

Tendencias de investigación en la enseñanza de la física en revistas académicas iberoamericanas

Physics Education Research trends in Iberoamerican journals

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Resumen

Este artículo presenta una revisión sistemática de la literatura referente a la investigación en la enseñanza de la física en las últimas dos décadas. En esta síntesis se analizaron las publicaciones de 33 diferentes revistas académicas iberoamericanas que son revisadas por pares y se reunieron 31 artículos de revisión de literatura de cuatro países iberoamericanos. Limitamos el período de búsqueda de enero de 2000 a junio de 2020. Se adoptó como referencial teórico el análisis de contenido de Bardin (2016). Los artículos de revisión de literatura fueron agrupados en cuatro dimensiones distintas: nivel de enseñanza, contenido de física, estrategias didácticas y enseñanza de la física en otros contextos. Los resultados indicaron que la mayoría de las revisiones de literatura son de la última década, y 45% de los artículos tienen como objetivo describir la presencia de contenidos específicos de física. De estos, 71% están relacionados a tópicos de física moderna y contemporánea. El 55% restante está dividido en: revisiones de literatura sobre el uso de estrategias didácticas o en la relación de la enseñanza de física con otros contextos. Además, respecto a la calidad de la divulgación de las informaciones relacionadas a los métodos de descripción de las revisiones, se verificó que 17 de los 31 artículos son de alta calidad. Resaltamos la ausencia de revisiones de literatura de investigación en la enseñanza de la física que buscara comprender la presencia de referentes teóricos didácticos o psicológicos, como base para planear o aplicar secuencias didácticas de cualquier contenido de física.

Palabras clave: Investigación en enseñanza de la física; Revisión de literatura; Análisis de contenido; Países iberoamericanos.

Abstract

This paper provides a systematic review syntheses of literature reviews concerning Physics Education Research (PER) in the last two decades. For this synthesis, we searched into 33 different peer-reviewed Iberoamerican journals individually, and we were able to gather and narrow down to 31 literature review articles from four different Iberoamerican countries. The search period was from January 2000 to June 2020. We adopted Bardin's (2016) content analysis as a theoretical framework; hence, grouping all the literature review articles into four different dimensions concerning: teaching level; physics content; didactical strategies; and physics education related to other contexts. Our findings indicated that most literature reviews are from the last decade, and 45% are aimed to describe the presence of specific content of physics. Of all these, 71% are related to topics in modern and contemporary physics. The 55% is divided into literature reviews concerning the use of didactical strategies, or the relation of physics education to other contexts. Moreover, concerning the quality of information disclosure related to the reviews' description methods, we have found that 17 out of 31 are of high quality. We point out the absence of literature review in PER that searched for the presence of theoretical frameworks, based on didactical or psychological theoretical references, as a basis to plan or apply didactic sequences of any physical content.

Keywords: Physics education research; Literature review; Content analysis; Iberoamerican countries.

I. INTRODUCTION

It is noticeable that the exchange of ideas and empirical findings lies in the heart of any research field development. Nonetheless, most of the research developed and published in other than the *lingua franca*, such as English, faces a major barrier in its dissemination. As underlined by Girwidz et al. (2019), Physics Education Research journals usually print in the native language of the authors. Furthermore, in the case of the European Union, which has 24 official languages, knowledge about what is discussed in neighboring countries becomes rarely shared. In most Iberoamerican journals consulted for this study, it is possible to submit a manuscript in the English language; however, it is rarely the case, since most review articles are published in the native language of the authors.

In this article, we analyzed the literature reviews that are mostly published in Portuguese and Spanish — the author's native language — in Iberoamerican well-established peer-reviewed science education journals. As we shall examine, although we focused on the Iberoamerican journals, a considerable number of the literature reviews reference journals published in English as sources.

This paper synthesizes Physics Education Research (PER) reviews at all levels, published in specialized peer-reviewed Iberoamerican journals. As stated by Tsai and Wen (2005, p.3) “having a systematic analysis of articles published in academic journals may assist science educators to explore the current status and future trends of research”. Hence, our goal is to describe and organize the last two decades of PER in Iberoamerican peer-reviewed science and physics education journals.

We acknowledge the importance of this work to help researchers, mostly those who do not speak Portuguese or Spanish, to be aware of and understand the field of physics education more broadly. We intended to get insights referring to the following research questions:

- 1) What are the most cited sources in the review papers in PER's literature reviews in Iberoamerican journals?
- 2) What are the most commonly addressed topics in PER's literature reviews in Iberoamerican journals?
- 3) What is the quality of information disclosure in the literature reviews in Iberoamerican's PER?

II. METHODOLOGY

We conducted a systematic literature review (Bennett *et al.*, 2005). This type of review enables the gathering of relevant information from the mass of specialized literature in a specific area of research (Teixeira *et al.*, 2012), and has the purpose to reach judgments about the quality of work in the review area.

