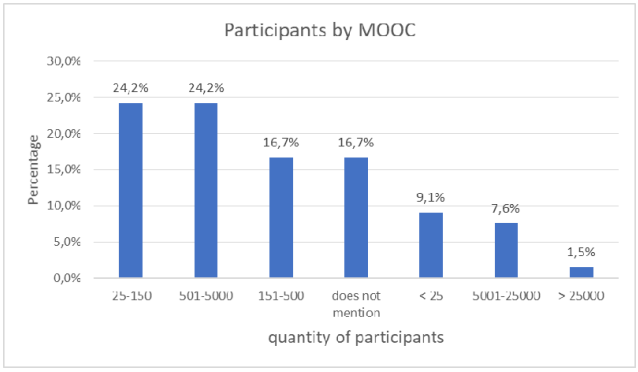

FIGURE 10. Participants by MOOC.

PhD (12), and individuals with a specialization (9), high school students (8), individuals with a not education (2) individuals with a technical, technological and primary degree profile (each with 1).

It can be also observed that there is a lack of research on self-regulated learning in MOOCs in technical, technological primary school education. It is also important to highlight a limited number of studies that include people with no studies due that MOOCs initially were an initiative oriented to increase the educational coverage which should favor inclusion of vulnerable people in education.

- NUMBER OF PARTICIPANTS

Student participation in different research initiatives continues to be an issue because not all students who enroll in a MOOC collaborate with the different self-reports or surveys in the investigations. As can be seen in Figure 10, the most representative sample size of research participants is in the range of 25 to 150 participants (24.2%), followed by the range of 501 and 5000 participants (24.2 %), and thirdly and fourth, the range of 151 to 500 and does not mention (16.7%); In fifth place there are those with samples of place there are those with samples of less than 25 participants (9,1%), and sixth the range of 5001 to 25000 participants (7,6%), and finally, there are the samples with a number of participants greater than 25,000. (1,5%).

- RESEARCH APPROACH

Regarding the research approach described in the analyzed studies, the largest number of studies report quantitative approaches (54%), being evident that this is the most used approach since MOOCs involve a wide variety of people and the most practical way to analyze information is quantitatively. Second, there are mixed approaches (20%), including qualitative data such as interviews in the studies. Finally, there are qualitative research approaches (14%) and systematic literature reviews (12%). These findings can be seen in Figure 11.

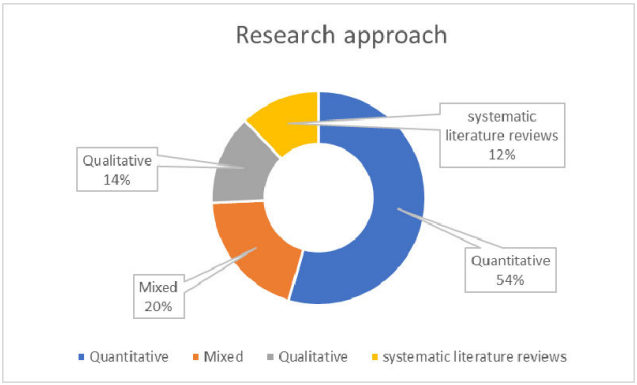

FIGURE 11. Research approach.

- DATA COLLECTION METHOD

According to the systematic review of the literature, the data collection methods used in the line of research on the support of self-regulation in MOOCs are: surveys (52%), in addition, 18% of studies report that they use mining of data that is stored in the text files called log files, on the other hand there are the interviews (16%) and it is also interesting to note that 5% of the studies apply process mining to obtain new data or new knowledge of the data initially collected. Other methods (5%). On the other hand, 5% of the studies do not mention the collection method used. It is also interesting to

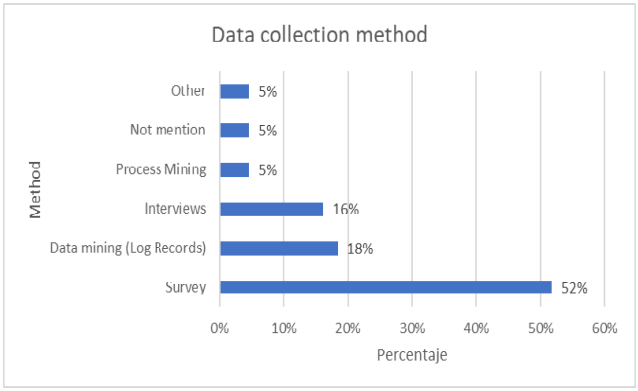

FIGURE 12. Data collection method.

