Methodology for Systematic Literature Review applied to Engineering and Education

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Abstract— **A systematic review of the scientific literature in a specific area is important for identifying research questions, as well as for justifying future research in said area. This process is complex for beginners in scientific research, especially if you have not developed skills for searching and filtering information, and do not know which high-level databases are relevant in their field of study. The method proposed leads the researcher from "My" to "The" current state of the problem; we propose an adaptation of the method by Kitchenham and Bacca, which divides the process into three sub-parts: planning, conducting and reporting results. From the approach of the research problem in the preliminary phase research questions (recommended between 3 to 5) and "mentefacto conceptual" is drawn; this last one gives originality to the method and facilitates the development of the thesaurus for searches and inclusion and exclusion criteria. Early research requires doing a basic systematic study to identify work done to review the literature in the area and, if any is found, to verify if those results yield an answer to our research questions. As part of planning the search process, general and specific inclusion and exclusion criteria were defined, along with some complementary inclusion and exclusion parameters. The method followed with rigor, returns to the researcher a list of impact journals in the study area, and a detail of articles that are related to each category of the research questions. A study case has been considered as a guide to expose each of the phases of the methodology in a practical way, with results that support the proposal.**

Keywords— systematic literature review; methodology; educational enginering;

I. INTRODUCTION

A systematic review of the scientific literature in a specific area is important for identifying research questions, as well as for justifying future research in said area [1]. In the scientific realm, it is essential for doctoral students who are just starting research in a specific area and who need a systematic approach to learn the work carried out to date, the methods that have been used (population, sample, statistics), the results obtained, the proposals put forth by the authors and, of course, to ascertain who the leading authors are in an area, and what databases and publications they use to present their work, thus enabling them to know how to obtain updated and permanent information on the dynamic results published by various laboratories, research centers and institutions of higher learning in general.

Another problem is the lack of knowledge and identification of journals and spaces for scientific dissemination, where researchers from similar fields of research, problems and objectives, are sharing progress, results, methods, strategies, databases, networks, etc., and are also, the main space in which as a researcher should be involved to interact and contribute. Likewise, for a researcher who starts in a new field of science, or wishes to complement his area of work, it is difficult to establish the key words of search from a thesaurus, as well as the inclusion and exclusion criteria for filtering the results. As a solution, a taxonomy is presented in [2], described in a table of several categories, subcategories and sub-subcategories/ topics, which help to understand the scope of the field of study, but the search procedure is not clear from a list so broad; likewise, in [3] they propose a taxonomy product of the crossing of four main categories, and breaking down from two diagrams, in the form of horizontal tree with double entry (rows and columns), with many keywords, without explaining the discrimination strategy to structure the search procedure. As a solution, we propose the adaptation of the "mentefacto conceptual", designed by De Zubiría [4], whose aim is to improve reading comprehension; however, its characteristics and graphic design facilitate the fulfillment of these needs efficiently.

Regarding the processes currently used for review of scientific literature in education and technology, in [5] they make a simple filtering, searching the Scopus database for the single variable: main topic; and, as discriminators, the date of

"Fundación Carolina" scholarship for doctoral studies (2014-2017).

publication, with a subsequent individual analysis of the list of resulting documents. The results are satisfactory for the researcher, although technically it is not a systematic review; and, from an external view, the bias in the search keywords is visible, as well as in the analysis, by not detailing inclusion or exclusion criteria, and limited to a resulting subjective discussion.

There are several methodologies that explain in detail the entire systematic process of elaborating a state of the art, and overcome the previous limitations, setting aside empirical practices. They have served as a guide to researchers during the last years, standing out among these, the proposals by Kitchenham et al. [6], applied by the same author in the search for literature reviews in engineering [7]; and in later, adapted by Bacca et al. [8] and several thousand researchers. They divide the process into three sub-parts: planning, conducting and reporting results. The Kitchenham team at Keele University [9], based on the previous proposals [6], [7] elaborate the Guidelines for performing Systematic Literature Reviews in Software Engineering, with adaptations and own specifications of Software Engineering, but extendable to all the fields of science. These methodologies already require a previous experience of the researcher, and his mastery of the field of science on which he wishes to establish his state of the art.

As they show in the results obtained by applying the method of Kitchenham et al. [6], [7], [9], this allows a rigorous process to obtain results based on the research problem, research questions, inclusion and exclusion criteria, and the corresponding analysis. These advantages and potentials of great impact, are inherited in this method, in the systematic search process, and are complemented with elements of conceptual thinking, to facilitate the tasks of the researcher. With the method, therefore, we propose improvements to the Kitchenham method, to optimize the first moment of work in the systematic review. In addition, a list of impact journals is established in the process, which in some way will be the space where the new researcher can share their research results, establish their network of work with the area experts, and update their state of the art continuously.

In the final part of the document, an overview of the application of the method is shared in a real case, detailing the *mentefacto conceptual*, search word thesaurus, search scripts by database, research questions, inclusion and exclusion criteria, related literature reviews, analysis characteristics of the research question, lists of related journals, results of systematic review and brief conclusions. This example demonstrates the validity of the model in a real case, facilitating the systematic review process.