To select the journals, we consulted the Brazilian journal evaluation system and database (Qualis Journals)¹, which is conducted by CAPES (Brazilian Coordination for the Improvement of Higher Level Personnel), and evaluates the item “intellectual production” in Brazilian and foreign journals (Rodrigues and Leite, 2015, p. 222). CAPES is a Brazilian national regulatory agency linked to the Ministry of Education. The Qualis Journals database is one of CAPES' evaluation systems. Its goal is “to assist the evaluation metrics in the qualification process of the bibliographic production of professors and students of graduate programs accredited by Capes” (Ferreira and Toti, 2022, p. 1028). This method is widely used by literature reviews in Iberoamerican peer-reviewed science education journals (Silva, 2017; Silva and Errobidart, 2019; Fontes and Rodrigues, 2021). As Kellner (2017, p. 1339) explains, the Qualis Journal system “classifies publications in strata that are further used to evaluate a particular graduate program. This system has been changed along the years, and presently there are eight levels: A1 and A2, the highest; B1 to B5; and C, the lowest that does not add anything for the evaluation process”. Our research was conducted on September, 2020 and we selected Science and/or Physics Education journals classified on the top three quality tiers (A1, A2, B1) out of eight possible in the Teaching category from 2010-2016 classification.

Then we searched individually each journal's website for the following words in the review articles title: *levantamento*, *revisão da literatura*, *estado da arte*, *metanálise*, *estado del arte*, *revisión*, *review*, *literature*, *meta-analysis*²; and we limited the search period from January 2000 to June 2020. Journals in which we could not search for keywords in the title of the articles were disregarded. A list of all 33 non-English science and physics education journals consulted is shown in Table I.

¹ The database can be consulted in <https://sucupira.capes.gov.br/sucupira/>

² The following are translations of the searched terms: levantamento (review); revisão da literatura (literature review); estado da arte (state-of-art); metanálise (meta-analysis); estado del arte (state-of-art); revisión (review).

TABLE I. Iberoamerican peer-reviewed journals consulted for literature reviews articles.

<i>Journal</i>	<i>Journal</i>	<i>Journal</i>
Caderno Brasileiro de Ensino de Física	Anais da Academia Brasileira de Ciências	Brazilian journal of Science teaching and Technology
Acta Scientiae	Acta Scientiarum Education	Brazilian Journal of Research in Science Education
Alexandria: Revista de Educação em Ciência e Tecnologia	Cadernos de Pesquisa: Pensamento Educacional	Revista de Educação, Ciências e Matemática
Cadernos de Pesquisa: UFMA	Ciencia & Cultura	Revista de Ensino de Ciências e Matemática
Educação e Pesquisa	Ensaio Research in Science Education	Ciência & Educação
Enseñanza de las Ciencias	Enseñanza de las Ciencias de la Tierra	Educação & Sociedade
Ensino de Ciências e Tecnologia em Revista	Experiências em Ensino de Ciências	Revista Electrónica de Enseñanza de las Ciencias
Góndola, enseñanza y aprendizaje de las ciencias	Investigations in Science Education	Revista Electrónica de Investigación en Educación en Ciencias
Revista de Enseñanza de la Física	Revista Brasileira de Ensino de Física	Revista Iberoamericana de Educación
Revista Electrónica de Investigación Educativa	Science and Mathematics Education Journal	Nuances: estudos sobre Educação
Contexto & Educação	Revista Eureka sobre Enseñanza y Divulgación de las Ciencias	Revista Amazônica de Ensino de Ciências-Areté

It is important to highlight that we were interested in systematic review articles that are specifically related to physics education. In that sense, reviews that fail to present a systematic review in physics education, but rather discuss the science education in general or other specific scientific subjects, such as biology, chemistry, etc., were excluded. For instance, even though we acknowledge the relevance of these studies for Science Education research, Giordan (2005) review's about the use of computer in science education, Castro and Bejarano (2013) review's on young students' scientific alternative knowledge, and Mozena and Ostermann (2014) review's of the role of interdisciplinary in science teaching, those discussions lines do not compose the scope of this reviews. This exclusion criteria was important to keep the focus on PER. In addition, we did not look for literature reviews printed in the proceedings of scientific events or in thesis and dissertation.

Thus, once the exclusion criteria had been applied, 31 literature reviews from 9 different journals and four different countries (Argentina, Brazil, Colombia, Spain) remained to the in-depth analysis.

Defining the dimensions and categories

We carried out the review articles categorization based on content analysis (Bardin, 2016), which enables the researcher to identify the topics most commonly examined through the review articles. According to Bardin (2016) content analysis is "a set of communication analysis techniques aiming to obtain, through systematic and objective procedures, the description of the content of the messages" (p. 48, our translation). The content analysis is a known method in science education research, and it has many applications and techniques (Ferreira and Loguercio, 2014). These analytical techniques aim to understand the documents through the processes of description, inference, and interpretation of the characteristics of the text (Menezes et al., 2018).

