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Self-regulated learning in MOOCs: Lessons learned from a literature review

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Self-regulated learning in MOOCs: Lessons learned from a literature review

Learners in Massive Open Online Courses (MOOCs) are required to be autonomous during their learning process, and thus, they need to self-regulate their learning to achieve their goals. According to existing literature, Self-regulated learning (SRL) research in MOOCs is still scarce. More studies which build on past works regarding SRL in MOOCs are required, as well as literature reviews that help to identify the main challenges and future research directions in relation to this area. In this paper, we present the results of a systematic literature review on SRL in MOOCs, covering all the related papers published until the end of 2017. The papers considered in this review include real experiences with at least a MOOC (other learning scenarios sometimes claimed as MOOCs, such as blended courses, or online courses with access restrictions, are out of the scope of this analysis). Most studies on SRL in MOOCs share some common features: they are generally exploratory, based on one single MOOC and tend not to specify in which SRL model are grounded. The results reveal that high self-regulators engage in non-linear navigation and approach MOOCs as an informal learning opportunity. In general, they prefer setting specific goals based on knowledge development and control their learning through assignments.

Keywords: open education; lifelong learning; literature review; Massive Open Online Course; self-regulation; self-regulated learning.

Introduction

MOOC environments, characterised by their massive and open nature, attract a diversity of learners who differ in learning paces and engagement levels according to their backgrounds and motivations. MOOCs demand learners to be autonomous and create their own learning path with little or no tutoring to help them (Min & Jingyan, 2017). In other words, learners in MOOCs need to be able to self-regulate their learning.

Self-regulated learning (SRL) has been defined differently depending on the theoretical models taken as a reference. However, according to a recent literature review on SRL by Panadero (2017), there is a general agreement in the community for defining SRL as a process that involves cognitive, metacognitive, behavioural, motivational and affective processes to face a learning situation and persevere until succeeding. In the literature, the definitions can be classified into two groups according to Puustinen and Pulkkinen (2001): (1) goal-oriented and (2) metacognitively weighted. On the one hand, interpretation (1) is followed, for instance, by Pintrich and Zimmerman. Pintrich (1999) perceived SRL as the use of cognitive, metacognitive and resource management strategies in order to control one's own learning. Zimmerman (2000) described SRL as thoughts, feelings and behaviours generated by students, and oriented towards achieving their personal goals. On the other hand, some authors prefer interpretation (2). For example, Winne (1996) views SRL as a metacognitive-driven process, consisting on the adaptation of cognitive tactics and strategies to tasks.

Several models have been proposed to study SRL. For example, Zimmerman (1990) developed three models under the socio-cognitive perspective, Boekaerts and Niemivirta (2000) developed a model focused on the role of emotions, while Pintrich (2000) developed another model which emphasised the role of motivation in SRL. Despite the different conceptualisations of SRL, all these authors agreed that SRL is

cyclic and conceived it as a process which can be grouped in three stages or general phases: preparatory, performance and appraisal phases (Puustinen & Pulkkinen, 2001). These stages have a time-based relationship: what happens before, during, and after the task is performed, respectively.

Self-regulation has typically been studied in face-to-face learning environments or in formal online environments, mostly focusing on behavioural study and development of instruments to detect students' SRL profiles (Zimmerman & Pons, 1986; Perry & Rahim, 2011; Harms, 2015; Onah & Sinclair, 2016). Regarding the study of SRL in terms of behaviour in face-to-face environments, Moos and Ringdal (2012) found that even students from kindergarten have the capacity to self-regulate their learning. However, despite the importance of SRL, specific training on SRL is not common. Regarding the instruments for measuring SRL some examples are: strategy inventories, think-aloud protocols, and learning diaries. Nevertheless, questionnaires are the most popular instruments, especially the Motivated Strategies for Learning Questionnaire (MSLQ) by Pintrich, Smith, Garcia and McKeachie (1991), but also the Learning and Study Strategies Inventory (LASSI) by Weinstein, Zimmerman and Palmer (1988), and the Academic Self-Regulation Scale (A-SRL-S) by Magno (2010).

Due to the evolution of technology, research on SRL was extended from face-to-face environments to other contexts. For instance, Bernacki, Aguilar and Byrnes (2011) reviewed some empirical studies regarding self-regulation in technology-enhanced learning environments (TELEs). They classified the used TELEs in 3 groups: *didactic*, those TELEs designed to teach learners how to self-regulate; *facilitative*, those TELEs which have tools to support SRL but do not prompt their use; and *unenanced*, those TELEs which do not enhance SRL. Among the conclusions of Bernacki et al. (2001), these authors highlight the link between the learning environment and learners'

behaviour, and importance of adaptive environments to meet the individual needs of each learner. Regarding online contexts, Broadbent and Poon (2015) stated that the correlation between SRL strategies and learning outcomes in face-to-face environments also applies to online environments. Nonetheless, the effects of traditionally useful SRL strategies, such as elaboration, appear not to be as effective in online environments. Thus, Broadbent and Poon (2015) encourage more research to understand what other factors are more effective to obtain a good achievement in online environments.

