METACOGNITIVE STRATEGIES AND LEARNING QUALITY: A SYSTEMATIC MAPPING STUDY

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ABSTRACT

The purpose of this study was to identify, analyze, synthesize and evaluate research papers aimed at the application of metacognitive strategies to improve the quality of learning in secondary school students. This document is a systematic mapping (SM) which offers a comprehensive overview of the methods, indicators, strategies, techniques and instruments used in those research. A literature review was conducted in seven widely recognized databases in the educational and scientific community worldwide; 722 documents were found and from these 19 were relevant to the search objective. 57.89% applied metacognitive strategies as follows: 15.78% to learning quality 42.10% to learning processes or skills; 31.57% on learning quality, and 10.5% on learning processes without the intervention of metacognitive strategies. The results confirmed the application of metacognitive strategies such as: planning, monitoring, evaluation, underlining, self-evaluation, modeling, thinking aloud, consciously choosing, reflection and reflecting on learners 'ideas, keeping journals, predictions, among others. Learning processes such as: motivation, understanding, transferring, evaluation, selective attention, knowledge association and advanced organization were intervened. Indicators of the learning quality were also used: potential, processes, results, the academic performance, peer evaluation, intrinsic motivation, understanding, knowledge construction indicator, teacher's expectation indicator, the Students' growth indicator, the superficial level of learning, and the deep level of learning , the level of learning achievement. There was a knowledge gap in the application of metacognitive strategies to improve the learning quality of secondary school students, which confirms the need to conduct studies with this type of classroom interventions.

1. INTRODUCTION

Metacognition is the cognition of cognition or the ability to consciously know, regulate and intentionally control one's own cognitive processes, Khan and Khan (2013), Flavell's studies on memory in the 70s were pioneers in these research issues, which eventually would be approached from pedagogy and other fields of knowledge, Flavell and Wellman (1975).

Flavell (1979) Proposed a cognitive process model for monitoring and regulation, which highlights what happens in the process of knowing, access to their own cognitive processes which would allow controlling and improvement of these processes. The elements involved in this model are metacognitive knowledge, metacognitive experiences, knowledge of goals or tasks and knowledge of strategies. According to Brown et al. (1982), there are two types of metacognitive knowledge: i) declarative knowledge about the person, the task and the strategy; and ii) a procedural knowledge of the cognitive process regulation expressed in planning, control and evaluation of them.

For Aguirre (2016), metacognition is the ability of thinking that allows knowing what is known, planning strategies to do the action of knowing, being aware of thoughts during the knowledge process, and reflecting and evaluating the moments and actions of the knowledge process. McCluskey, Treffinger, Baker and Lamoureux (2013) Says that metacognition is the awareness of the learning processes itself, the strengths and weaknesses when solving a problem or a task, and the organization supervision, regulation and evaluation of these processes.

Metacognition has two main components or dimensions: knowledge of cognition and regulation of cognition. The metacognitive strategies according to Osses and Jaramillo (2008), are actions aimed at knowing

our operations and mental processes, knowing how to use them, readjust them and / or change them, according to the goal demandings. For Nosratinia and Adibifar (2014) metacognitive strategies are general skills that allow students to manage, direct, regulate, monitor and evaluate their learning; therefore they can contribute to improve the learning quality of students.

The learning quality construct is a complex and relatively new concept in the theoretical educational body of literature. In the last three decades, several authors have made efforts to study and theorize on this issue. Pérez (2008) states that the learning quality can be assessed through the following quality criteria: i) quality as a goal (outcome evaluation) (Kinzie, 2019; Iyer and Moore, 2017); ii) consistency (process evaluation) Biggs (2004); iii) volume of data remembered; iv) information explained from a personal understanding; v) ability to solve problems, among others. This same author, Perez (2008), states that the learning quality should have a purpose of change on students, being able to solve problems in context and generalize them, making decisions and learning autonomously, diversely, actively, cooperatively, reflectively and critically.