In this work, we focused on a particular technique, known as categorical analysis. In doing so we were able to identify the topics most commonly examined through the review articles. Bardin (2016) explains that categorical analysis intends

to take into account the entirety of a text, passing it through the sieve of classification and census, according to the frequency of presence (or absence) of items of meaning [...] It is the method of categories, kind of drawers or significant rubrics that allow the classification of the elements of meaning constituting the message. It is, therefore, a well-conceived taxonomic method to satisfy collectors concerned with introducing order, according to criteria, into apparent disorder. (Bardin, 2016, p. 43, our translation)

The content analysis in general and the categorical analysis in particular can be generally divided into three main phases: a) pre-analysis; b) material exploration; c) treatment of results, and inferences and interpretation (Bardin, 2016). In the present study, the pre-analysis process was based on the choice of the study material. That is, the reviews were initially selected within the given period (from 2000 to 2020). Subsequently, reviews were chosen considering if

the subject is related to PER to undertake an in-depth review which involves a process called data extraction, in which the contents of the studies are summarized and evaluated (Bennett *et al.*, 2005). Then, a detailed description of the studies was carried out, followed by a quality analysis, and finally a synthesis of the results.

III. GENERAL OVERVIEW OF PER LITERATURE REVIEWS

The total number of review articles by year of publications can be seen in Figure 1, and observing it, we note the presence of a peak in 2015, and the majority of publications in the period between 2011 and 2019 with 24 review articles.

The 31 review articles mostly chose journals to conduct their search. Altogether, 1027 articles were revised by consulting 93 different journals, and 54 of them were consulted just by one PER literature review article. There are, however, some journals that were consulted many times. In Table II it is shown the 18 journals that were consulted at least by 5 different review articles.

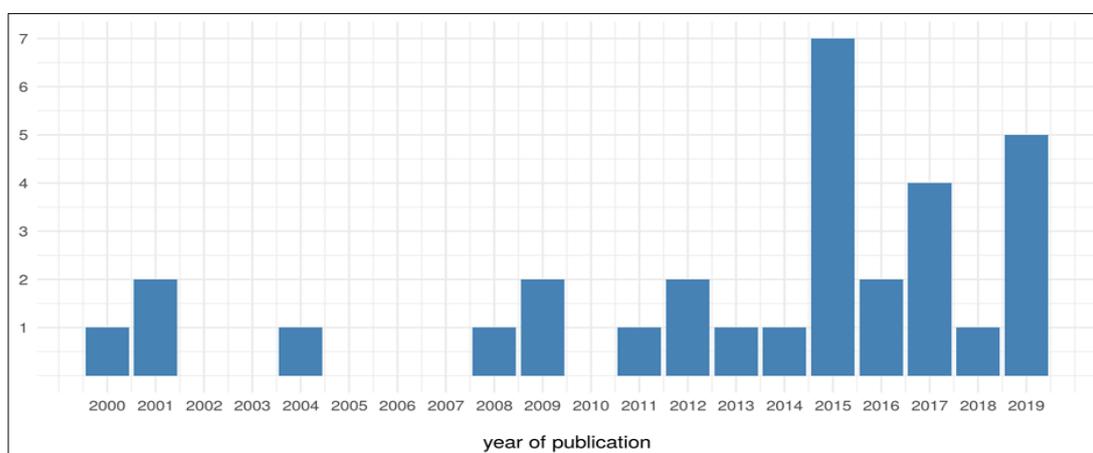


FIGURE 1. Number of PER literature review articles distributed by year of publication.

To understand how the reviews are organized, and what the most common sources of information are, we looked which were the most commonly searched sources at the 31 articles examined. This gives a better idea of which journals have impacted the research that uses literature reviews in the Iberoamerican region.

TABLE II. Mostly cited journals as source by the PER literature review articles.

<i>Journals</i>	<i>Number of times consulted</i>
Caderno Brasileiro de Ensino de Física	17
Revista Brasileira de Ensino de Física	17
Ciência & Educação	11
Enseñanza de las Ciencias	10
Investigações em Ensino de Ciências	10
American Journal of Physics	9
Physics Education	9
Revista Electrónica de Enseñanza de las Ciencias	9
Science Education	9
International Journal of Science Education	8
Revista Brasileira de Pesquisa em Educação em Ciências	8
Ensaio - Pesquisa em Educação em Ciências	7
A Física na Escola	6
Research in Science and Technological Education	6
Science & Education	6
Journal of Research in Science Teaching	5
Revista de Enseñanza de la Física	5
The Physics Teacher	5

From Table II, we see that 5 journals were consulted at least by one-third of the literature review articles, 4 of them being Brazilian journals. The most non-Iberoamerican journals consulted by the authors were the American Journal of Physics, the Physics Education, and the Science Education, 9 times each.

Of the material analyzed, we have not found PER literature review that specifically searched for the theoretical framework, based on didactical or psychology theoretical references such as Piaget, Vygotsky, David Ausubel, and so on, as a basis to plan or apply didactical sequences of any physical content. However, we are aware that might have literature review articles in PER out of this study scope that specifically target for the theoretical frameworks. Systematic literature review is needed to give a comprehensive panorama of how PER are grounding themselves in the theoretical framework from the education field. In addition, we noticed that in our findings there is no PER literature review with scope to teacher education. In general, teacher education appears as a category or dimension within the literature reviews.