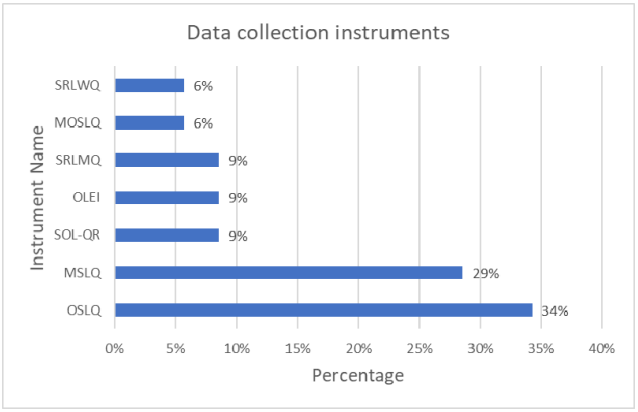

FIGURE 13. Data collection instruments.

highlight the record of user interactions on platforms. These findings can be seen in Figure 12.

RQ.7) WHAT INSTRUMENTS ARE USED IN THE COLLECTION OF INFORMATION ON SELF-REGULATED LEARNING SHOWN BY PARTICIPANTS IN MOOCS?

- DATA COLLECTION INSTRUMENTS WITH WHICH THE RESPECTIVE SELF-REPORTS ARE CARRIED OUT.

Finally, the data collection instruments used in the respective self-reports of the surveys or questionnaires in the analyzed studies are shown below. The following stand out: Online Self-regulated Learning Questionnaire (OSLQ) used in 34% of studies by researchers [37], [40], [83], [84]; then, the Motivated Strategies for Learning Questionnaire (MSLQ) used in 29% of the studies [38], [41], [85], [79]; After that, the Revised Self-regulated Online Learning Questionnaire (SOL-QR) used in 9% of the studies, in investigations of Jansen [86], Online Learning Enrollment Intentions (OLEI) used in 9% of the studies, in investigations of Kizilcec [47] and, additionally, the Self-regulated learning Motivated Questionnaire (SRLMQ) used in 9% of the studies [87]. Self-Regulated Learning at Work Questionnaire (SRLWQ) used in 9% of the studies, in works carried out by Lee [17], the Other instruments were only used in one investigation and each one only covered 5% of the studies, these are: MOOC Online Self-regulated Learning Questionnaire (MOSLQ), Self-regulated learning Workplace Questionnaire Modified (SRLWQ-M), These data collection instruments can be seen in Figure 13.

RQ.8) HOW CAN SELF-REGULATION LEARNING AND ITS STRATEGIES SUPPORT DIFFERENT ASPECTS OF THE DESIGN, TEACHING AND LEARNING OF A MOOC?

- THE DIFFERENT ACTIONS THAT SUPPORT MOOCS IN ASPECTS SUCH AS DESIGN, TEACHING AND LEARNING.

As described previously in this systematic review, research on SRL in MOOCs occurs in different settings. At this point, according to the literature, we will discuss how self-regulation learning and / or its strategies can support the design of MOOCs environments.

Wong et al [45] carried out a research in 2019 consisting of an analysis on the use of weekly videos in which they explained how students could self-regulate their learning. The authors verified that students who use the videos to understand and learn about self-regulation learning could later continue with the MOOC in a better way, applying what they had learned.

It is also a key element in the scholarly debate how MOOCs teaching process can be supported and how students are able to self-regulate their learning, specifically with the use of tools such as the eLDa platform described by Onah *et al* [35], [78]. Also Pérez-Álvarez et al [81] published a paper about the NoteMyProgress tool in which they propose that each participant can assess their learning by considering SRL strategies such as setting their goals and time management and thus being able to support students to go at their own pace by analyzing the times used in the development of the objectives. In this way the participant of a MOOC is motivated and avoid dropping out. It is also noteworthy that these tools have interactive displays progress bars which have a positive effect on the motivation of students because they can observe their achievements at their own pace.

Another interesting finding is the fact that the students who most self-regulate their learning do not learn in a linear way in MOOCs, but rather they analyze what is really necessary to learn. In short, they study how to be able to carry out and finish a MOOC in a satisfactory way without having a sequential learning progress. This finding made by Alonso Mencía et al [44], [48], can be used effectively in the creation of MOOCs considering a diversity of activities, tasks and means, providing the possibility that students can build their own way of learning.

According to the review, the courses designers must achieve total clarity about each of the activities to be carried out in the MOOC, with their objectives and times, in addition to the general information provide at the beginning of the MOOC. Everything that is going to be developed must be reflected so that the participant can outline their learning path.