II. METHOD

We used the method for a systematic review of the literature by Kitchenham [6], [7], [9], and later adapted by Bacca [8], which divides the process into three main phases: planning, conducting the review, and report the review. A preliminary conceptual analysis process has been added, which is developed from an early approach to the general research problem; this conceptual analysis is carried out from the proposal of the conceptual mind, designed by De Zubiría [4] or analysis and understanding of a specific field of study, from a graphic model; this resource will guide the entire process of organizing the search, and discrimination from inclusion and exclusion criteria. With the changes previously discussed, the procedure for the systematic review has the following stages:

1. Planning
   - 1.1. Identification of the need for review
     - 1.1.1. Current State of the Problem Research.
     - 1.1.2. Research Questions
     - 1.1.3. "Mentefacto Conceptual"
     - 1.1.4. Related Systematic Reviews
   - 1.2. Development of a review protocol
     - 1.2.1. Definition of inclusion and exclusion criteria
     - 1.2.2. Preparing a data extraction form
     - 1.2.3. Selection of Journals
2. Conducting the review
   - 2.1. Identification of research
   - 2.2. Selection of primary studies
   - 2.3. Study quality assessment
   - 2.4. Data extraction and monitoring
   - 2.5. Data synthesis & monitoring
3. Reporting the review

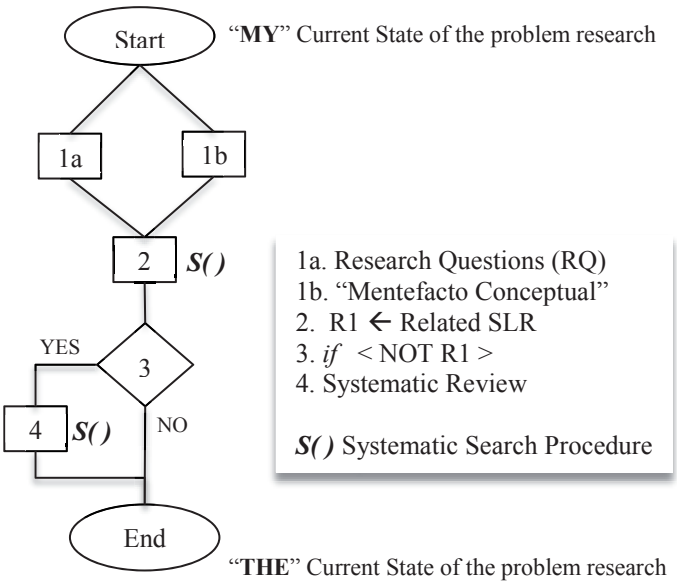

Fig. 1. *Macro procedure of the Methodology*

The researcher starts from an early state of "personal/individual" knowledge of the problem, which in Fig.1. is shown as "'**MY**' Current State of the problem", and, at the end of the whole process, it moves to a universal state: "'**THE**' Current State of the problem". In addition to knowledge about the problem, and area of knowledge, for which the literature review will be conducted, the researcher should at least write the research questions and draw the *mentefacto conceptual*. From this previous knowledge base, the first systematic search ***S( )*** is made, to determine the existence of systematic reviews conducted on the subject in particular. Only, if a systematic

review that answers the research questions has not been found, a systematic review will be carried out.

The *Systematic Search Procedure* ***S( )*** requires several sub-stages, which detail part of phase 2 of the macro process. As shown in Fig. 2., it starts with a set of search words, obtained from the *mentefacto conceptual* and the scientific thesaurus, a search semantic structure, search script adapted to each database, a specific process of selection of studies, and, a list with the search results as a variable resulting from this procedure.

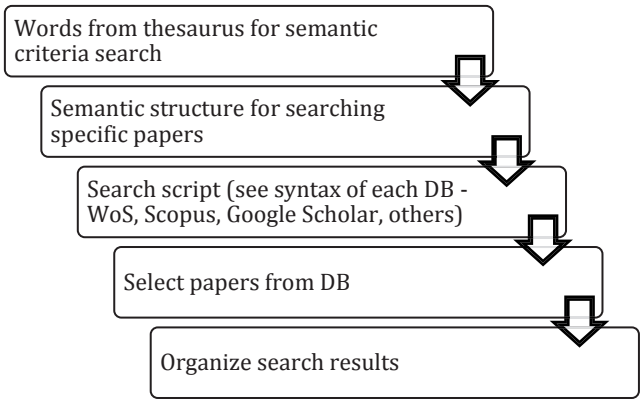

Fig. 2. *Systematic Search Procedure* ***S( )***

Despite seeming like a linear process, several of the processes are iterative and take place in continuous cycles until the goals of each phase and sub-phase are completed. In keeping with a methodological outline, we followed the suggestions proposed in "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) [1] for the "Development of a review protocol" stage, as well as in the final part for presenting the report, considering that the goal of PRISMA is to help researchers prepare systematic review reports through the use of a 27-item evaluation checklist and a specific flowchart to follow [10]. In the proposed design, at least one iteration is required for each research question posed.