IV. DIMENSIONS AND CATEGORIES OF ANALYSIS

After we have selected all 31 literature review articles, we carried out a content analysis in which four different aspects (dimensions) were taken into account in the categorization. This was the grounding to form a deductive category in the first step. In an iterative process, the selected articles were analyzed, and decisions were made for every paper and every category, whether a paper was assigned to the category or not. Major results of the qualitative content analysis are the category system itself (17 categories in 4 dimensions) as well as the frequencies of papers' assignments to categories.

The dimensions are the following: teaching level; didactical strategy; physics content; and contexts on physics education. We further divided each dimension into 3 to 6 categories as detailed below. All reviews are at least in two dimensions (teaching level and one of the others), but the categories are mutually exclusive, there is no review in two categories from the same dimension.

The teaching level dimension means that we looked up for what level of schooling each one of the review articles was reviewing. This dimension was divided into six different categories: All, which means that review articles in this category were searching for their specific content in all levels of teaching with no restriction; HS, which means high school level (age 15 to 17); MHS, which means middle and high school level (age 7 to 17); INF which ranges from pre-kindergarten (age 3) to grade 8 (age 14); HSC, which means high school and undergraduate level; and COL, which means just undergraduate level.

The didactical strategy dimension was divided into four different categories: TIC, which means new technologies; EXP, which means experimental or laboratory work; PBL, which means problem-based learning; and HPS, which means history and philosophy of science approach.

The physics content dimension was divided into three different categories: CP, with contents related to contemporary physics; OP, which is related to optics; and PM, related to physics applied to medicine.

The physics education on context dimension was divided into four different categories: LIT, which means the specific context related to literature; MULT, which means multiculturalism in physics education; DE, which means physics education through distance education; BCPE, which means literature reviews with broader contexts in physics education (as an example, we have been reviewing the relationship between physics teaching research and the teaching practice, and training argumentation of future physics teachers).

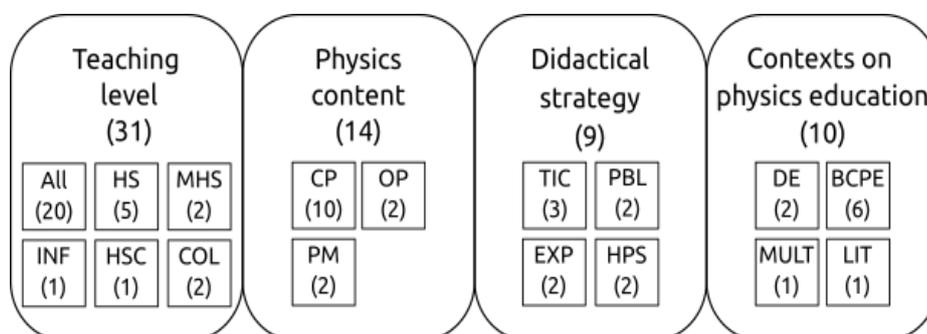


FIGURE 2. Dimensions are represented by the ellipses, and categories are represented by the squares. The number inside parenthesis tells how many review articles are in that category.

A. Physics content

We found 14 of the 31 literature review articles that had specific physics content in their review search. The dominant topics are those related to contemporary physics, followed by optics and physics applied to medicine. There may be two major reasons for that interest in reviewing the presence of contemporary physics in PER.

First, from a historical point of view, topics in contemporary physics are more recent when compared to others like Newton's law or classical electromagnetism. Specifically, it would be after the 1986 Conference on the Teaching of Modern Physics, held at Fermilab, that the teachers and researchers physicists would give more importance to these topics in school and college curricula (Aubrecht, 1986, 1989). One year later, in 1987, during the third Inter-American Conference on Physics Education, in Mexico, was established a workgroup to discuss the importance of having topics of modern and contemporary physics in introductory physics courses in high school (Ostermann and Moreira, 2000). Later, in 1989, Oxford University hosted a workshop on teaching concepts in particle physics, and "a group of school and university physics teachers formed a steering committee with the aim of introducing particle physics to school and college students" (Swinbank, 1992, p. 87).

Secondly, contents related to modern and contemporary physics are exciting and attract young students to pursue a physics degree (Kalmus, 1985; Swinbank, 1992). Maybe, that is influenced by the fact that children and young people come into contact with the language, concepts, and implications of these theories through the media and new technologies, and they are the basis of many contemporary scientific and technological developments (Shabajee and Postlethwaite, 2000).

Concerning the 10 contemporary physics review articles, 3 of them (R1, R6, R11) are aimed at a broader review of the motives and perspectives of teaching contemporary physics content, mostly in high school. From the others, 2 out of 7 are related to teaching quantum mechanics (R2 and R8), and the remaining 5 are related to photoelectric effect (R15), radioactivity (R18), special relativity (R28), nanoscience (R27), and ionizing radiation (R30). Concerning optics, we found a literature review looking for experimental activities in any topics related to optics (R10), and a literature review looking at any didactical resource in teaching light reflection (R20).