In the context of MOOCs, the first articles focused on studying SRL in MOOCs date from early 2010s. Research works from that time on apply techniques and define instruments to understand both the SRL profile of MOOC participants and their behaviour. Main instruments which are being applied to study SRL in MOOCs are: log data (Min & Jingyan, 2017), questionnaires or surveys (Alario-Hoyos, Estévez-Ayres, Pérez-Sanagustín, Kloos & Fernández-Panadero, 2017), interviews (Littlejohn, Hood, Milligan & Mustain, 2016), or combinations thereof (Maldonado et al., 2016).

Additionally, studies on SRL in MOOCs face a great diversity of learners, and are conditioned by the MOOC, the population sample whose data is analysed, and the research instrument used. It is noteworthy that the instructional design of the MOOC (Littlejohn & Milligan, 2015) and the learning context (Hood, Littlejohn & Milligan, 2015) have a strong influence in the learning process. Therefore, the diversity of learning contexts in which SRL in MOOCs has been studied makes it difficult to generalise conclusions. Despite the efforts to study SRL in MOOCs, back in 2014, Gašević, Kovanović, Joksimović and Siemens already announced the importance of this topic, the low number of related works, and the need for more studies in the area.

In order to understand better the progress made regarding research on SRL in MOOCs, and how to approach future research in this area, we propose a systematic

literature review. This work complements other reviews, such as the one by Devolder, van Braak and Tondeur (2012), who found that studies supporting SRL processes in computer-based environments are mainly focused on cognition, and the one by Zhu, Sari and Lee (2018), who presented an analysis of instruments applied in empirical studies on MOOCs and concluded that quantitative methods (especially surveys) are the preferred ones.

This article aims to give a broader view, synthesising the advances achieved regarding SRL and MOOCs, and identifying the main research avenues. As far as the authors know, the work of Lee, Watson and Watson (2019) is the only one that reviews SRL in MOOCs without focusing on a specific subtopic. Our work extends the analysed time interval by adding documents published in 2017, which might be valuable as researchers have increased their attention in this area in the last years.

Moreover, our paper also presents the exploratory approaches in addition to the supports of SRL in MOOCs. Finally, our work examines the SRL strategies but presenting the most analysed ones for each SRL stage, instead of considering the types (e.g., cognitive, behavioural) as Lee, Watson and Watson (2019).

Research Questions (RQ)

This work aims to review the current literature regarding SRL in MOOCs and propose future lines of work in this area. In this section, our motivation is presented, as well as the corresponding research questions. Firstly, we are interested in studying the characteristics of the MOOCs used in this research area because prior works suggested that the learning context has a direct influence on self-regulation (Jakešová & Kalenda, 2015). Specifically, this conclusion was reinforced by Ferguson et al. (2015) in MOOC environments.

- **RQ1:** What are the characteristics of the MOOCs used in studies of SRL in MOOCs?

Moreover, it is interesting to understand the instruments to study SRL in MOOCs. Despite the popularity of SRL questionnaires as a research instrument in this area, most of existing questionnaires are not designed specifically for online environments, and even less so for MOOCs. In fact, Jansen, Van Leeuwen, Janssen, Kester and Kalz (2017) already stated that no existing questionnaire covers all SRL aspects in MOOCs. Therefore, current instruments to study SRL in other environments might not be sufficient. Additionally, techniques need to be more complex because we have more and more diverse data (Baker & Inventado, 2014).

- **RQ2:** Which are the sample sizes, research instruments and techniques applied in studies of SRL in MOOCs?

Additionally, it is critical to understand how SRL is studied in MOOC environments and what approaches are used in the analysis. MOOC scenarios have particular characteristics, such as less supervision by instructors, as well as different types of data which can be gathered from learners compared to other contexts.

- **RQ3:** Which approaches are adopted in studies of SRL in MOOCs?

So far, most SRL studies are focused on traditional contexts. These works have found consistent results that relate learners' SRL skills and characteristics to their performance. In recent years there has been an impulse for studies in this area applied to MOOC environments. However, these studies are scattered and very diverse in their analyses. It is important to understand what has been studied and discovered so far in order to know how to move forward.

- **RQ4:** What are the topics of analysis and aspects of SRL taken into consideration in studies of SRL in MOOCs?

Methodology

This work presents a systematic literature review, following the guidelines defined by Kitchenham (2004), who established three phases for the review: planning, conducting and reporting. While the planning and conducting phases are presented in this section, selected papers and results are reported in the following section.

Planning phase

This work is based on the results of a search performed on early 2018 (including papers until the end of 2017) in the following well-known databases: ACM, ERIC (Education Resources Information Center), IEEE Xplore, Oxford Academic Journals, ScienceDirect, Scopus, Springer Link, and Semantic Scholar. These databases were chosen as relevant for the educational technology field, following other related works, such as the one by González-Martínez, Bote-Lorenzo, Gómez-Sánchez and Cano-Parra (2015).

Documents included in the literature review had to present a study of SRL applied to (at least) a real MOOC, not including blended courses, or online courses closed to a set of learners. Terms initially used for the search were “self-regulated learning” and “MOOC” linked through the boolean AND. SRL was originated in the educational and cognitive psychology field, and was initially applied to classroom environments (Zimmerman & Martinez-Pons, 1988). Additionally, the term “self-directed learning” (SDL) initially appeared in the context of adult education (Garrison, 1997), beyond school settings. However, as Saks and Leijen (2014) mentioned, SDL and SRL “have not been clearly distinguished” and are often used as synonyms in e-

learning research works, as it happens in the work by Davis, Chen, Jivet, Hauff and Houben (2016a). Thus, the term “self-directed learning” was also included for further completeness in the search, always paying attention to the context in which it was applied. Therefore, the combinations of terms were: (1) “self-regulated learning” AND “MOOC”; (2) “self-regulated learning” AND “MOOCs”; (3) “self-directed learning” AND “MOOC”; and (4) “self-directed learning” AND “MOOCs”. These searches were repeated with terms “self regulated learning” and “self directed learning”, but the removal of the hyphen resulted in no new additional papers.