A. Planning

1) Current State of the Problem Research

The research problem is the starting point of all scientific process, and therefore it is also the systematic review of Literature. As Anger-Egg[11] puts forward as recommendations for the approach of the problem: one should not pretend to make a perfect formulation from the first moment; we must consider the personal and social dimension; and, it has to be done with sociological ideology. In this field, Hernández [12] proposes some elements that should have the approach of the problem in research:

1. Objectives: study guides.
2. Research questions.
3. Justification of the study: Why? and for what? of the study.
4. Feasibility of the study.
   4.1. Availability of resources.
   4.2. Scopes of the study.
   4.3. Implications and consequences of the study.
5. Deficiencies in the knowledge of the problem
   5.1. State of knowledge.
   5.2. New perspectives to study.

Of these, some are obtained as a result of the systematic review; however, the first must be clear to start the process. How Ackoff [13] expose, *a correctly raised problem is partially solved; more accurately, there are more possibilities to obtain a satisfactory solution ... the researcher must be able not only to conceptualize the problem, but also to write it in a clear, precise and accessible way*. The correct approach to the problem, and the clarity that the researcher has about this, are the input on which all the other phases of the methodological process depend.

2) Research Questions

Hernández [12] exposes research questions as one of the components of the problem statement; These first questions are the ones that will guide the whole process, since they summarize the intrinsic interests of the researcher, and the knowledge that this has of the state of the specific science. For Hienemann [14] the question determines the design of the research, and establishes what results can be expected, so it is essential at the beginning of a study to formulate the research questions with precision and to explain the reasons for their formulation. The research questions, establish in the process a first orientation regarding what has to be investigated, and how it should be done. From the first list of research questions, these are labeled and must be clearly distinguishable. The labeling syntax begins with the letters RQ, follows a numerical sequence and in later the narrative properly of the question:

- *RQ1_* Explain about first question?
- *RQ2_* Explain about second question?
- *RQn_* Explain about final question?

The initial list of research questions can be reduced if after carrying out the search for systematic reviews any of these questions is already answered from the results of another researcher's review. The question could also be maintained and some of its categories of analysis changed, if it had been partially answered. Kitchenham recommends writing between 3 and 5 research questions, as a balance between the coverage of the research and the depth of the answer required by each question.

3) Mentefacto Conceptual

The *mentefacto conceptual* was designed by De Zubiría [4] as one of the necessary instruments to make a good reading and learning. The *mentefacto conceptual* is tool created by Conceptual Pedagogy in order to represent concepts. In the words of its author, it is an ideogram or graphic sketch that represents something, assumes a complex idea, and conceptualizes it. This action requires answering four questions: what characterizes it, in essence? In what group of things include it? What are your differences with similar objects? and, are there subtypes of yours? From these questions, the scaffolding of the concepts is assembled, being four groups of thoughts resulting: 1) isoordinated, 2) superordinate, 3) excluded, and 4) infraordinated, as shown in Fig. 3. The isoordinados show essentialities; the superordinates, the group that includes the

concept; the excluded, point out the notions closest to the concept; and, the infraordinates, specify the classes and subtypes of the concept.

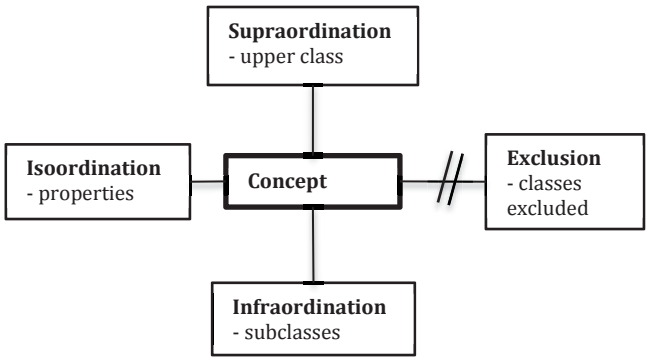

Fig. 3. *"Mentefacto conceptual"* [4]

From this ideogram will be obtained the search words, which are usually found on the left side (Isoordination). The subclasses (Infraordination) are also considered for search words, taking into account that a study carried out on a subset of the concept, would also belong to it. The data available in exclusion and supra ordination, are considered for the detail of the inclusion and exclusion criteria.

4) Related Systematic Reviews

TABLE I. SEARCH SCRIPT FOR EACH DATABASE

DB	Syntax	Resulting papers *val/ref/res*
WOS	Initial Filter: <Tittle> and year >(current year - 5) `(keyword_1 OR synonymous_1) AND (keyword_2* OR synonymous_2_1* OR synonymous_2_2* OR synonymous_2_n) AND (keyword_n) AND (review)` Refine results: • `(keyword m* OR synonymous m*)`	*v1/rf1/rs1*
Scholar	Parallel filters: (year > (current year - 5)) • `allintitle: review, keyword_1, OR synonymous_1, keyword_2, keyword_n, OR synonymous_n_1, OR synonymous_n_2, OR synonymous_n_m` • `allintitle: review, study, keyword_1, OR synonymous_1, keyword_2, keyword_n, OR synonymous_n_1, OR synonymous_n_2, OR synonymous_n_m`	*v2/rf2/rs2_ 1+rs2_2)*
Scopus	Initial Filter: <Article Title, Abstract, Keywords> and year >(current year – 5) `(keyword_1 OR synonymous_1) AND (keyword_2* OR synonymous_2_1* OR synonymous_2_2* OR synonymous_2_n) AND (keyword_n) AND review` Subject Area: Computer Sciences, Social Sciences	*v3/rf3/rs3*