According to this, a research study was proposed about the quality of learning tackled from the consistency perspective, that is, from the learning processes. In this case the learning acquisition process of students has been selected, using metacognitive strategies to improve three acquisition learning sub-processes: understanding, retention and transformation. The present work shows the initial phase of this research aiming at developing a systematic mapping study (SM) which will allow a comprehensive overview of the methods, indicators, strategies, techniques and instruments used in existing research done on this specific area of knowledge.

This document is organized as follows: section II details the research method used, section III shows the results; Section IV describes the possible threats to this study validity, finally, section V presents the conclusion and further work issue.

2. RESEARCH METHOD

For the review of literature, the method of systematic mapping (SM) was used, which according to Kitchenham and Brereton (2013) consists on identifying, evaluating and interpreting the studies linked to a research question, issuec, discipline or phenomenon. These authors propose a process involving five procedures: 1. Definition of the research question, 2. Doing the research tracking, 3. Classification of the studies, 4. Extracting relevant data and 5. Elaboration and publishing the report. The adaptation of the model proposed by Costa, Amorim and Salvador (2019) was followed with the first four steps.

2.1 Defining the Research Question

Five research questions were defined for this systematic mapping study:

RQ1: What evidence does indicate the use of metacognitive strategies to improve the learning quality of secondary students?

RQ2: What kind of metacognitive strategies have been applied for secondary students' learning process?

RQ3: What learning processes from secondary students have been intervened through the use of metacognitive strategies?

RQ4: What indicators are used to measure the learning quality of secondary school students?

RQ5: What evidence does indicate the completion of studies about the Learning Acquisition Process and its sub-processes (Comprehension, Retention and Transformation) from secondary school students?

The RQ1 aims at selecting research done in regard to the use of metacognitive strategies to improve learning quality from secondary school students. RQ2 seeks to identify the metacognitive strategies applied to secondary school students' learning process. The purpose of the RQ3 is to inquire about learning processes intervened using metacognitive strategies from secondary school students. RQ4 searches for indicators to assess the learning quality from secondary school students. RQ5 intends to identify research tackling the learning acquisition and its sub processes from secondary school students.

2.2 Tracking the Information

In this section, the tracking process of relevant search chains of studies was established. Kitchenham and Brereton (2013) Proposes guidelines for designing efficient search strings. With this purpose keywords related to the research questions were selected and three search strings were defined. See table 1.

Table 1. Searching strings and key words

#	String	Total
String 1	"Metacognitive Strategies AND Learning Quality" OR "Metacognitive Strategies" OR "Learning Quality" OR "Acquisition process quality" OR "The Acquisition Process" OR "The retention process" OR "The Assimilation Process"	393
String 2	"Metacognitive Strategies" AND "Learning Quality" OR "Acquisition process quality" OR "The Acquisition Process" OR "The retention process" OR "The Assimilation Process" OR "The understanding process" OR "School learning processes"	12
String 3	"Learning comprehension" OR "Understanding of knowledge" OR "Acquisition of learning" OR "Acquisition of knowledge" OR "Assimilation of learning" OR "Assimilation of Knowledge" OR "Learning retention" OR "Knowledge retention" OR "Learning Transformation" OR "Knowledge Transformation"	317

Seven databases were used to do the systematic mapping: Scopus-Elsevier, Science Direct-Elsevier, Springer Link, Web of Science, IEEE Xplore, Taylor & Francis and Wiley Online Library. The studies found in each database searching process were 722, these can be seen in table 2.