After this stage, a total of 752 documents were collected (see Fig. 1). For completeness reasons, these documents were not initially filtered by author, publication type, geographic region or time interval. However, MOOCs are a recent topic (Yuan & Powell, 2013) and this indeed limited the time interval. This fact was supported by the fact that all the 752 documents were published from 2011 onwards.

The followed methodology by one author to review and discard unrelated documents was: (1) eliminating duplicate articles due to overlap between databases; (2) checking that the language used in the article is English or Spanish, which are the languages spoken by the authors; reading the (3) abstract (excluding only those which were clearly out of scope); (4) conclusions; (5) research questions and/or objectives; and (6) characteristics of the study performed to guarantee that the study involved real experiences with at least a MOOC, and no other learning scenarios, such as blended courses, or online courses with access restrictions. For documents which required a more thorough examination, (7) introduction and (8) main body were also read.

Upon the completion of this process, the sample was reduced to 42 selected documents (see Appendix - Table A.1), all of them ranging from 2014 to 2017.

Figure 1. Planning phase schema with the number of selected papers per phase.

Conducting phase

Publications were analysed according to the research questions quantitatively and qualitatively. To explore the features of the MOOCs used in the studies (RQ1), the individual courses and their editions were identified, as well as their duration and hosting. Moreover, research instruments and sample sizes of the studies (RQ2), approaches (RQ3), and aspects of SRL (RQ4) were also identified.

Limitations of this systematic literature review include the chosen databases, criteria fulfilment examination by one author and language, or time restrictions of the search (until the end of 2017), which might cause some papers not to be included (e.g., later publications). Additionally, constraints related to the need for a real MOOC in the study imply the exclusion of theoretical proposals, frameworks, and studies on other types of courses.

Results

This section presents the general characteristics of the selected works (publication type, contributing countries, and MOOC sample) and reports the findings of the analysis organised according to the research questions.

Characteristics of the set of selected papers

Most of the papers (71.4%) were published from 2016 and 2017. According to publication type, the set is composed by 22 conference papers (mainly from 2016) and 20 journal articles (mainly from 2017). Regarding contributing countries, researchers from most continents are studying SRL applied to MOOCs. The high productiveness in the USA may be due to its leadership in MOOC offering with well-known platforms such as Coursera, edX, and Udacity. Figures 2 and 3 describe the main characteristics of the selected papers.

Figure 2. Classification of selected documents per year and publication type.

Figure 3. Summary of contributions by country. Computation criteria: for papers whose authors belong to universities located in different countries, one contribution per country is considered; for papers whose authors work at the same university (or institutions located in the same country), one contribution for that country is considered.

Regarding MOOCs, as Fig. 4 shows, most of the documents consider data from one individual MOOC. Therefore, generalisation of the results (constrained to the analysed MOOC and/or environment) is a problem. This limitation should be addressed by studies which compare findings among different MOOCs and topics to reduce misleadingness. Exceptions to this are the works by Kovanović et al. (2016) and Dai, Asano and Yoshikawa (2016), who stand out by considering 11 and 73 individual MOOCs in their analysis, respectively. However, these numbers were due to other research goals (examining course returners and learning path recommendation among different courses, respectively). In total, 133 different MOOCs were considered among the 42 selected studies (assuming MOOCs for which no details are provided as individual ones). For the rest of this analysis, the set of 73 MOOCs is excluded for better visualisation, as details of these courses are not provided by Dai et al. (2016).

Figure 4. Summary of MOOCs considered per study. The total number of editions is specified in brackets next to the number of studies. For example, “31(37)” means that 31 studies considered 1 individual MOOC and (37) means that 37 editions of these 31 MOOCs were analysed.

Regarding MOOC topic, no constraints are found (see Fig. 5). The MOOCs were classified according to Class Central categories – a well-known search engine for MOOCs. Our results show that education and teaching, and science MOOCs comprise most courses considered in the literature on SRL and MOOCs. This contrast with Shah (2017), who reported business and technology as the predominant knowledge areas.

However, Gašević et al. (2014) found that most MOOC research is done by authors from the education discipline and computer scientists. In fact, universities typically have access to data only from the MOOCs they create (Dillenbourg, Fox, Kirchner, Mitchell & Wirsing, 2014), as data sharing is difficult and uncommon due to privacy and ethical problems (Reich, 2015). Therefore, our findings suggest that researchers (mainly educators and scientists) create MOOCs in their disciplines and use the obtained data in their research.

Figure 5. Summary of different encountered MOOCs by topic.

There exists a clear dominance of MOOCs in English (see Fig. 6), consistently with Class Central MOOC data (77% courses in English), which can be the result of: the aim of reaching a broad audience, as English is the main international language; and the fact that some of the most important MOOC platforms (e.g., edX, Coursera, Udacity or FutureLearn) have been created by institutions of English-speaking countries.

Figure 6. Summary of MOOCs by language. Number of individual MOOCs and, in brackets, total editions of the considered MOOCs (if more than one edition is considered in the studies).