In this phase of rupture, the first systematic search is performed by following the steps proposed in Fig. 2. From *mentefacto* graph model, the first moment of bibliographic search requires doing a basic systematic study to identify work done to review the literature in the area and, if any is found, to verify if those results yield an answer to our research questions.

The search words are obtained from the *modelo conceptual*, and related to the thesaurus of the area of science to establish words that indicate synonymy and antonym, input for the generation of the semantic structure of search for papers. *Table I* shows an example search structure, which will then be transformed into a script adapted for each DB. The resulting papers are organized into three categories: valid, referents and response, to finally be with the last ones that have managed to overcome the subjective criteria of the researcher.

The following is to highlight if the literature reviews found, allow us to answer the research questions that we have raised in our problem; if yes, this study is taken as the basis from which to support our research proposal; Otherwise, the unanswered research questions will be specified, labeling them to provide a structured follow-up of the bibliographic research that begins.

B. Development of a review protocol

1) Definition of inclusion and exclusion criteria

This sub-stage is the first of the Development of a review protocol, and both this and the following ones are conditioned by the lack of systematic review studies that answer the research questions and their categories of analysis. Bacca et al. [8] explains this sub-stage detailing general, specific and additional criteria, taking into account research questions. For this procedure, one should also look at the excluding classes and upper classes of the *mentefacto conceptual* (Fig. 3.).

As part of planning the search process, several general and specific inclusion and exclusion criteria are defined, along with some complementary inclusion and exclusion parameters (ignore editorials, book reviews, technical reports and data sets; consider only papers published in the last five-ten years). Variables are set up involving theoretical research, international standards and research methods adaptable to each item in order to steer the replies to the research questions. As a result of this sub-phase, a list of the specific inclusion and exclusion criteria applicable to all resulting papers must be prepared. Some additional parameters are also written to guide the exclusion of articles, in case of wanting to make the process more or less rigorous.

2) Preparing a data extraction form

It is necessary that the researcher prepare the platforms for the organization of the results that will be obtained. You must specify and configure tools and results organization spaces, such as spreadsheets and bibliography management applications. When applying the search process to scientific articles, the results should be classified and codified, being advisable to make use of a bibliography management tool, such as Mendeley, Zotero or other that the researcher considers. To organize and facilitate the analysis, protocols are specified for the identification of papers according to the research question, author and year. If the research is shared, the creation of documents in the cloud, with the ability to edit all the members of the research group is the best option. The storage space for

papers and other documents resulting from the search is also necessary, and for collaborative work and contingency, storage in the cloud is one of the best options.

3) Selection of Journals

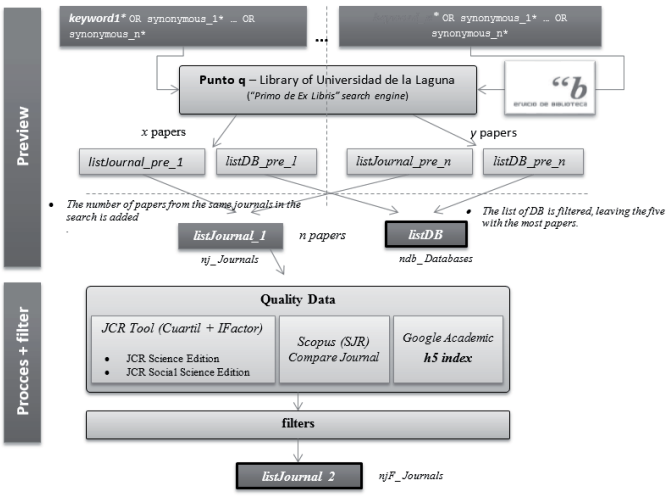

Fig. 4. *Flow chart for selecting relevant journals*

It has been designed a *flow chart* for selecting relevant journals. The platform used for this initial filtering is "Primo de Ex Libris" (licensed to the library of the Universidad de La Laguna), specifically through its search engine, "Punto q"[1]. The platform automatically generates lists that are arranged into two groups, one for journals and another for databases (*listJournal_pre_1* to *listJournal_pre_n* and *listDB_pre_1* to *listDB_pre_n*, where ***n*** is the number of searches. Most scientific research tends to be multi-disciplinary, and that applies to this study, which combines the disciplines of Education, Computer Science and other. The goal in this sub-stage is to select those journals with the highest impact factor. To this end, we propose the systematic search, where a search structure is applied that makes use of a *semantic sentence*[2] that combines the research disciplines using terms found in a scientific thesaurus, which is used to identify research in the areas in question through keywords. This filter focuses our attention on the databases and journals that are of interest to our area of research.