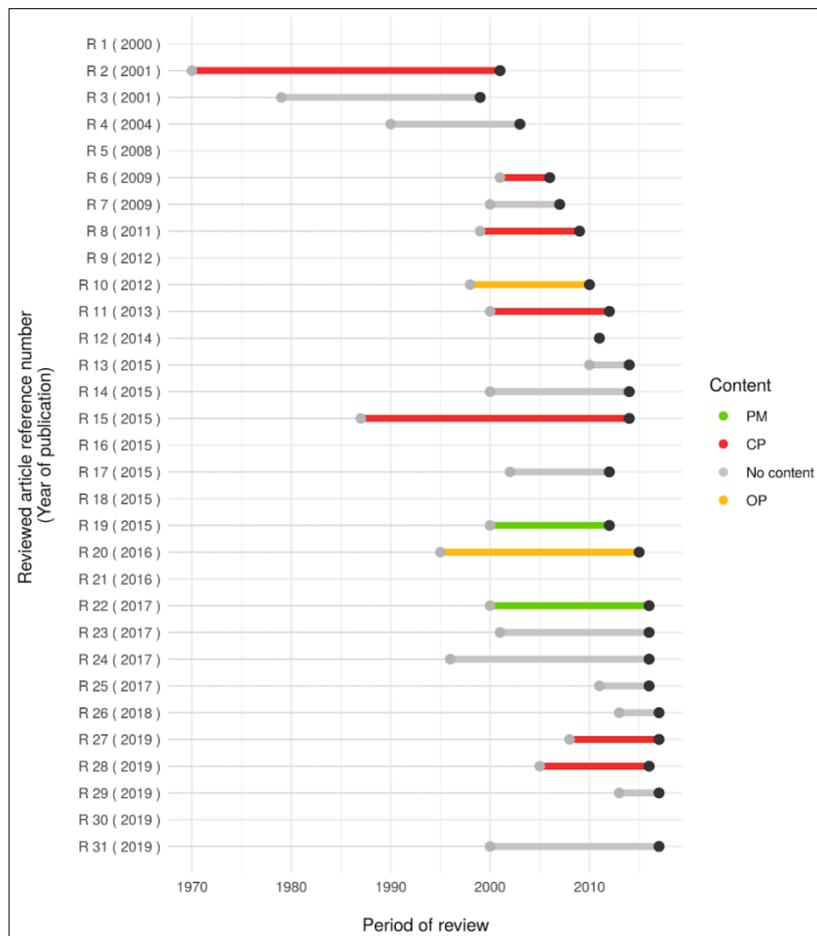


FIGURE 3. Summary of content analysis of studies.

One finding shared between reviews R1, R2, and R6 is that articles in contemporary physics, mostly quantum mechanics, focus on the bibliography for teachers, and there is a dearth of research reporting proposals tested in class with the presentation of learning outcomes, and assessing students' previous conceptions in this subject area. However, this trend seems to be changing as pointed out by the R8, more recent review. Although R1, R2 and R6 have pointed out in their respective review scopes a relative scarcity of works directed to the teaching-learning processes and evaluation of the students' previous conceptions, it is known that there is a considerable number of researches articles that deal with this theme beyond the scope of contemporary physics. We did not find literature reviews in physics content related to any other common topic such as mechanics or thermodynamics published in the journals we analyzed.

As Figure 3 shows, most articles explicitly inform the period in which they conduct their literature review research. The broadest period was 30 years, and the shortest one year. It is important to underline that seven review articles (R1, R5, R9, R16, R18, R21, R30) did not explicitly define the period of their literature review. Thus, they appear in Figure 3 with missing values.

B. Didactical strategy

The data indicate that about one-third of the reviews searched for specific strategies in physics teaching. They are categorized either as a more hands-on approach like using a computational simulator or virtual laboratories (TIC), for help students and teachers in visualizing and having comprehensive learning of many topics in physics, mostly mechanics and electromagnetism; or building experimental devices to help to teach (EXP); or in a more theoretical framework to support teachings like problem-solving in physics (PBL); or the use of history and philosophy of science (HPS).

TABLE III. The number of documents analyzed by the PER literature review articles according to their categories.

<i>Didactical strategy</i>	<i>Review ID</i>	<i>Number of documents analyzed by each review, respectively</i>
TIC	R4; R12; R16	109; 31; 47
EXP	R10; R26	58; 20
PBL	R3; R24	72; 47
HPS	R13; R23	36; 14

From those articles reviewed by R3 and R24, which used problem-solving in physics as a strategy in the classroom, the authors noticed the majority presence of classical mechanics, composing nearly 50% of their samples. Moreover, both reviews found that the problem-solving approach is mostly considered at the undergraduate level, followed by high school level. Together, R3 and R24 cover up to 40 years of problem-solving in physics education and comprehend 119 research articles in their reviews.