Table 2. Studies found in each database

Digital Library	Retrieved	Relevant Papers	Papers	Year of Publication							
				2012	2013	2014	2015	2016	2017	2018	2019
Scopus	314	7	15, 16, 17, 26, 28, 29, 32				32	28	26	15, 16, 17, 29	
Springer Link	68	4	18, 27, 30, 31		27	31			30		18
Web of Science	88	5	19, 20, 21, 22, 23				20		19, 23	22	21
Science Direct	138	2	24, 33	24	33						
Taylor & Francis	15	1	25					25			
IEEE Xplore	60	0									
Wiley Online Library	39	0									
Total	**722**	**19**	**19**	**1**	**2**	**1**	**2**	**2**	**4**	**5**	**2**
Percentage	100%	2,63%	100%	5,2%	10,5%	5,2%	10,5%	10,5%	21%	26,3%	10,5%

Table No. 2 describes the amount of publications found (722). Number of relevant publications related to the main issue, methods and populations (19), year of research publication, which mostly were between 2018 and 2019 (7 = 36,8%) and only four papers were published between 2012 and 2014. This searching process was conducted between August and October 2019.

2.3 Studies Classification

Selection process of papers was done using both inclusion and exclusion criteria. According to Costa et al. (2019) the objective of this process is to select relevant documents related to the purpose of the study and the research questions proposed in the previous step in order to reduce useless publications. Six inclusion criteria and six exclusion criteria were used. These criteria are presented in Table 3.

Table 3. Inclusion and exclusion publication criteria

Inclusion Criteria	Exclusion Criteria
IC-1: Relevant studies.	EC-1: Papers not written in English, except if the research was conducted in Colombia.
IC-2: Studies conducted between 2012 and 2019.	
IC-3: Studies conducted using quantitative approach and experimental methods applying, metacognitive strategies to learning.	EC-2: Publications without access to full-text.
	EC-3: Qualitative, exploratory or descriptive studies or papers tackling philosophical aspects excepting research aimed at reporting learning quality or learning acquisition process and its sub- processes.
IC-4: Research conducted using secondary or high school students as target population.	
IC-5: Research documenting improvements in the quality of student's learning.	EC-4: Research conducted with university population. Only for the metacognitive strategies variable.
IC-6: Studies presenting findings related to the process of student's learning acquisition and its sub-processes.	EC-5: Studies conducted in fields other than education, except if the research was developed in the health area or the research is related to the topic, method and population of this research.
	EC-6: Research conducted with teacher population.

2.4 Data Extraction

In this stage, the papers were completely and detailed read in order to answer the above-mentioned research questions, and in this way to obtain the evidence supporting this mapping study.

3. RESULTS

Firstly, dissemination media, type of research method and the target population of selected papers were analyzed. It was found that 57, 89% (11 papers) of the relevant papers were published in journals. 26.3% (5 papers) were published in conferences and 10.5% (2 papers) were book chapters. Regarding the research methodology, 63.15% (12 papers) used quasi-experimental, pre-experimental or experimental designs with intervention; 10.5% (2 papers) used mixed designs; 10.5% (2 papers) made correlational approximations; 5.2% (1 paper) used longitudinal design; 5.2% (1 paper) used action research design and 5.2% (1 paper) used another type of design. Regarding the target population , it was found that 63.15% (12 papers) were conducted using secondary school students; 10.5% (2 papers) were developed with university students; 10.5% (2 papers) were carried out with an open education population, this same amount of papers were conducted with a disable population and 5.29% (1 paper) was carried out in primary school.

3.1 Answers to Research Questions

In this section, answers are given to the previously asked questions.

RQ1: What evidence does indicate the use of metacognitive strategies to improve the learning quality of secondary school students? Among all the retrieved research, just three studies were identified (Susantini, Sumitro, Corebima and Susilo, 2018; Yusnaeni, 2018; Mulyono and Hadiyanti, 2018) answering this question.

In Susantini et al. (2018), the authors verified the effects of metacognitive strategies (MS) on general techniques for improving thinking skills through: i) Four stages: differentiate, refine, elaborate and interrelate; ii) Six phases: to clarify learning objectives and to explore pre-existing knowledge, to organize the students 'learning process, to monitor students' conceptual change, to introduce important concepts, to verify student understanding ,to provide feedback, and to encourage self-control and self-assessment; iii) Four activities: questioning, clarifying, summarizing and predicting. For this, the Self-Understanding and Evaluation Sheet (SUES) was used. The authors found that students with high capacity developed higher metacognitive skills, high levels of knowledge in the specific area and better academic achievements in students with a low capacity were identified.