The ***listJournal_1*** (first journal list) includes columns for the JCR (Impact Factor, Quartile in Category and Category, obtained from the Journal Rankings), SJR and h5 indexes. The filter of *sorting* are also applied, resulting in ***listJournal_2***. Specifically, the following filters can be applied:

- Sorting formula:

*Ord = (#r papers research * 25%).(JCR IF).(SJR).(h5 index)*

The 25% corresponds to the quantitative percentage of the number of papers obtained in the journals, and is set to equate this variable to the other three parameters.

- All of the journals not associated with the area of study must be removed from list. For instance:
  - The JCR considers the following fields: Computer Science – Interactive Application, Computer Science – Information Systems and Multidisciplinary Sciences; Education & Educational Research, Psychology – Education, Psychology-Multidisciplinary and Rehabilitation.
  - In the h5 index, the sub-areas: "Education Technology", "Education", "Human Computer Interaction" and "Engineering & Computer Science (general)".
  - The "Aims and Scope" section in each journal's website must be individually checked as a definitive discriminating factor.
- Journals not indexed in JCR or SJR must be removed.
- Only the first twelve journals in the list must be kept, arranged in descending order based on the Ord formula given earlier.
- The journals must be organized into two blocks based on the classification in JCR 2016: *JCR Science Edition* and *JCR Social Science Edition*.

C. Conducting the review

As Kitchenham [7] explains, once the protocol has been agreed, the review proper can start. This process relies on the results from the previous phase: the inclusion and exclusion criteria and the list of journals (*listJournal_2*). Some of the procedures to follow here are detailed in Fig. 2. *Systematic Search Procedure* ***S( )***, which were also applied in the planning phase, in Related SLR. This stage includes 5 sub-stages that are detailed in Kitchenham's [7] proposal, with the adaptations of the new method.

All the sub-stages that involve the review are iterative and incremental, so the process will follow as many times as the researcher considers necessary until the research questions are answered.

1) Identification of research

This first sub-stage complements in some way the protocol exposed in the previous phase. Involves activities such as establishing search strategies, publication bias, bibliography management and document retrieval, and documenting the search. As search strategies, the first three stages of *Systematic Search Procedure* ***S( )*** apply: 1) Words from thesaurus for semantic criteria search; 2) Semantic structure for searching

[1] *Punto q* is the digital document search engine for the Universidad de la Laguna library. It can be accessed at http://www.bbtk.ull.es/view/institucional/bbtk/Biblioteca_Digital/es (checked February 2018)

[2] A semantic sentence is used to consult databases through structured query languages (SQL).

specific papers; and 3) Search script. Here, the hard search is performed on the selected databases; it is suggested to do it in WoS, Scopus and Google Scholar having as filter the list of previously obtained journals.

The "Knowledge Discovery in Databases" (KDD) process [15], is recommended to conducting a continuous search in each of the journals and arranging the results based on the structure of the variables from research questions. The semantic structure of searches is done following the principles of structured search, common in SQL; the logical gates AND, OR, NOT, SAME, among others, help the filtering to be efficient. As explained in the example, AND is used to unify search levels and OR for sequence of synonyms according to the previously elaborated thesaurus; NO is used to limit certain words that are "messing up" our search.

When applying the search process to scientific data bases, the results should be classified and codified, being advisable to make use of a bibliography management tool, such as Mendeley[3], Zotero[4], Endnote[5] or another that the researcher considers. Bibliographic packages are very useful to manage the large number of reference that can be obtained from a thorough literature research.

About publication bias, it refers to the problem that positive results are more likely to be published than negative results; the concept of positive or negative results sometimes depends on the viewpoint of the researcher [7]. The search in Google Scholar helps in some way to limit the bias; However, it must be mentioned that for the realization of high-level state of the art, it is necessary to rely on studies that have been endorsed by academic peers with a recognized track record, and who are generally behind high-impact journals, in indexes JCR and SJR in first quartile.

2) Selection of primary studies

Once reference lists have been finalized the full articles of selected studies will need to be obtained. It is necessary that the entire research group be logged into the bibliography administration system, to access the administration and joint selection of papers. Study selection criteria are intended to identify those primary studies that provide direct evidence about the research question [7]. In order to reduce the likelihood of bias, selection criteria are decided during the protocol definition; in this sub-stage these criteria guide the entire process, and make the difference between a systematic and traditional review. Final inclusion/exclusion decisions should be made after the full texts have been reviewed.

Each paper must be labeled, downloaded and placed in the repository previously created for this purpose. This is the suggested syntax for organizing of the digital files:

RQ[n]_[nArt]_J[nJournal]_[year]_[last_name Author]_[Title_article]:

For instance:

***RQ2_01_SSE3**_2013_Torres_Usabity studies in gestural environments*, where:

RQ2: Research Question ***2***
01: Paper number ***1*** (referring to the first paper selected)
SSE3: Journal number from List in Social Sciences.