The analysis shows similar findings related to physics content when considering the use of technology information and communication (TIC) in physics teaching. R4 found that 82 of them are directed to teaching aspects of classical mechanics, followed by 18 concerning electromagnetism content. Similarly, by reviewing 31 articles from an important national conference in physics teaching, R12 found the predominance of multidisciplinary topics when it is involved more than content, followed by mechanics and electromagnetism.

The four didactical strategies, which are presented in the literature reviews (TIC, EXP, PBL, and HPS), are reported as successful in promoting conceptual learning from topics related to physics. In particular, besides the physics content related learning, HPS is reported as enabling students to understand science as a process, closely linked and defined by social, ethical, cultural aspects, and political interests (Rodrigues Junior *et al.*, 2015).

C. Contexts on physics education

The last one-third of the literature review articles — 10 out of 31 — was not focused on any specific physics content or didactical strategy. We identified that six of them (R5, R7, R21, R25, and R31) have broader contexts than the other four (R9, R14, R16, R17). As an example, R7 presented a literature review conceiving Brazilian's publication on the teaching and learning of physics, and R25 highlighted the importance of argumentation and argumentative skills activities in physics teachers' training, employing the reflective practice as part of the training process.

Reviews in this dimension and narrower categories are diverse, and comprehend the exploration of possibilities of teaching physics in distance education (R9) allied to the use of remote laboratories (R16); and the necessity of revising school curricula to address sociocultural and political aspects of the science and physics teaching (R17), enabling and giving more importance to reading and interpretation of texts, analogies and metaphors, and the relationship between physics and literature (R14). These results indicate that PER is diverse, because it presents literature reviews articles that are beyond the dimensions of a physics content or didactic strategy.

V. QUALITY ANALYSIS OF THE LITERATURE REVIEWS METHODOLOGIES

The Science Education research in general and PER in particular has already reached institutional maturity, constituting itself as research areas for more than four decades. In this context, it is necessary that literature reviews research also pay attention to the “quality of research produced in the area and the problem of theoretical-methodological improvement” (Teixeira and Megid Neto, 2017, p. 546) due to “methodological weaknesses either in qualitative approaches, as well as in quantitative approaches” (Salem, 2012, p. 57).

Therefore, an analysis of the information disclosure quality of the selected reviews was undertaken, regarding the five following parameters: (P1) explicit mention of the keywords utilized to search for selected documents; (P2) delimitation of the period reviewed; (P3) mention to the number of documents analyzed after exclusion criteria; (P4) mention to the sources; (P5) use of a methodological framework to bases the analysis process.

This analysis of the quality of information disclosure was undertaken by the authors via a thorough reading of the entire literature review papers. We attributed 3 different concepts: *low*, when none or only one of the aforementioned items are found in the papers; *medium*, when two or three of these items are found; and *high*, when four or five of these criteria are explicitly mentioned in the papers. As a result, 5 out of 31 were categorized as concept low; 9 were categorized as concept medium; 17 were categorized as concept high. Of the material analyzed, 17 literature reviews satisfy P1; 24 satisfy P2; 23 satisfy P3; 25 satisfy P4; and 13 satisfy P5.

These results indicate that most literature reviews in PER are concerned with making explicit the delimitation of the period reviewed, the number of articles analyzed after exclusion criteria, and the sources analyzed. Also, P5 is the parameter least satisfied by the literature reviews. This indicates that in most cases, authors do not base their data analysis process on specific methodological frameworks. It is important to note that this is a trend that seems to be changing in recent years, since of the 6 most recent literature reviews (those published in 2018 and 2019) 5 of them present the methodological framework adopted for data analysis. Furthermore, it is interesting to notice that, in general, the literature reviews have been methodologically more detailed over time, which indicates a maturity of this type of research within PER. In the period from 2000 to 2009, only 28.6% of the literature reviews satisfy at least 4 of the 5 parameters. In the period from 2010 to 2019, this percentage grew to 62.5%.

We highlight the importance of describing in detail the methodology used in literature review articles. Researches that intend to present a detailed or an overview of a specific topic should attend some criteria like present the length period, and where and how they conduct their search. We understand that presenting the five parameters described above help and enable the literature review search to be reproduced by future reviews and independent authors to get similar results. In other words, parameters like these are related to reproducibility, reliability, and coherence, which represent a valuable resource in terms of systematically identifying and characterizing the work that has been undertaken in the area (Bennett *et al.*, 2005). We stress that we are not criticizing the content presented by the authors in their literature reviews, but rather the description of the methodology that they have used to gather their documents.

VI. LIMITATIONS AND FUTURE RESEARCH

The analysis methodology we used, although it has certain limitations, it still configures a reliable approach to investigating the contents of a written work (Oliveira *et al.*, 2003). As stated by Ferreira and Loguercio (2014, p. 46, our translation) “the most effective way of mitigating the limitations of the content analysis method is, surely, the rigorous pursuit of the means of gauging its validity and reliability”.

Our data for this study was limited to journal articles indexed by Qualis Journals, and therefore excluded other forms of academic and professional publishing, book chapters, conference proceedings, dissertation, and theses. It is suggested that future studies be performed on other databases and compare their results with those of the present study.