Also in the creation of the MOOC that support SRL, the diversity of people must be taken into account as analyzed by Li Kun [88]. An interesting framework to apply when creating a MOOC is the Universal Learning Design and thus have different ways of reaching people based on its three basic principles which are: provide multiple levels of commitment, provide multiple means of representation and provide multiple means of action and expression [89].

Finally, Littlejon *et al.* [87] favoring the following self-regulation strategies establish how to help students to complete MOOCs:

•That the objectives of the MOOC course are adaptable, supporting the SRL strategy of establishing the objectives.

•That when defining activities, it is verified that they can be applied in real life, strengthening the SRL strategy, interest and value for the task.

•Heterogeneity must be capitalized by creating attractive content for diverse people, supporting the SRL strategy of result expectations.

•It is important to break down the barriers that all activities are carried out within the MOOC by promoting the use of social networks, which supports the help-seeking strategy.

•MOOCs must be productive for the student. It does not have to be considered only as a way to achieve a certificate, but it is important to motivate the student to sustain the SRL strategy of encouraging interest in the task

V. DISCUSSION ON CHALLENGES FOUND IN THE REVIEW

Based on the analysis carried out, we consider that the definition that clearly explains self-regulated learning is that of Zimmerman (2000) as: ''A process formed by self-generated thoughts, emotions and actions that are cyclically planned and adapted to achieve personal goals'' (p. 13).

From the definition of Zimmerman, other psychologists of great relevance in the field have generated different definitions of self-regulated learning, such as Panadero y Tapia (2014), which define it as: ''the control that subjects perform over their thoughts, actions, emotions and motivation through personal strategies to achieve the goals they have set'' (p. 450).

This definition is interesting, because, on the one hand, it includes the idea of ''control of thoughts'', that is, the cognitive component of self-regulation also called metacognition that is based on the strategic control of cognitive processes; and, on the other hand, it includes the aspect of ''control of the action'' since the behavior itself must be controlled in order to achieve the educational objectives. Likewise, it includes ''control of emotions'', as students experience emotions, being crucial that they can be controlled so that they positively affect their learning. Finally, it includes ''control of motivation'', which is essential to conclude the achievement of a task and maintain, during the execution, concentration and interest [89]. The last element of the definition has to do with the objectives, ''to achieve the objectives that they have set.'' Students establish their objectives and regulate themselves in order to achieve them.

As we can see, Panadero and Zimmerman converge both in their perspectives on the process and control of thoughts, emotions and actions- all geared towards achieving the proposed objectives, also taking into account that these personal strategies are generated within and that they are carried out cyclically.

The review developed allows us to conclude on a series of challenges and open questions in the research area of self-regulated learning in MOOCs.

The first challenge presented is the lack of evidence in the state of the art of comprehensive evaluations that clearly show the effect of the presented tools [30]. It can be observed that SRL really contributed to the students enrolled in MOOCs.

Another challenge that is observed is the lack of a methodology that integrates both the theoretical conceptualization achieved on self-regulation and the means of strengthening it in the students, with the use of the developed software tools addressed in the studies instrumentally. MOOC design elements need to be considered so as to contribute to student self-regulated learning [61].

A third challenge is oriented towards data collection methods, since most of the research carried out is limited to the use of questionnaires and interviews [37], [38]. For this reason, for future work, click flow data should be combined and analyzed, SRL self-reports of students, text mining, content analysis, record analysis and also demographic background analysis and course grades, all in order to generate comprehensive evaluations of the impact of the solutions proposed in the area of self-regulated learning in MOOC participants.

A challenge in future studies has to do with participants' behavioral sequence patterns when conducting a MOOC [45]. Analyzing this should be strengthened in order to conclude which type of course design or interface navigation design can facilitate more effective SRL behavioral sequences that would lead to increased performance, persistence, and engagement of MOOC participants.

The fifth challenge identified is the importance of investigating the interaction sequence patterns extracted through the use of other teaching resources available in MOOCs such as: forum messages, readings, use of the dashboard, access to external resources outside MOOC and training activities [13]. This would help analyzing how students are self-regulating and thus propose solutions in this field.

The sixth challenge identified refers to the lack of evaluation reports that would address the medium and long-term effects of the use of tools that support SRL in MOOCs and their impact [30]. Advancing this knowledge would allow verifying the actual effectiveness of this type of technology in learning scenarios. In general, the studies analyzed report the existence of SRL tools in MOOCs, but none verify the impact of these tools.