Likewise, the bibliographical references should be downloaded and imported into the bibliography manager. In the previous example the data to be located in the application should be: *Tags:* (RQ1, SSE1, SLR), and places the relevant data in the *Notes* area. The selected document must also be tabulated in the electronic record sheet, for subsequent statistical processing.

3) Study quality assessment

This sub-stage is complementary to previous. In addition, to general inclusion exclusion criteria, it is generally considered important to assess the "quality" of primary papers [7]. These considerations are supported by the inclusion and exclusion criteria, adding aspects of quality represented in the relevance of the study, quality of the bibliographic sources, relevance and academic prestige of the authors, impact factor of the journal in which it was published, among others. In [7] *CRD Guideline* is mentioned because explain an assessment of study design to guarantee a minimum level of quality; also to *The Australian National Health and Medical Research Council guidelines* because suggest that study design is considered during assessment of evidence rather than during the appraisal and selection of studies.

Databases and search engines such as *Scopus*, *WoS*, Elsevier's *ScienceDirect*, *GoogleScholar*, allow you to quickly know the relevance of an article. Likewise, to establish the ranking of a journal, sites such as *Scimago* (SJR) and Journal Citation Reports, index h5 of Google Scholar, have a bibliometric detail of all journals indexed in its database; variables such as: h index, impact factor and dating trend, will be of great help to establish the quality of the journal. Mention also, that by strategy of the methodology, having previously made a rigorous review and listing of journals, the requirements of this phase are in large percentage covered.

4) Data extraction and monitoring

The objective of this stage is to design data extraction forms to accurately record the information researchers obtain from the primary studies; these forms could have: name of review, date of data extraction, title, authors, journal, publication detail, and a space for additional notes [7]. Current bibliographic management software (shared in section B1), allows to manage this information in an organized way; if used in an orderly manner, this platform could be adequate to fulfill this sub-stage, even if working from a group of researchers. The order, rules of interaction and identification patterns of each variable during

[3] https://www.mendeley.com/. Mendeley – Reference Management Software & Researcher Network. (checked on 2 Feb 2018)
[4] https://www.zotero.org/. Zotero [zoh-TAIR-oh] is a free, easy-to-use tool to help you collect, organize, cite, and share your research sources. (checked on 2 Feb 2018)
[5] http://www.myendnoteweb.com/. EndNote is a software package for the management of bibliographic references developed by Clarivate Analytics (checked on 2 Feb 2018)

data registration, will give efficiency and effectiveness to the process. It is important that in the keywords section the documents are recorded as belonging to the literature review, and the research question to which it belongs; also in the notes section of the bibliographic reference, locate the relevant points and related to the research question, which will be the basis for the analysis of results.

5) Data synthesis and monitoring

In this final sub-stage the quality of the systematic review is defined. The synthesis can be descriptive (non-quantitative), or to complement a descriptive synthesis with a quantitative summary; in this case, it is a *meta-analysis* [7]. Kitchenham also explains some attributes that this analysis should have, depending on its type: qualitative or quantitative.

D. Reporting the review

The results must always be communicated to the scientific community, to receive feedback through peer review. The results of a systematic review generate a lot of interest when organizing research results over a period of time, from a specific field of science. It is an integral part of a PhD thesis and therefore always attached to them; it can also be presented in a conference or specialized journal in the area [7].

As a suggestion for the systematic review report, Kitchenhand [7] exposes and details the following components:

1. Title.
2. Authorship.
3. Executive Summary or Structural Abstract: Context, Objectives, Methods, Results and Conclusions.
4. Background.
5. Review questions: Each review question should be specified.
6. Review Methods: Data sources and search strategy, Study selection, Study quality assessment, Data extraction and Data synthesis.
7. Included and excluded studies: Inclusion and exclusion criteria, List of excluded studies with rationale for exclusion.
8. Results: Findings and Sensitivity analysis.
9. Discussion: Principal findings, Strengths and Weaknesses, and Meaning of findings.
10. Conclusions and Recommendations.
11. Acknowledgements.
12. Conflict of Interest.
13. References and Appendices.

III. CASE STUDY

For the purpose of validating the methodology and explaining to the researchers, a general view of the application of each phase and sub-phase is presented. In addition, the methodology has been evaluated in the PhD thesis [16], [17] in the year 2017, with satisfactory results. A summary version of the revision work is shared, in order to expose the novel components to the Kitchenham method. The *Gestural-Computer Interaction for Children in Inclusive Educational Settings* has been chosen as a general context, as a field to expose the methodology.

A. Planning

1) Current State of the Problem Research

Gestural Interaction has been considered as a research field; is a subarea of the natural interaction (NI), in Human-Computer Interaction (HCI), Computer Science. Studies on HCI are becoming increasingly relevant to technology designers and manufacturers, as well as to groups of people with some kind of disability and who require personalized equipment and sensors to enable them to interact with computers. IN has allowed the user to interact from media that are natural and intuitive, being able to give orders to the computer through voice commands, movements of hands, fingers, arms, body; and even indirectly from bio-physiological signals captured by wearable sensors [18]. The gestural interfaces in turn use body movements of upper extremities (arms, hands, fingers) and lower (legs, feet), torso, neck and face as input controls for a computer; They differ from the apt interfaces in the remarkable absence of tactile feedback returned by the machine[19]. The digital teaching strategies from gestural interaction environments have shown significant improvements in learning of people with cognitive disabilities [17], [20], being therefore necessary to know and organize the results of research related to this field.