In Yusnaeni (2018) the effects of the models Search Solve Create and Share (SSCS), were analyzed: this same model associated with the use of metacognitive strategies (SSCS + MS), and traditional learning, for the improvement of learning quality of secondary students were taken into account. Underlining Metacognitive

strategies were used when reading text and self-assessment, to identify students' strengths and weaknesses, to monitor and assess their learning. The authors found that (SSCS + MS) may increase student learning outcomes, as they provided better learning outcomes in students with lower academic levels than those with SSCS and traditional models.

This study Mulyono and Hadiyanti (2018), was conducted to test and analyze the quality of learning based on problem solving of secondary school students in mathematics and science. In this, students were grouped according to their metacognitive level into four: tacit using level, conscious using level, strategic using level and reflective using level. The learning quality test was carried out tackling the planning, process and outcome phases. The authors state that the high level of students' metacognition is directly proportional to the ability to solve problems. Students with tacit using levels completed the tasks without understanding the reason for using the strategy; instead those from conscious using level solved the problem and were able to build new knowledge through problem solving.

RQ2: What kind of metacognitive strategies have been applied to secondary school students' learning process? It is reported that 57.89% (11 studies), applied metacognitive strategies in their interventions. However, the contributions of (Cai, King, Law and McInerney, 2019; Makela et al. 2019; Erdoğan and Şengül, 2017; Lei, Sun, Lin and Huang, 2015) are highlighted, since they made a detailed explanation of the strategies used and the methodological process carried out during the intervention.

Regarding Cai et al. (2019), it was examined how future objectives, metacognitive strategies and achievements dynamically influence each other over time. To do this, they used a Self-Learning Scale (SLS), which is composed of three metacognitive strategy sub-scales, which are: i) changes to improve: ways in which students try to improve their learning by identifying their mistakes ii) monitoring: regular self-test of students' learning and understanding; iii) planning: activities: prepared by learners for future work. Authors found that metacognitive strategies influenced the further searching for future objectives.

In Erdoğan and Şengül (2017) the level of metacognitive awareness of sixth grader students in mathematics was measured, in the knowledge and regulation dimensions. The metacognitive strategies used were: i) modeling; ii) thinking aloud; self-appraisal; iii) metacognitive instruction; iv) putting action cards online; v) problem solving and thinking aloud; vi) choosing consciously; vii) reacting to comments and reviewing; viii) writing ("thinking aloud" on paper); ix) Reflecting about and reflecting on learners 'ideas; x) keeping journals; xi) and predicting. These strategies were measured with the Junior Metacognitive Awareness Inventory (Jr. MIA) version B. The authors affirmed that, participation in debates where thoughts are reflected about, thinking aloud and promoting strategies, can facilitate the development of metacognitive skills in students such as planning, monitoring and evaluation.

In the study Lei et al. (2015) the influence of metacognitive strategies: planning, monitoring and evaluation in searching behaviors and learning about performance on You Tube videos related to animal understanding, a questionnaire using the Chiu (2006) modified metacognitive strategy (MSUQ) was applied to evaluated fifth grader students. It was reported that children with better evaluation and planning skills efficiently identified the videos that met the task requirements.

In Makela et al. (2019) it was verified that children with fetal alcohol spectrum disorder (FASD), based on the metacognitive approach: problem identification, planning, fragmentation and reinforcement, could acquire 26 metacognitive strategies. In this, a metacognitive strategy checklist was used based on the Flavell learning stages: what is taught, requested, spontaneous and mastered. It was found that with the right training these 26 metacognitive strategies improved children performance during sessions.