RQ1: What are the characteristics of the MOOCs used in studies of SRL in MOOCs?

The number of weeks in a MOOC and the way content is delivered (whether the material is released gradually or from the beginning) affects the way learners deploy different strategies to self-regulate their learning process (Ferguson et al., 2015; Hood et al., 2015; Littlejohn et al., 2016). For instance, in addition to self-paced courses (no start or end date), some platforms such as Coursera and edX also offer instructor-paced MOOCs (with end dates). This delivery mode affects the way enrolees work in the

course, fostering the establishment of short-term goals (which are not necessarily self-defined) that allow learners to persist in the MOOC. Moreover, the length of the course influences SRL as longer courses demand more effective SRL abilities to control and adjust the learning process during several weeks. Thus, learners with weaker SRL skills might not be able to complete long MOOCs. For example, Min and Jingyan (2017) analysed a 10-week MOOC, finding that learners with better SRL skills persisted more in the course. The same result was found by Davis, Chen, Van der Zee, Hauff and Houben (2016b) after analysing a 13-week and a 7-week MOOC, specifically focusing on study planning skills.

Other authors state that persistence in the course can be increased by improving goal setting (Jo, Tomar, Ferschke, Rosé & Gašević, 2016), which can be achieved even through the course design and platform (Milligan & Littlejohn, 2016). For example, MOOC platforms condition the instructional design of the course. Among the MOOCs used in the selected studies, most of these courses are available on Coursera and edX platforms, in line with conclusions by Ossiannilsson, Altinay and Altinay (2016). In the literature, existing studies analyse MOOCs of different length (see Fig. 7) and platform (see Fig. 8). However, there is a lack of studies that compare MOOCs of different lengths or in different platforms, aiming to investigate deeper the influence of these factors on the SRL, which might be an interesting challenge to explore.

Figure 7. Classification of MOOCs by week duration. Number of individual MOOCs and, in brackets, total editions of the considered MOOCs (if more than one edition is considered in the studies).

Figure 8. Summary of MOOCs by platform. Number of individual MOOCs and, in brackets, total editions of the considered MOOCs (if more than one edition is considered in the studies).

RQ2: Which are the sample sizes, research instruments and techniques applied in studies of SRL in MOOCs?

Following the work of Zhu et al. (2018), studies were classified according to sample sizes for which data is obtained (see Table 1), except from the study by Dai et al. (2016), who did not specify the sample size. Results show that the use of different instruments to study SRL in online environments go hand in hand with the sample size. On the one hand, studies using small sample sizes are often qualitative in nature, where interviews or think-aloud protocols are used to report on the SRL strategies that learners apply in their learning process. On the other hand, studies using medium or large sample sizes are usually quantitative, since qualitative approaches are difficult to implement, even more so in MOOC environments where personal contact is not possible. In general, sample sizes of MOOC studies are bigger than previous SRL works applied to more traditional environments. However, the heterogeneity of learners, the influence of context factors (e.g., MOOC length, delivery type, or platform) and limitations on the types of available data in quantitative approaches are important barriers to generalise conclusions.

Surveys or questionnaires are mostly used to quantify the SRL level: MSLQ (Motivated Strategies for Learning Questionnaire, by Pintrich et al., 1991), LASSI (Learning and Study Strategies Inventory by Weinstein, Palmer and Schulte, 1987), OSLQ (Online Self-regulated Learning Questionnaire by Barnard, Lan, To, Paton and Lai, 2009), SRL professional (Littlejohn et al., 2016) and AMS (Vallerand et al., 1992). The main limitation of these instruments is that, in general, they are not designed specifically for online (and MOOC) environments. In addition, these instruments are valid to quantify learner strategies to a limited extent, as they are self-reported, and prior studies (Hadwin, Winne, Stockley, Nesbit & Woszczyna, 2001; Kizilcec, Maldonado & Pérez-Sanagustín, 2017) showed a mismatch between answers and real

behaviour. One reason for this mismatch may be that enrolees lack self-objectivity. Other reason might be that self-regulation is not fixed as some authors argue both in online (Hood et al., 2015) and traditional environments (Moos & Ringdal, 2012). Consequently, instead of relying on a single resource or only one type instruments, several approaches are essential to obtain reliable and unbiased data.

Table 1. Instruments of SRL researches by sample size.

RQ3: Which approaches are adopted in studies of SRL in MOOCs?

Selected documents can be divided into: those based on (1) an exploratory methodology - 29 documents - and (2) an evaluation of interventions - 13 documents. First subset comprises researches which delve into learner characteristics and SRL strategies applied or develop instruments to measure SRL. Onah and Sinclair (2017) built a Russian version of the OSLQ, whereas Martinez-Lopez, Perera-Rodríguez, Tuovila and Yot (2017) preferred to adapt the OSLQ to the MOOC environment (MOSLQ). Conversely, Jansen et al. (2017) consider that no existing questionnaire covered all the SRL aspects and developed a new one.

Moreover, due to the complexity of self-regulation and its importance in this pedagogical context (Dawson, Joksimović, Kovanović, Gašević & Siemens, 2015), receiving active support for those learners who lack SRL skills is critical (Maldonado-Mahauad, Pérez-Sanagustín, Kizilcec, Morales & Muñoz-Gama, 2018) to reduce possible difficulties in course completion. Studies that analyse the effectiveness of specific tools and educational strategies are included in the second subset, comprising: (1) external tools, (2) MOOC interventions or path recommendations, and (3) study groups.