2) Research Questions

From the exposition of the problem, and as a requirement for future research the following research questions have been proposed:

- RQ1. Which methods have been applied in gestural interaction learning environments?
- RQ2. How has the didactic resources for gestural interaction been designed?
- RQ3. What gestural interaction technologies have been applied in educational institutions?

3) Mentefacto Conceptual

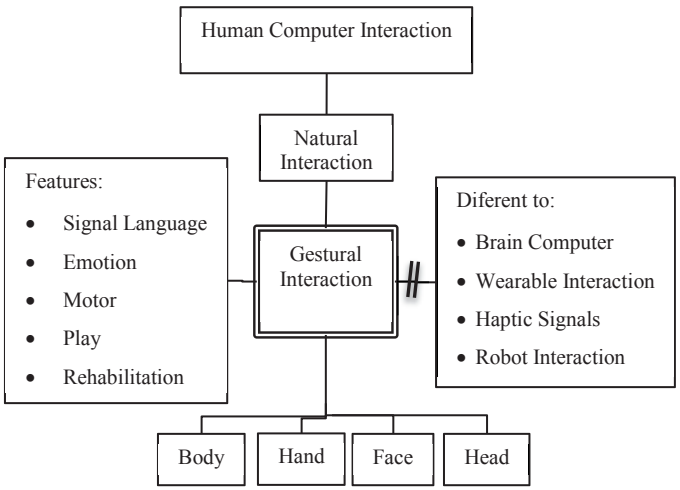

Fig. 5. *Mentefacto Conceptual – Gestural Interaction*

Gestural Interaction is a subclass of NI, and this one of HCI. Also, it is different from some types of natural interaction, such as: Brain Computer Interaction, Wearable Interaction, Haptic signals and robotic interaction. In the field of study, gestural interaction allows the interaction of deaf people by sign language; also to know the emotional state of the user from his facial features and patterns in movements; the interaction is carried out by motive movements, opening the gamification; another field of application is rehabilitation while the student learns. Finally, some of the types of gestural interaction are: body, hand, face and head.

4) Related Systematic Review

In this sub-stage, the first systematic search will be applied following the steps of Fig. 2. Table II is obtained, from the conceptual mind and the information available in *Current State of the Problem Research*.

TABLE II. WORDS FROM THESAURUS FOR SEMANTIC CRITERIA SEARCH

Computer Science				Education
Human-Computer Interaction				
Gestural interaction	Child-Computer Interaction			
1. (gestur*)	comput*	interact*	child*	educa*
2. (hand* OR body OR leg)	automat*	interfac*	boy	learn*
3. (mov* OR motor* OR motion*)		recognit*	kid	train*
4. (fac* OR eye*)		track*	infant*	
5. (mobile OR touch*)				
dynamic	**static**			

The asterisk (*) at the end of each word is used in SQL to generalize any symbol (be it a letter, number or special character) after the last letter, thus making the search more efficient. So in the case of "**gestur***", for example, this could refer to gesture, gestures, gestural, etc. Applying the structure in Table 3 yields five search phrases for Gestural interaction. The first of these would be:

(gestur*) (comput* OR automat*) (interact* OR interfac* OR recognit* OR track*) (child* OR boy OR kid OR infant*) (educa* OR learn* OR train*)

All of the studies were for the last five years (year > 2012). The resulting papers were categorized into *valid/reference/resulting (val/ref/res)*. A systematic general search is designed, for work with WoS, Scopus and Google Scholar databases. Also, it use a search syntax as similar as possible in all three platforms and adhering to the rules in place for each one. Doing a qualitative review of the titles and abstracts of each paper on specific subjects involving HCI and children yields a *reference* list (12/75 = 16%), and a final systematic review on gesture interaction technology for children in school settings (3/75 = 4%) gives the result shown in *Table III*.

TABLE III. INITIAL SEARCH SYNTAX FOR LITERATURE REVIEW STUDIES IN THE FIELD OF HCI-GESTURAL

DB	Syntax	Resulting papers *val/ref/res*
WOS	Initial Filter: <Tittle> and year >2012 `(child* OR boy) AND (comput* OR gestur* OR hand* OR motor* OR touch* OR body) AND (review)` Refine results: • `(interact* OR interfac*)`	**1**/3/9
Google Scholar	Parallel filters: (year > 2012) • `allintitle: review, child, OR boy, OR children, computer, OR gesture, OR touch, OR interaction, OR interface` • `allintitle: review, study, child, OR boy, OR children, computer, OR gesture, OR touch, study, OR school, OR teach`	**2**/6/ (33+3)
Scopus	Initial Filter: <Article Title, Abstract, Keywords> and year >2012 `(child* OR boy) AND (comput* OR gestur* OR hand* OR motor* OR touch* OR body) AND (interact* OR interface*) AND (educa* OR learn*) AND (syndrome OR disabilit* OR inclusiv* OR special*) AND review` Subject Area: Computer Sciences, Social Sciences	**0**/3/30

As detailed in Table III, only three systematic reviews regarding gestural interaction were obtained [21], [22], [23] which is related to the research questions posed; however, they do not allow answering any of the questions, from the context of their "categories of analysis".

