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In the need of self-regulated learning interventions in undergraduate medical education: A systematic review

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**Abstract**---Medical knowledge keeps growing and education doesn’t end with college, on the contrary, we need lifelong learners. Our future doctors require new tools to develop goal-outcome behaviors, select strategies to achieve better care to patients and to become lifelong learners. Thus self-regulated learning (SRL) emerge as a promise land. Our objective in this review is to describe the research conducted on interventions and training programs to promote self-regulated learning skills in medical students. A literature search was conducted following Garcia Peñalvo model for systematic reviews and the PRISMA statement, the search includes Web Of Science (WOS), EBSCO, ProQuest, Scopus, PubMed and Scielo from 2009 to 2022. We identified 362 articles, 7 were eligible for evaluation. Seven (100%) studies were longitudinal, three were randomized clinical trials. The country that contributed the most literature was the United States, no articles were found in Latin America; the most used instrument to measure SRL was the Motivated Strategies for Learning Questionnaire (MSLQ), most of the interventions teach SRL skills in implicit manners, two of them teach SRL skills in explicit manners. There is a large field to explore regarding interventions and training programs to foster SRL in medical students.

**Keywords**---Self-regulated learning, medical education, self-directed learning, interventions.

**Introduction**

Self-regulated learning is the process in which students show “metacognitive, motivational and behavioral proactivity towards their learning goals”, Zimmerman model describes SRL as a process of three phases: forethought, performance, and self-reflection. In the forethought phase the student analyzes the task, sets goals and plans how to reach those goals. In the performance phase the student executes the task and inhibits other behaviors, one important component of this phase is monitorization in which students can think about their strategies and
adjust them to accomplish their goals. The last phase is reflection in which students assess themselves and how well they performed the task, then they make causal attributions and can adapt to achieve their goals (Panadero, 2017; Pintrich et al., 1987; Zimmerman, 2013).

One of the main objectives in education is academic success one abstract construct that depends on academic achievement, and academic achievement also have determinants, one of them is SRL. The current evidence supports that SRL is associated with expertise in learning, academic achievement, and student well-being. Self-regulated learning interventions also have been associated with higher student retention in other careers. (Broadbent & Poon, 2015).

In 1987 Pintrich published the first SRL intervention called “learning to learn” that covered topics as how to learn from lectures, texts, how to use memory models and strategies, use motivation, acquire test-taking strategies, problem solving and self-management. Multiple courses arises since this moment, one from Bail that demonstrates that a SRL course had long-term impact in academic achievement and graduation rate. (Bail et al., 2008; Pintrich et al., 1987)

Regarding healthcare education, reviews have been conducted exploring self-regulated learning in healthcare education and in the clinical context, but no reviews have been conducted in medical students, but most of the research has been conducted in postgraduate medical education (Broadbent & Poon, 2015; Theobald, 2021). (Álvarez-Cruces et al., 2020; Theobald, 2021)

In the current review we seek to identify the gaps regarding interventions to promote SRL skills in medical students., for that task we will answer the following questions:

What studies have been conducted on SRL interventions in medical students?  
What types of interventions have been conducted to develop SRL skills in medical students?  
What instruments did they use to measure the impact of SRL interventions in medical students?  
What were the theories used in the published studies on SRL interventions in medical students?

**Method**

The following state of the art followed the recommendations established by the PRISMA statement and Garcia Peñalvo (Garcia-Peñalvo, 2022; Page et al., 2021).

**Source of information**

The search was conducted in Web Of Science, ProQuest, Scopus, EBSCO-Host, Scielo and PubMed; reference of selected articles and articles cited in systematic reviews on self-regulated learning and their reference were also reviewed.

**Search strategy**

The search strategy consisted of the combination of the following keywords: self-regulation, self-regulated learning, medical students, university students, medical
students, intervention, program, intervention, and program, selected after review of the relevant literature, for more information on the searched terms refer to additional files. The literature search includes articles from January 2009 to May 2022. We include Spanish and English articles.