The literature review articles reviewed in the present study are related to the period 2000–2020. It is suggested that future researchers select another time period and compare their results with those obtained in this study. The data used in this paper are limited by the 31 literature review articles in PER. However, there may be some review articles that discuss and present findings on PER through a broader analysis that encompasses science education as a whole. These review articles would represent another step in the inexorable progress of research analytics and the knowledge of the PER field.

Finally, future research could use the same corpus (see the appendix) but adopt different techniques from content analysis, such as word clouds, descending hierarchical classification, and factor analysis. Further, they can use analysis software to process textual segments of the data through lexical analysis (see examples in Ferreira and Loguercio, 2016; Ferreira *et al.*, 2021). Another possibility is to use other methods such as social network analysis to identify and describe its structure and network.

VII. CONCLUSION

This study aimed to investigate PER literature reviews in peer-reviewed Iberoamerican journals. We intended to write an English work presenting an overview of PER area mostly published in Portuguese and Spanish, with the intention to share the results from Iberoamerican countries with a broader international community. Despite the above limitations, this work provides a useful contribution to understanding PER in some of its dimensions.

Although the 31 literature reviews are distributed in nine different journals from four different countries, 26 of them are written in Portuguese, four in Spanish, and only one in English. Data in table II shows that in the top 5 most cited journals, four of them are Brazilian and one is from Spain. From the 18 most cited journals, eight are from either USA or Europe. Regarding the initial research questions presented, the most cited sources in the reviewed papers in PER are from Brazilian journals. Although they accept submissions in Portuguese, Spanish and English languages, the most reviewed papers are published in Portuguese. This undermines the spread of scientific findings due to language barriers.

The most commonly addressed topic in PER literature review is related to modern and contemporary physics. Of all the literature reviews that have their scope in a specific physics content, 10 of them (71,4%) are direct to topics covering this area of physics. Silva, Arengi and Lino (2013) — in their review of the literature (R11) — summarize in four main justifications for the insertion of modern and contemporary physics in high school: (a) it allows the understanding of modern technological apparatuses; (b) it promotes curricular updating; (c) it allows the understanding of the scientific revolutions related to the topics of modern and contemporary physics; (d) it allows academic formation focused on the debate of current scientific issues. Nowadays, the discussion is centered on the possible ways of introducing topics of modern and contemporary physics rather justify its importance and presence in students' daily lives (Fontes and Rodrigues, 2019).

Concerning the reproducibility in PER literature review, we have found that 17 out of 31 (54,8%) are of high quality, meaning they present enough detailing in their methodology description that enables their reproduction. Only 5 out of 31 (16,1%) literature reviews were classified as low quality, in particular, R5 and R21 do not meet any of the methodology parameters. It is unfortunate since both reviews present a useful discussion: the first concerning the difficulties of research in Physics Teaching to the entry of pieces of information supported by the results of the research in the school context; and the last presenting an analysis of the conceptual construction of context within the cultural, and discuss this concept in physics education from some epistemological perspectives and practices.