B. Development of a review protocol

1) Definition of inclusion and exclusion criteria

For research purposes, it is necessary to define criteria for selecting journals related with our objectives and with the research questions posed.

General Criteria:

- Studies involving gestural interactions by children with technology devices and whose main purpose is inclusive education processes.
- Studies published in the last ten years, that is, between 2008 and 2017.

Specific Criteria:

The studies must comply with one or more of the following specifications:

- Studies that share methods used in researches applied in gestural interaction learning environments.
- Studies that present design didactic resources for gesture-based interfaces.
- Studies on technologies applied in gestural interaction learning environments.

2) Selection of Journals

The goal in this sub-stage is to select those journals with the highest impact factor that deal with gesture-based human-computer interactions in the field of education. The process followed for this search is the same as that used to select the systematic reviews in the previous stage.

TABLE IV. LIST OF JOURNALS ARRANGED BY CATEGORY BASED ON JCR

Ord	**Journal Name**	N° of papers	JCR		SJR	h5	***Ord***
			IF	Quartile in category			
	JCR Science Edition						
1	Pediatrics	10	5,473	Q1	2,894	116	4593,27
2	Computers & Education	23	2,556	Q1	2,578	88	3334,22
3	PLoS ONE	9	3,224	Q1	1,300	161	1518,26
8	IEEE Transactions On Neural Systems And Rehabilitation Engineering	4	3,188	Q1	1,042	45	149,49
10	Physical Therapy	2	2,526	Q1	1,270	52	83,41
	JCR Social Science Edition						
4	Journal Of Autism And Developmental Disorders	9	3,665	Q1	1,696	61	853,12
5	Child Development	3	4,061	Q1	3,065	64	597,45
6	Research in Developmental Disabilities	22	1,887	Q1	0,986	47	480,96
7	Journal of Learning Disabilities	7	1,901	Q1	1,596	34	180,52
9	Journal of Intellectual Disability Research	9	1,778	Q1	0,935	33	123,44
11	Computers In Human Behavior	1	2,694	Q1	1,582	75	79,91
12	Journal of Computer Assisted Learning	2	1,370	Q1	2,048	41	57,52

C. Conducting the review

The search by journal was carried out with help from the Expert Search tools on Elsevier's *ScienceDirect* platform, using the criteria in the script below for each of the publications in *JournalList_2*. In keeping with the structure of the initial search, we divided the areas and sub-areas of interest into five levels so as to facilitate the selection of scientific papers relevant to our research. The search structure is applicable to the WoS platform (extending to its syntax) and yields similar results once a filter is applied to specifically to a journal.

TABLE V. SEMANTIC STRUCTURE FOR SEARCHING SPECIFIC PAPERS IN EACH JOURNAL

L1	Gestural Computer Interaction	`(gestur* OR hand* OR body OR leg OR mov* OR motor* OR motion OR fac* OR eye OR mobile OR touch*) AND (comput* OR automat*) AND (interact* OR interfac* OR recognit* OR track*)`
L2	+ Child *	`AND (child* OR boy OR kid OR infant*)`
L3	+ Education	`AND (educa* OR learn* or train*)`
L4	**Question**	Q1: **`(method*)`** Q2: **`(didactic resource)`** Q3: **`(technolog*)`**

Applying the options in *Table V* to a specific query, the resulting script for searching for papers in the *Computers & Education* journal that provides an answer to the third question would be:

```
pub-date > 2005 AND Title-Abstr-Key((gestur* OR hand* OR body OR leg OR mov* OR motor* OR motion OR fac* OR eye OR mobile OR touch*) AND ((comput* OR automat*) OR (interact* OR interfac* OR recognit* OR track*)) AND (child* OR boy OR kid OR infant*) AND (educa* OR learn* OR train*) AND "method") AND src({Computers & Education})
```

In the `src` section (**`{Computers & Education}`**), the name of the journal has to be changed as required. Each of the defined variables must be evaluated and related to the general research needs proposed. Then a comparative analysis of the results with respect to previous studies is carried out; as well as the list of selected studies and possible research proposals. Finally, the findings of the study are presented, complementing with suggestions of application to other areas of research.

CONCLUTIONS

In this article a new methodology has been presented to design, carry out and publish a systematic review of scientific literature. This methodology is supported by the method presented by Kitchenham, later adapted by Bacca, and the ideogram called *mentefacto conceptual* designed by De Zubiría.

In particular, it focuses on the adaptation of the *mentefacto conceptual*, as a basis for establishing the set of search words, their synonyms from the scientific thesaurus, the semantic structure for searching scientific papers, and the specific search script for databases.

Each phase of the methodology is explained from a case study. In this process, the adaptation of the *mentefacto conceptual* and all the necessary process has been prioritized until we have established the search script in the databases.

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