Tools in approach (1) consider encouraging methods such as self-assessment and reflection (Baneres & Saíz, 2016), self-data visualisations (Pérez-Álvarez, Maldonado-Mahauad, Sapunar-Opazo & Pérez-Sanagustín, 2017) or badges (Howley, Tomar, Ferschke & Rosé, 2017). Findings were that these systems have a high usability level, are valued by learners as helpful, and improve participants' outcomes (e.g., higher number of submissions, average grades, and retention time). However, these tools tend to focus on specific SRL strategies. Therefore, a comparison with tools that support participants during all learning process and not just specific SRL areas might be useful to observe if learners' performance increases.

Subset in approach (2) is composed mainly by works that analyse the effectiveness of several types of interventions. Some examined intervention types are recommending peer assistance (Jo et al., 2016), comparison with others (Davis et al., 2016a) and suggesting (Kizilcec, Pérez-Sanagustín & Maldonado, 2016) or exploring (Davis et al., 2016b) some SRL strategies. Specifically, interventions targeting time management seem to be more effective to enhance students learning, possibly because time management is reported as one important barrier for MOOC participants. Additionally, Li and Zue (2015) proposed a modification of MOOCs structure through a framework that links and organises educational material into an easily accessible structure, which facilitates SRL.

Regarding approach (3) (study-group proposals), co-regulation in learning environments is the chosen approach for Chen and Chen (2014 and 2015), relying on self-determination theory (i.e. researchers did not give direct instructions). Their basis are face-to-face weekly-meetings discussing self-regulation strategies, motivation and competency, together with learning diaries whose importance has been acknowledged (Panadero, 2017). Study-groups appear to be useful for students but seem unfeasible

due to, for example, location problems (e.g., not many people taking the course in the same area).

RQ4: What are the topics of analysis and aspects of SRL taken into consideration in studies of SRL in MOOCs?

In the set of selected papers there is a tendency of using Zimmerman's (Hood et al., 2015; Min & Jingyan, 2017; Littlejohn et al., 2016) or Pintrich's (Kizilcec et al., 2016; Alario-Hoyos et al., 2017; Kizilcec et al., 2017) self-regulation models, or a mix of both (Jansen et al., 2017; Maldonado et al., 2016), which is consistent with the findings of Panadero (2017). However, the base of most selected studies is unknown because they do not specify the chosen SRL model or consider several sub-processes which are not specific to one model. In some cases, for instance in the work of Martinez-Lopez et al. (2017), the SRL model can be inferred through the instruments used. Additionally, some other popular SRL models, such as those by Winne and Hadwin (1998) or by Boekaerts and Corno (2005), are not explicitly mentioned in any document of the set. It might be interesting to analyse learners' information using diverse models and compare conclusions.

Puustinen and Pulkkinen (2001) considered that despite the differences among existing SRL models, all of them distinguished phases that can be grouped in 3 stages or general phases: **preparatory**, **performance**, and **appraisal**. From the 42 selected documents, 17 consider sub-processes from all the phases.

Preparatory

This preliminary phase prepares the learner for the performance phase, through task planning and self-deliberations about one's own motivation to perform the tasks. 27 works study this phase, mainly focusing on two metacognitive strategies: **goal setting** and **strategic planning**. In fact, learners' performance across the metacognitive

processes of the three SRL phases appears to be closely related (Jansen et al., 2017).

Participants who have difficulties in strategic planning or goal setting are likely to struggle also with other metacognitive processes included in subsequent phases. Due to this relationship, learners might need help in metacognition across all the phases in order to achieve an effective support.

Goal setting. In the goal setting process, the learner should select his learning goals and define strategies to achieve them. This process is considered helpful in the literature (Jo et al., 2016; Kizilcec et al., 2017; Milligan & Littlejohn, 2014) but, in general, is a weak area for learners (Jo et al., 2016; Chen & Chen, 2014). However, participants in the study by Martinez-Lopez et al. (2017) obtained high scores when assessing this strategy. This might be explained due to the fact that the sample only included university students, and Kizilcec et al. (2017) found that those learners with, at least, a professional degree have higher goal setting levels. These authors also found higher goal setting levels among women, learners who are currently working or those enrolees who had completed more online courses. Therefore, participants who do not meet these criteria might need more support in goal setting. Researchers aiming to develop personalised tools or MOOC interventions may take special consideration with these high-risk groups.

Learners' goals are divided in two blocks which are related to their SRL skills (Littlejohn et al., 2016). Firstly, non-specific learning goals are those linked to extrinsic measures, such as obtaining a certificate or completing all the assignments in a MOOC (Chen & Chen, 2014; Milligan & Littlejohn, 2016; Littlejohn et al., 2016). These goals are associated to learners with low SRL skills who want to increase their learning or are curious about the topic. Secondly, specific learning goals are those linked to the development of knowledge which is useful for the working context (Milligan &

Littlejohn, 2014 and 2016). These goals are associated to engaged learners with high SRL skills who see the MOOC as an opportunity to develop their career. Interestingly, Jansen et al. (2017) highlighted that some well-known questionnaires to measure SRL such as MSLQ (Motivated Strategies for Learning Questionnaire) and LS (Learning Strategies questionnaire) do not include this scale. This fact points out the need to develop new instruments to evaluate more deeply the SRL skills of the learners in online contexts.