A seventh challenge evidenced has to do with the fact that there are very few tools to support SRL in MOOCs, as found in this systematic literature review [18]. Therefore, the creation of such tools is necessary, since it has been shown to be of benefit to students with respect to SRL, specifically

supporting strategies such as: goal setting, strategic planning, organization, note taking, and time management.

The eighth challenge that arises is that the design of future tools should be based on a clear relationship between students, activities and SRL strategies in order to facilitate the measurement of their impact. In addition, the tools to help the SRL in MOOCs should provide the student with interactive visualizations so as to be able to self-evaluate in addition to the social comparison and feedback between students [19].

In a ninth challenge, it is evident that the current SRL tools are mostly external to the actual platforms where MOOCs are implemented. This implies that users must log in to both the platform and the external tool, which causes participants to lose the interest. At the same time, there are cases where students use different data to access the two different platforms, which means that the analysis carried out is not entirely reliable. For this reason, it is recommended that the creations of new tools be embedded into the MOOC platform [33].

Another challenge is the lack of feedback systems that facilitate self-management of SRL strategies for students with weak metacognitive skills and that would therefore support SRL for a global and diverse student population [47].

Finally, the last challenge identified is the need to diversify the use of MOOCs at different educational levels, for example primary and secondary education [39]. According to the data analyzed in this systematic literature review, more research is needed in this field and it's very important to continue by exploring ways to successfully integrate MOOCs in primary and secondary schools, which could help strengthen self-regulation strategies for early learning in students. On the other hand informal learning is a really

VI. CONCLUSION

A systematic review of the literature on the subject of MOOCs was carried out in the context of self-regulated learning; A total of 66 studies were analyzed, mainly conference articles and journal papers from recognized databases. The following factors were considered in the selected studies: the academic community that investigates self-regulation in the context of MOOCs - the way it's shaped and its interests, the definitions of self-regulated learning or SRL, the strategies identified so far that are meant to support the self-regulation of students in the context of MOOC. Additionally, ICT-supported methodologies which have been designed to aid student self-regulation in the context of MOOC, technologies and software platforms to support SRL in the context of MOOCs, description research reported on the use of SRL support in MOOCs as well as the instruments used in collecting information on self-regulated learning shown by MOOC participants.

Here is a brief summary of the main conclusions:

The number of studies published on SRL in MOOCs between 2010 and 2020 has been an average of 8 per year, with 2020 being the year in which the majority of articles were published, an average of 9 (until May 2020, when the revision ended).

The areas where solutions and research on self-regulated learning in MOOCs have been most performed and applied are in Education, followed by Information and Communication Technologies. The least explored are Humanities and Arts, in addition to the area of health and welfare.

The systematic literature review shows that the most representative authors in self-regulated learning are: first, Zimmerman, followed by Pintrich.

Among the self-regulated learning strategies most investigated by the authors in the articles in this review are: goal setting, help seeking, self-evaluation, strategic planning, self-efficacy, task strategies, environment structuring, task interest and elaboration. Less used strategies are: organization, self-monitoring, self-satisfaction and critical thinking.

The research approach that works in the 66 papers is firstly the quantitative approach, followed by the mixed approach and finally we can find qualitative and systematic literature review.

According to all research considered, it is concluded that the number of students participating in the SRL research in MOOCs is still low, since there are very few students who collaborate with the different forms of information collection. The range of 25 to 150 participants is reflected in 24,2% of the studies. Alternatives should continue to be sought in order for more students to participate in the research carried out regarding SRL in MOOCs.

The tools that stand out in the MOOCs SRL and that contribute to learning are: eLDa, The Serious Game, Mylearningmentor, Prosolo, Learning Tracker, NoteMyprogress and Forge.

The most used software in data analysis is SPSS, which is statistical software, and the platform that stands out in research on self-regulated learning in MOOCs is Coursera followed by Edx, Futurelearn, Open Edx and finally Moodle.

Finally, there are the data collection instruments used so as to carry out the respective self-reports. The one that stands out the most is the Online Self-regulated Learning Questionnaire (OSLQ), which is the most used, followed by the Motivated Strategies for Learning Questionnaire (MSQL), where you can analyze the information according to self-regulated learning strategies that are defined in these self-reports.

This work contributes to expanding the current state of research in the field of self-regulated learning in MOOCs, covering aspects such as methodologies, strategies, technology designs and instruments, with the aim of identifying the benefits and effects to be considered by future studies.

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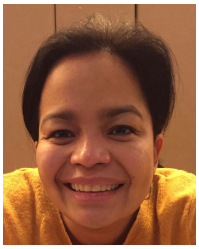

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