Eligibility Criteria

To initiate the search, we had to identify those studies that conducted interventions focused on or fostered self-regulated learning, so studies that did not explicitly focus on self-regulated learning or self-regulated learning variables (e.g., Planning, Performance, and Reflection) were excluded. The sample in which these studies were conducted had to be medical students, emphasizing this because in another systematic review most studies focused on residents and a more recent one on university students in general (Theobald, 2021; van Houten-Schat et al., 2018). Because the interventions should be evaluated over time, we excluded cross-sectional studies, which have been the most conducted according to Álvarez, so we only selected longitudinal or quasi-experimental or experimental studies (Álvarez-Cruces et al., 2020).

Selection Process

The literature search yielded 389 potential articles, of which 362 were identified in the database search and 27 in the search of the bibliography of two previous systematic reviews. After the removal of duplicates (n=158), 231 articles remained, the remaining articles were screened by the author and a peer, resulting in 108 selected articles, of which only 91 articles were retrieved and were subjected to the eligibility criteria, 78 were withdrawn because they were cross-sectional studies or involved a population other than medical students, to review the unselected articles please refer to additional files.
Question 1: What are the studies conducted on SRL interventions in medical students?

Of the selected studies (n=7), 4 have been conducted in USA, 1 in UK, 1 in Japan and 1 in Australia, the time spans from 2010 to 2020, in the latter year two articles were published. Three studies involved third year students, while two studies used first year and second year student, only one study does not mention the year of the students. Regarding the design of the studies, three (43%) were randomized controlled trials and four (57%) were longitudinal studies with intervention without a control group. As described in the systematic review by Álvarez in which he reported only one study on self-regulated learning in Latin America, specifically in Brazil, a finding that is supported by the work of Ronald et al, where the scientific production in Latin America represented only 4.9% of
the global production between the years 2000 and 2006. 9% of the global production between the years 2010 and 2019, being the country with the highest production again Brazil, this existing gap in the first place must be closed since interventions in self-regulated learning promote academic performance, which ultimately is a component within academic success and it’s an obligation as medical educator to promote SRL in our students (Álvarez-Cruces et al., 2020; Theobald, 2021; York et al., 2015). With respect to the designs, during the study selection process we found results like those of other researchers where most of the studies conducted on medical students were of cross-sectional design with the search to associate different variables, being the most associate variable academic performance. (Álvarez-Cruces et al., 2020; Broadbent & Poon, 2015)

**Question 2: What kind of interventions have been conducted to develop SRL skills in medical students?**

There was no established or uniform model in interventions or training programs, only one study reported having conducted a skills workshop oriented to the development of self-regulated learning explicitly following Zimmerman's cyclical model; the rest of the studies fostered self-regulated learning implicitly: a tutoring model favoring co-regulation and allowing students to perform deliberate practice; a professional identity formation program; making presentations with the GOLE (Guided Outcome Learning Efficiency) methodology; a program in which digital tablets were provided with a notes application; a workbook with self-monitoring exercises proposed by Legget in which the skill it sought to develop was metacognition and another one that also involved objectives proposed by Larsen, among those interventions focused on goal-setting and self-monitoring, two of the vastly components of SRL (Larsen et al., 2017; Leggett et al., 2012; Thomas et al., 2016). In the literature there are explicit self-regulated learning interventions with good results both in academic performance and university retention, however, in the area of medicine there are few interventions as described by van Houten in his systematic review of which less than half of the studies were interventions (n= 9) and following an implicit methodology promoting self-regulated learning through mentoring, by setting goals or by using digital tools, we suggest that future interventions focus on metacognition development, because according to Theobald’s systematic review metacognition development had the greatest impact on academic performance (Bail et al., 2008; Pintrich et al., 1987; Theobald, 2021; van Houten-Schat et al., 2018).