Strategic planning. Strategic planning includes the design of the succession and timing of tasks which the learner considers necessary to complete in order to achieve his learning goals. Kizilcec et al. (2017) found that the strategic planning ability is correlated to goal setting, and is a good predictor of goal attainment. This result might indicate that those participants who plan their learning are those who know better which goals they want to achieve. Therefore, they need to design a learning strategy on how to accomplish their personal goals. This also implies higher engagement with the course, which can be identified through higher persistence (Davis et al., 2016b) or spending more time in assignments (Kizilcec et al., 2017). Thus, enrollees with good strategic planning skills seem to value the assignments as a way to receive feedback on their performance and their closeness to achieving their goals.

According to Kizilcec et al. (2017), there are differences in this scale by gender, educational level and employment status. Specifically, lower levels are reported by learners who are unemployed or have a Bachelor's degree, as well as by women. Learners who do not have good strategic planning skills will not concretise their goals and the specific needed means, may not manage their study time properly, and might not be as focused on their goals. Thus, in the MOOC design, instructors should add elements to promote planning. For instance, in each module, they can include an initial

task explaining the number of each type of activities in that module (e.g. lectures, assignments), and in which the participant should allocate them in a week.

Performance

In this phase, the participant completes the learning tasks, monitors his progress, and strives to keep a good engagement or motivation level. Researchers seem to emphasise the importance of what is happening at this phase, because almost all the documents (38 works) consider sub-processes included in the performance phase. However, Min and Jingyan (2017) also highlight the value of the other phases (preparatory and appraisal). Both persistence and grade performance dropped dramatically among those learners who missed the other two phases, which implies that researchers should not overlook the other stages. The most examined strategies from the performance phase are **task strategies, help-seeking, time management and environmental structuring**

Task strategies. Task strategies refer to learners' ability to identify and use learning approaches or strategies to learn effectively, as well as adapting them throughout the performance phase. Among the selected documents, a variety of task strategies were identified such as note-taking (Milligan & Littlejohn, 2016), completing several consecutive lectures (Maldonado et al., 2016) or delving into the topic through external material (Littlejohn et al., 2016). Furthermore, low and high self-regulators differ in their approach towards learning and the adaptability of their strategies (Littlejohn et al., 2016). The formers tend to follow a structured linear learning path, and approach the MOOC as a formal learning opportunity. The latter tend to be more flexible in their task strategies, as well as more likely to adapt their behaviour according to personal

objectives and current needs.

In general, low competency in task strategies is reported among the MOOC participants (Chen & Chen, 2014; Martinez-Lopez et al., 2017). However, researchers have found significant differences in the task strategies level according to some features. Better abilities are found, for instance, among older learners or those from a country with low student-teacher ratio (Guo & Reinecke, 2014a). Moreover, higher scores in task strategies are obtained by women (Kizilcec et al., 2017) or those who are familiar with the topic addressed in the MOOC (Hood et al., 2015). These groups seem to identify the needed strategies when approaching a task. Additionally, a higher education level (especially Ph.D.) is associated to better task strategies (Hood et al., 2015; Kizilcec et al., 2017). These results may assist instructors to identify useful survey questions which allow to have a prior insight into the SRL characteristics of the participants and, specially, regarding task strategies. According to these findings, pre-course questionnaires should include questions about the objectives and aforementioned characteristics (i.e., age, location, gender, educational level, and prior knowledge about the topic of the MOOC).

Help-seeking. Help-seeking is the ability of the learner to look for help when needed during his learning process among his peers, the instructors or external sources. In general, learners tend to have low help-seeking skills (Kizilcec et al., 2016 and 2017; Martinez-Lopez et al., 2017; Hood et al., 2015). This result should raise concern among instructors as help-seeking is seen as a predictor for success in MOOCs (Breslow et al., 2013). Kizilcec et al. (2017) found that some groups that reject to seek help are male or older learners, those who have a university degree, specially a Ph.D., and participants who have some prior knowledge about the MOOC topic. These findings may help instructors to identify a subset of learners who may be less inclined to share their

difficulties.

The most common tool offered by MOOC platforms to support help seeking is the course forum, which is considered helpful and valuable by most learners (Milligan & Littlejohn, 2014 and 2016). They use the forum to share or increase their knowledge, as well as to grow their learning network. Moreover, participants who reported to have had a bad experience with the forum claimed that the weaknesses of the forum are unanswered questions, repeated topics, poor organisation or technical problems (Milligan & Littlejohn, 2014 and 2016). Therefore, there is still room for improvement both for MOOC platforms and instructors, mainly on the organisation and supervision of the forum threads. Learners who might not be able to find the needed help to keep up with their learning, may drop out of the course. Considering the importance of this skill, fostering participation in the forum is crucial in MOOCs.

Time management. Time management allows the learner to schedule and manage their study time in order to be able to perform the desired tasks which will allow him to get closer to his personal goals. Several documents in the set study the time management due to its well-known importance and influence to succeed in MOOCs (Kizilcec et al., 2016; Kukulska-Hulme, Sharples & Waard, 2015). However, learners seem to have difficulties to effectively manage their own time according to their goals (Loizzo, Ertmer, Watson & Watson, 2017; Milligan & Littlejohn, 2016; Beaven, Hauck, Comas-Quinn, Lewis & de los Arcos, 2014). Findings of Chen and Chen (2014) point to a disagreement between the amount of time spent doing assignments and the expectation of MOOC participants. Therefore, instructors should be aware of this barrier and try to establish a realistic estimated working time for each week. In addition, it would be beneficial if the workload was similar every week, in order to help participants in their time management. Establishing a weekly routine might be easier if the same amount of

time for the MOOC is allocated each week.