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APPENDIX

List of literature reviews articles selected for analysis

<i>Review ID</i>	<i>Year</i>	<i>Authors</i>	<i>Title</i>	<i>Journal</i>
R1	2000	Ostermann, F. and Moreira, M. A.	Uma revisão bibliográfica sobre a área de pesquisa "física moderna e contemporânea no ensino médio"	Investigações em Ensino de Ciências
R2	2001	Greca, I. M. and Moreira, M. A.	Uma revisão da literatura sobre estudos relativos ao ensino da mecânica quântica introdutória	Investigações em Ensino de Ciências
R3	2001	Fávero, M. H. and Sousa, C. M. S. G.	A resolução de problemas em física: revisão de pesquisa, análise e proposta metodológica	Investigações em Ensino de Ciências
R4	2004	Araujo, I. S. and Veit, E. A.	Uma revisão da literatura sobre estudos relativos a tecnologias computacionais no ensino de física	Revista Brasileira de Pesquisa em Educação em Ciências
R5	2008	Pena, F. L. A. and Ribeiro Filho, A.	Relação entre a pesquisa em ensino de física e a prática docente: dificuldades assinaladas pela literatura nacional da área	Caderno Brasileiro de Ensino de Física
R6	2009	Pereira, A. P. and Ostermann, F.	Sobre o ensino de física moderna e contemporânea: uma revisão da produção acadêmica recente	Investigações em Ensino de Ciências
R7	2009	Rezende, F., Ostermann, F. and Ferraz, G.	Ensino-aprendizagem de física no nível médio: o estado da arte da produção acadêmica no século XXI	Revista Brasileira de Ensino de Física
R8	2011	Pantoja, G. C. F., Moreira, M. A. and Herscovitz, V. E.	Uma revisão da literatura sobre a pesquisa em ensino de mecânica quântica no período de 1999 a 2009	Revista Brasileira de Ensino de Ciência e Tecnologia
R9	2012	Silva, H. C., Weiss, K., Costa, D. A. M. and Viegas, G.	Produção de conhecimentos sobre ensino de física na modalidade a distância: tendências, lacunas, novas questões	Caderno Brasileiro de Ensino de Física
R10	2012	Ribeiro, J. L. P. and Verdeaux, M. F. S.	Atividades experimentais no ensino de óptica: uma revisão	Revista Brasileira de Ensino de Física
R11	2013	Silva, J. R. N., Arengi, L. E. B. and Lino, A.	Porque inserir física moderna e contemporânea no ensino médio? Uma revisão das justificativas dos trabalhos acadêmicos	Revista Brasileira de Ensino de Ciência e Tecnologia
R12	2014	Macêdo, J. A., Pedroso, L. S., Voelzke, M. R. and Araújo, M. S. T.	Levantamento das abordagens e tendências dos trabalhos sobre as tecnologias de informação e comunicação apresentadas no XIX SNEF	Caderno Brasileiro de Ensino de Física
R13	2015	Rodrigues Junior, E., Oliveira, F. J. L., Linhares, M. P. and Hygino, C. B.	Implicações didáticas de história da ciência no ensino de Física: Uma revisão de literatura através da análise textual discursiva	Caderno Brasileiro de Ensino de Física
R14	2015	Lima, L. G. and Ricardo, E. C.	Física e literatura: uma revisão bibliográfica.	Caderno Brasileiro de Ensino de Física
R15	2015	Silva, R. S. and Errobidart, N. C. G.	Sobre as pesquisas relacionadas ao ensino do efeito fotoelétrico	Caderno Brasileiro de Ensino de Física
R16	2015	Matarrita, C. A. and Concari, S. B.	Hacia un estado del arte de los laboratorios remotos en la enseñanza de la física	Revista de Enseñanza de la Física
R17	2015	Rodrigues, M. S. and Leite, C.	Multiculturalismo e ensino de Física e Ciências: um levantamento bibliográfico em periódicos	Revista de Enseñanza de la Física
R18	2015	Cao, C. J. and Castiñeiras, J. M. D.	Estado de la cuestión sobre el aprendizaje y la enseñanza de la radiactividad en la educación secundaria	Enseñanza de las Ciencias
R19	2015	Parisoto, M. F., Pinheiro, L. A. and Moro, J. T.	A literature review on applied physics in medicine in the context of teaching	Investigações em Ensino de Ciências
R20	2016	Ribeiro, J. L. P. and da Silva Carneiro, M. H.	A reflexão da luz nos periódicos de Ensino de Física: evidenciando tendências e carências de pesquisa a partir de uma revisão bibliográfica	Caderno Brasileiro de Ensino de Física
R21	2016	Zapata, J.	Contexto en la enseñanza de las ciencias: análisis al contexto en la enseñanza de la física	Góndola, Enseñanza y Aprendizaje de las Ciencias
R22	2017	Silva, A. C.	Radiações e suas relações com a medicina: uma revisão na área de ensino de física	Investigações em Ensino de Ciências

<i>Review ID</i>	<i>Year</i>	<i>Authors</i>	<i>Title</i>	<i>Journal</i>
R23	2017	Jardim, W. T. and Guerra, A.	Experimentos históricos e o ensino de física: agregando reflexões a partir da revisão bibliográfica da área e da história cultural da ciencia	Investigações em Ensino de Ciências
R24	2017	Oliveira, V., Araujo, I. S. and Veit, E. A.	Resolução de problemas abertos em ensino de física: uma revisão da literatura	Revista Brasileira de Ensino de Física
R25	2017	Ramos, W. F., Stipcich, S., Domínguez, A. and Mosquera, C. J.	La formación en argumentación de futuros profesores de física: revisión de estudios actuales	Revista de Enseñanza de la Física
R26	2018	Moreira, M. M. P. C., Romeu, M. C., Alves, F. R. V. and Silva, F. R. O.	Contribuições do arduino no ensino de física: uma revisão sistemática de publicações na área do ensino	Caderno Brasileiro de Ensino de Física
R27	2019	Tonet, M. D. and Leonel, A. A.	Nanociência e nanotecnologia: uma revisão bibliográfica acerca das contribuições e desafios para o ensino de física	Caderno Brasileiro de Ensino de Física
R28	2019	Silva, A. G. and Errobidart, N. C. G.	Abordagem da teoria da relatividade restrita em periódicos de ensino de ciências 2005-2016	Revista de Enseñanza de la Física
R29	2019	Duarte, S. S., Gonçalves, R. and Oliveira, E. A. G.	Estudantes deficientes no ensino de Física: revisão no Simpósio Nacional de Ensino de Física e no Encontro Nacional de Educação em Ciências	Revista de Enseñanza de la Física
R30	2019	Nossa, I. M., Mendes, L. G. and Londero, L.	O que sabemos sobre propostas didáticas destinadas ao Ensino da Física das Radiações Ionizantes?	Revista de Enseñanza de la Física
R31	2019	Santos, R. C. M., and Macke-danz, L. F.	O ensino de física para crianças: uma revisão bibliográfica	Acta Scientiae