RQ3: What learning processes in secondary school students have been intervened through metacognitive strategies? It was found that 21.05% (4 articles) carried out interventions with metacognitive strategies focused on learning processes.

In Al-Jarrah, Mansor and Rashid (2018) the influence of using metacognitive strategies in the development of EFL writing skills in secondary school was researched taking into account five stages: i) preparation, students associated their previous knowledge with contents, they were taught about the details, the advanced organization and the selective attention; ii) presentation, students were given personal preparation strategies, as well as self-control and self-evaluation strategies for their application; iii) practice: students planned their writing compositions in accordance with the self-planning strategy. Evaluation: phase of effective understanding about what has been learned, about reevaluation, self-evaluation, coevaluation, hetero-evaluation and self-questioning; iv) expansion, included transference strategy to other contexts (practicing, combining, evaluating, estimating and incorporating the learned strategies); v) writing tests,

students showed their writing skills, whose instructions on using metacognitive learning strategies were found that improved students' writing abilities.

In Muñoz and Ocaña (2017), metacognitive strategies of planning, supervision and evaluation were implemented in secondary school children to improve reading comprehension processes. The following sub-processes of reading comprehension were intervened: vocabulary understanding, detailed understanding, understanding to perform text macrostructure, and understanding for main ideas identification. In addition, the following inferencing processes were also intervened: inference in expository texts: lexical inferences, causal inferences, comparison inferences, specification inferences, inclusion inferences, macrostructural inferences. Through a pedagogical intervention in the three reading moments: before, during and after reading. The authors evidenced significant improvement on children's textual comprehension by applying metacognitive strategies such as planning, supervision and evaluation of reading.

In Tajalli and Satari (2013), the effectiveness of metacognitive strategies for improving reading skills of students with hearing disorders was identified. These impaired children improved significantly their reading skills using metacognitive strategies.

In Wagaba, Treagust, Chandrasegaran and Won (2016), the intervention effects for the improvement of secondary schoolers metacognitive abilities focused on motivational processes to get achievement and understanding were evaluated. Interventions included: focused results, collaborative activities, improvement in their reading abilities of scientific texts, and draw concept maps; The evaluation of the metacognitive capacities was measured through the Metacognitive Strategies Questionnaire (MStQ) and the Metacognitive Support Questionnaire (MSpQ). It was found that there were no significant rates in any of the scales of the (MStQ), but did have significant gains in all scales of the (MSpQ) which implies that most children perceived that their science classroom environment is oriented for using metacognitive strategies, but hardly ever they used .

RQ4: What indicators are used to measure the learning quality of secondary learners? Only 31.57% (6 articles) from the selected documents provided evidence of learning quality indicators. The studies (Stracke, 2017; Zhao, Wu, Chen and Wan, 2016) tackled the learning quality from open education. In Stracke (2017) improvement indicators were: potential indicators, process indicators and results indicators; additionally three levels of learning and education indicators were used: macro (organizational), meso (institutional) and micro (individual student process). In Zhao et al. (2016) were taking into account the following criteria for assessing the quality of learning: student's participation and their academic performance in forum, the emotions of being part of these activities, and the fact of searching videos and their academic performance.

The research (Yogica and Helendra, 2018; Ermolayev, Keberle and Borue, 2013), were developed at university level with the purpose of improving quality of learning, using motivational processes. In Ermolayev et al. (2013) they applied peer evaluation to improve extrinsic motivation, taking into account the quality of the reports submitted by the students. The quality of the cross-evaluation and their objectivity. In Yogica and Helendra (2018) they applied the method called "they do it, they get it and they know it". The learning quality indicators were intrinsic motivation and understanding.