In order to support learners in this SRL skill, some instruments have been developed such as NoteMyProgress (Pérez-Álvarez et al., 2017). This tool is composed by a Chrome plug-in and a web application. In this application, users can visualise graphs displaying the study time in which they have procrastinated versus the time dedicated to the course. Thus, these graphs are intended to help them reflect on their time management, and encourage them to evaluate if they concentrate on the work. Moreover, this approach may allow students to be more realistic in their perceptions of their own abilities and weaknesses. In many cases, perceptions of oneself are not consistent with actual behaviour. Thus, there may be students who erroneously consider their time management to be good and therefore are not focused on its improvement.

Environmental structuring. Environmental structuring is the process of choosing and restructuring the study environment aiming to facilitate learning and avoid distracting elements. Finding a suitable environment for learning is important, as it allows the learner to concentrate better on his learning. Scores of this sub-process are, at least, moderately high in the selected documents that study it (Alario-Hoyos et al., 2017; Chen & Chen, 2014), although no differences by sex or age were found by Martinez-Lopez et al. (2017).

Moreover, Alario-Hoyos et al. (2017) showed that MOOC learners prefer a quiet environment. Thus, they can concentrate and focus on the course work better. Additionally, these authors also found that it is not always a dedicated space. Therefore, it seems that participants do not use an arranged study space and need to adapt themselves to find a suitable one in each occasion. One possible reason is that learners might not establish a fixed schedule or approach the MOOC to fill in the free time they have (Watson, Watson, Yu, Alamri & Mueller, 2017).

Appraisal

This phase includes the self-reflection and evaluation of outcomes after the performance phase, and influences the following preparatory phase by adapting the strategies to increase the efficiency. From the set, 25 documents analyse sub-processes of this phase, mainly focusing on **self-evaluation** and **self-satisfaction** strategies.

Self-evaluation. Self-evaluation is the ability of a learner to be aware of his learning behaviour, judge one's own performance and outcomes according to his established learning goals. To apply the self-evaluation strategy in MOOC context learners can rely on, for instance, assignments. However, there exists some dissimilitude between the approach to assignments of high and low self-regulators. The formers see the assignments as a way to control their learning. They consider assignments as a checking point to evaluate and get feedback about their knowledge, or reflect on possible improvements. The latter consider the assignments as a milestone that signals the end of their learning. In fact, they appear to use the exercises to learn, instead of evaluating their knowledge. Additionally, some MOOC platforms (e.g., edX, Coursera) offer another self-evaluation tool: self-assessments. Learners can evaluate their own assignments based on a rubric created by the instructors. Self-assessments can be also included in the MOOC design to complement and improve peer assessment, as in the work of Phan, McNeil and Robin (2016).

In the literature, researchers aim to encourage self-evaluation, mainly through social comparisons with peers or successful participants. For example, Davis et al. (2016a) designed a tool called Learning Tracker, which displays graphs comparing the performance between the learner and successful past participants. The evaluation of this

tool showed its usefulness to improve the performance of learners, for example resulting in more timely submissions of assignments. Additionally, study groups are also a good source of social comparisons. However, despite the promising outcomes of social comparisons, researchers should be cautious when encouraging these comparisons, as negative competition might also arise (Garcia, Tor & Schiff, 2013).

Self-satisfaction. Self-satisfaction allows participants to reflect on their degree of satisfaction with the performance they have achieved in the course and their fulfilment of personal goals. Littlejohn et al. (2016) found a strong connection between this degree of satisfaction with the expectations and goals of the participants at the beginning of the course, which are also linked to the SRL skills of the learners. Low self-regulators tend to consider the MOOCs as formal learning, and have extrinsic goals such as earning a certificate or completing all the assignments of the course. These learners evaluate their performance with extrinsic measures such as the achievement in assessments and degree of course completion (Littlejohn et al., 2016). They tend to be disappointed with their performance, regardless of whether they drop out the course (believing they could have improved their performance to complete it), or whether they pass the course (being concerned about how they could have improved their participation and outcomes of the MOOC). On the contrary, high self-regulators tend to show a high satisfaction with their performance in the MOOC. Their goals tend not to be focused on extrinsic measures, but on developing expertise and increasing knowledge. These learners approach the MOOC as a non-formal learning opportunity and do not rely on extrinsic evaluations as much as low self-regulators (Littlejohn et al., 2016).

Moreover, Hood et al. (2015) also found differences in the self-satisfaction score by role. More specifically, those learners who work as data professionals or study for a high education qualification reported higher level of self-satisfaction. This finding

might indicate that higher education improves self-satisfaction. Other explanation may be that these learners tend to approach the MOOC with non-formal learning goals, such as increasing their learning in a subject they like. Thus, as related to the learning objectives of these set of participants, their self-satisfaction is higher. As self-satisfaction appears to be closely related to goal setting and attainment, it might be worthy that MOOC platform interfaces include displays with the enrollee's objectives (set at the beginning of each module) and their status (i.e., completed or not completed). Therefore, participants may be more focused on their goals and reflect on their self-satisfaction more often, and not at the end of the MOOC.