**Question 3: What instruments were used to measure the impact of SRL interventions in medical students?**

Only two studies reported using a questionnaire for self-regulated learning: Motivated Strategies for Learning Questionnaire. The rest did not report instruments to measure self-regulated learning. In scientific literature the most common used questionnaire is the MSLQ, result that we corroborate. Regarding Instruments used to measure self-regulated learning, we can describe the following: Motivated Strategies for Learning Questionnaire (MSLQ) which has been the most used according to a systematic review (61%), followed by the Learning and Study Strategies Inventory (LASSI) and the Inventory of Learning Style. These results are also supported by another systematic review conducted in Health Sciences students where the most used questionnaire was the MSLQ (Álvarez-Cruces et al., 2020; Roth et al., 2016).
The MSLQ was introduced in 1990 by Paul R. Pintrich. Pintrich, this questionnaire evaluates motivational strategies such as intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self-efficacy in learning, test anxiety and learning strategies such as repetition, elaboration, organization, critical thinking, metacognitive self-regulation, time and environment management, effort regulation, learning with peers and the ability to seek help, due to its relevance since its creation, multiple adaptations and validations have been made in different languages, This has led to question whether the MSLQ is still relevant today or whether it has remained with the passage of time, for which it should be remembered that Pintrich designed the questionnaire to associate self-regulated learning with academic performance, a finding that was corroborated by Credé in a meta-analysis published in 2011 in which the MSLQ score was weakly to moderately associated with academic performance, the most important areas for predicting it being effort regulation, self-efficacy and time and environmental management (Credé & Phillips, 2011). In future research we need to validate or adapt MSLQ to new theories, or design new questionnaires to measure SRL in different populations as Latin America. We also need to evaluate SRL with other instruments as case-studies or micro-analysis to get a bigger picture on the impact of these interventions. (Artino et al., 2015)

Question 4: What were the theories used in the published studies on AAR interventions in medical students?
The most used model was the cyclical model described by Zimmerman used in four studies, the rest of the studies did not establish which theory or model to use for the design of interventions, within the phases of self-regulated learning it can be established that emphasis was placed on self-monitoring in 5 studies and in 2 studies emphasis was placed on goal setting, This finding is related to that found in another systematic review, however, as Panadero points out, since Zimmerman's first model was proposed time has passed and new models have emerged, such as the Efklides model and Hadwin model that involves metacognition, in the current review we will explore the interventions made putting them in the cyclical model of Zimmerman (Álvarez-Cruces et al., 2020; Panadero, 2017; Zimmerman, 2013).

Forethought phase
The forethought phase involves task analysis, where students do goal setting and strategic planning, in our review two studies involve goal setting one use SMART methodology and the other doesn’t mention the methodology of goals, netherless both studies show improvement in SRL skills (Larsen et al., 2017; Thomas et al., 2016). The other component is self-motivation beliefs that includes self-efficacy, outcome expectations, intrinsic value, and goal orientation; one study focused on professional identity formation, one concept that we include in goal orientation. There is another component of forethought phase to explore in future research

Performance phase
Regarding performance it includes self-control, in order to learn students need to choose task strategies or learning techniques for every phase of cognitive processing, in order to better the elaboration of information in one study the GOLE method was used to make presentations and facilitate elaboration of
medical knowledge having an impact on external perception of teachers and students (Patil et al., 2014), in other study the use of tablets to take notes and facilitate encounters with patient had a positive influence in students (Alegria et al., 2014).

One aspect that has been studied and maybe is the most important factor of SRL to predict academic achievement is meta-cognition or monitoring, according to Zimmerman it’s a part of performance phase. In one study the use of a workbook of self-monitoring exercises improves self-efficacy, satisfaction, academic achievement, and calibration certainty.

Reflection phase

Recently Hadwin, Miller and Jarvela proposed a new model of SRL and introduce co-regulation (CoRL) : “refers broadly to affordances and constraints stimulating the (student’s) appropriation of strategic planning, enactment, reflection, and adaptation (occurring when in interaction with other students or group members)”, remediation programs are an example of CoRL because they bring opportunities to students with suboptimal performance a chance to self-evaluate, adapt and react to learning problems, in one study the implementation of remediation program help student with low academic achievement to improve, to better understand the role of this programs, in future research we recommend to evaluate SRL as an outcome. SRL models gave us a framework to design new intervention and to understand the results, nether less one intervention could have effect on other SRL phases, and one intervention also requires using other phases or components of SRL, we recommend exploring other components of the cyclical model as help-seeking, environmental structuring, time management, causal attribution and adjusting.

Conclusion

Most of the studies published about SRL in medical students are cross-sectional, giving us a limited sample of interventions and the most used instrument was the MSLQ. There is a gap in terms of scientific production on self-regulated learning interventions, with the United States being the leading country, while we have not been able to identify scientific publications from Latin America countries on self-regulated learning interventions. There is a great need in terms of producing interventions to foster self-regulated learning since we are not taking full advantage of the opportunity that the SRL provides us on the development of medical students.

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References