The studies (Yang and Dong, 2017; Zou, Li, Chen, Zhong and Wang, 2014), were carried out in secondary school to apply the Bloom's taxonomy and the SOLO (Structure of the Observed Learning Outcome) taxonomy, respectively. In Yang and Dong (2017) a set of student learning progress indicators based on the Diffuse Cognitive Map was proposed to comprehensively describe the progress of learning. For this, a Student Attribute Model (SAM) was taken into account to incorporate performance-based learning (PA) and non-performance-based learning attributes (NPA). In this study, a different version of Bloom's taxonomy that classifies psychomotor domains into 7 levels was applied. To analyze the learning progress they established the following groups: learning attributes students, subjects, learning stages, and study and performance groups. The indicators used were: knowledge construction indicator (KCI), teacher expectation indicator (TEI) and student growth indicator (SGI).

In Zou et al. (2014) they applied the taxonomy SOLO and their learning approach levels: superficial, deep and achievement level to establish their relationship with the learning quality. Data Indicators on learning approaches were obtained through the Student Learning Process Questionnaire (SLPQ), which contains six scales: grading about the surface learning motive, grading about the deep learning motive, grading of reasons for learning by achievements, grading about the strategy of superficial learning, grading about deep learning strategy and grading about learning strategy by achievements.

RQ5: What evidences are there about studies aimed at learning acquisition process and sub processes of Comprehension, Retention and Transformation in secondary school students? 10.55% of the papers (2 articles) could answer this question. Wäschle, Gebhard, Oberbusch and Nückles (2015) was aimed at verifying the effects of writing reflective journals to critically reflect on scientific issues. It was trained in using learning strategies during the writing process with two cognitive instructions with the objective of stimulating reading comprehension sub-processes: elaboration and organization, and two metacognitive instructions with the purpose of stimulating the understanding when monitoring and planning corrective strategies. It was evidenced that writing reflective journal proved to be more successful than any other traditional writing tasks for self-regulated learning. In Hong et al. (2013), based on the dual process theory, the Solitaire and Heart Attack games were used to determine their effects on the retention sub-process of secondary students learning process. It was found that Solitaire game was more effective in increasing long-term memory retention rates.

4. THREATS

According to the contributions of Costa et al. (2019) the SM method is a formal research process, highly conceptualized and with a quite precise approach applied to the literature review; but validity problems can be presented if any appropriate key words selection is applied and also it is necessary to plan an effective design of searching strategy.

5. CONCLUSION

With the use of the SM method, a detailed searching was conducted in seven widely recognized databases in the field of educational research. 722 articles were selected and 19 of them were relevant to this research.

From the papers retrieved several applications of metacognitive strategies in the dimensions of knowledge and regulation were found such as : planning, monitoring, evaluation, underlining, self-evaluation, changes to improve, modeling, thinking aloud, consciously choosing, reacting to the comments and reviewing, writing ("thinking aloud" on paper), reflection on and reflecting about learners' ideas, keeping diaries, predicting, among others.

Regarding the learning processes intervened by metacognitive strategies, they were: motivation, understanding, transference, evaluation, selective attention, knowledge association, advanced organization and inference.

From relevant publications, it was possible to show that the indicators of learning quality used were: potential, processes, results, academic performance, peer evaluation, intrinsic motivation, understanding, knowledge construction indicator (KCI), teacher expectation indicator (TEI), student's growth indicator (SGI), superficial level of learning, deep level of learning and level of learning achievement.

Only three studies applied metacognitive strategies to improve learning quality in secondary students and seven applied strategies related to other aspects. This confirms that research contributions in this particular knowledge area are very scarce.

In regard to studies aimed at the learning acquisition processes and its sub-processes any paper was found tackling these characteristics, only interventions were applied in the comprehension and retention ones.

This confirms the existence of a knowledge gap in the application of metacognitive strategies to improve learning quality of secondary students, therefore, it is essential to carry out studies with these types of interventions in classroom settings which will provide greater relevant knowledge in the pedagogical area at school and contribute to the improvement in the educational field.

These findings may contribute to decision-making processes on methodologies, indicators, strategies, techniques and instruments to be used in conducting research aimed at researching on metacognition and secondary students' learning quality.

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