Lessons Learned

The lessons learned of this literature review can be organised according to 2 factors: those related to the characteristics of the current literature on SRL in MOOCs; and those related to the SRL profile of MOOC participants.

Lessons learned regarding literature

- (1) There is an increasing number of contributions related to the topic under study in recent years (mainly since 2016 from the USA and the UK). Additionally, researchers can analyse a greater amount of data due to higher sample sizes than traditional environments, which may lead to firmer conclusions. However, the heterogeneity of enrollees and their backgrounds makes it difficult to conduct comparable studies in order to generalise the obtained conclusions. Little data sharing may also be a barrier for advances in this area, and researchers are encouraged to overcome it.
- (2) Studies analysing data from a small sample size (i.e. number of learners) tend to be qualitative (more personal procedure and direct interaction between

researchers and learners). With a bigger sample size, quantitative approaches are preferred because personal contact does not scale up well. However, using several instruments might be more effective to get unbiased data.

- (3) Most researches of SRL applied to MOOCs are exploratory. These works tend to be based on a quantitative approach, aligned with Veletsianos and Shepherdson (2016) and Zhu et al. (2018), mainly through questionnaires.
- (4) Several studies lie on the ground of Zimmerman or Pintrich's SRL models. However, researchers tend not to specify clearly the model that is used in the study.

Lessons learned regarding MOOC learners

- (5) Low self-regulators approach MOOCs as a formal learning opportunity. They usually set non-specific goals based on extrinsic measures (e.g., earning a certificate or completing all the assignments) and tend to be disappointed with their performance. Conversely, high self-regulators include MOOCs in the category of informal learning. These learners usually set specific goals based on the development of knowledge and tend to have higher self-satisfaction than low self-regulators.
- (6) Low self-regulators appear to use MOOC assignments to learn and see these activities as a milestone signalling the end of their learning. Oppositely, learners with high SRL skills approach assignments to control their learning and get feedback of their knowledge.
- (7) Learners with low SRL skills seem to follow more structured and linear learning paths. Contrarily, those learners with higher SRL skills tend to be more flexible in their learning path, and more likely to adapt it according to their goals and needs.

Conclusions

This study has presented a systematic literature review with the 42 papers which as of late 2017 had addressed SRL in actual MOOCs, with the aim to delimit the current importance of this topic and contribute with a summary of main findings. Results confirm and extend the findings in online education of Artino (2007), who performed a literature review regarding empirical works on self-regulation. Firstly, SRL skills are critical in achieving learner's goals in online environments (Chen & Chen, 2014), and specifically in MOOCs. These courses imply flexible and open learning situations, due to the limited enrollee-instructor interaction, focusing the interaction on the delivered content.

Secondly, Artino's work states that there is a relationship between task value and self-efficacy beliefs with academic performance. The sample size of the studies considered in Artino fluctuates between 30 and 235 participants and considered mostly undergraduate students. However, some limitations of these studies are: 1) the obtained results are correlational and, thus, no causality can be inferred; 2) the studies are only based on surveys as research instrument (which is related to the sample size); 3) the studies are limited regarding the analysed learner characteristics. In this sense, MOOCs provide an opportunity to extend these limitations. For instance, MOOCs offer the possibility of using larger sample sizes than those considered in traditional online studies. Additionally, the heterogeneity of MOOC enrollees allows to consider effects of personal factors such as intentions, motivations, interests and previous knowledge of the learners that affect their academic achievements.

Thirdly, due to the large amount of collected data and the heterogeneity of participants, along with current computational methods, it is possible not only to classify learners through their SRL profile, but also to group and categorise them

according to their behaviour within the MOOC platform. This helps us to understand better the goals of MOOC participants. For example, in Maldonado-Mahauad et al. (2018), two groups of MOOC learners classified by their behaviour were found to have a similar SRL level but their objectives with the course contents were different. One group (*targeting*) aimed to get a course certificate independently of using the available material, while another group (*comprehensive*) had the objective of traversing the course sequentially to achieve deep learning. This result in MOOCs extends what was found by Artino, where McManus (2000) suggests that "highly self-regulating learners learn poorly in mostly linear Web-based hypermedia learning environments, where they have very few choices, while medium self-regulating learners learn poorly in highly non-linear environments where they are given too many choices" (p. 219). Thus, as Bernacki et al. (2011) mentioned, the more we know about learners, the better we can characterise them and adapt the learning environment to meet their needs.

Regarding the instruments used to study SRL in MOOCs, we found a need to adapt instruments for this environment. This is in line with what Artino (2007) states: "studies reviewed here attempted to study online instruction by utilizing instruments developed for traditional classrooms. Although some measurement instruments may work equally well in classroom and online settings, considering the differences between the two learning environments, an instrument that works well in the classroom may not be valid in online and/or computer-based learning situations (Tallent-Runnels et al., 2006)". It is important that future studies which use surveys, adapt these instruments in the learning environment of interest.

Finally, this study is focused on a very specific area but intends to highlight the importance and complexity of self-regulation in MOOCs. Reported findings try to present the status of the field and help researchers identify literature gaps. Further

investigation in this area is encouraged with the aim of exploiting the potential of MOOCs and supporting participants to develop a lifelong learning.

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