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DEVELOPMENT OF MOTIVATIONAL STRATEGIES FOR FACE-TO-FACE TEACHING OF EXPERIMENTAL PHYSICS IN BASIC PHYSICS LABORATORIES: A REVIEW

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Abstract

A documentary review was carried out on the production and publication of research papers related to the study of the variable Elaboration of motivational strategies for teaching physics. The purpose of the bibliometric analysis proposed in this document, is to know the main characteristics of the volume of publications registered in Scopus database during the period 2015-2020 in Latin American countries, achieving the identification of 80 publications. The information provided by said platform, was organized by means of graphs and figures categorizing the information by Year of Publication, Country of Origin, Area of Knowledge and Type of Publication. Once these characteristics were described, the position of different authors regarding the proposed topic was referenced by means of a qualitative analysis. Among the main findings of this research, it is found that Brazil, with 31 publications, is the Latin American country with the highest production. The area of knowledge that made the greatest contribution to the construction of bibliographic material referring to the study of the development of motivational strategies for the teaching of physics was social sciences with 47 published documents, and the type of publication that was most used during the period mentioned above was the journal article, which represents 53% of the total scientific production.

Keywords: Experimental Physics, Motivation, Teaching Strategies.

1. INTRODUCTION

Physics is one of the sciences that helps to find the explanation to different natural phenomena which helps to know how universe works. The teaching of this science does not have a great understanding among students, one of the causes of this is the lack of motivation for the study of physics either by the use of old methodologies that do not go according to the needs and interests of students who begin in the first cycles of the study of this science. So this need to generate curiosity about the study of physics leads to introduce teaching methods that motivate students to understand the knowledge in physics and apply it to their daily life; a clear example of these new methods is 4MAT (Ramirez, 2010) which is a system oriented to meet the 4 learning styles which is adapted to the teaching of physics at the university level and to the needs of each student, who with the use of this learning strategy showed progress in the appropriation of concepts.

The development of motivational strategies for teaching physics should also take into account the digital transformation that education has been presenting in recent years, taking into account that students belong to the digital era and may be more interested in methodologies that integrate the use of technological tools in the pedagogical processes implemented in the appropriation of knowledge in physics, since according to (Fernández-Valverde, García-Herrera, Erazo-Álvarez, & Erazo-Álvarez (2020), there is not a good use of digital methods in physics teaching as a result of the lack of knowledge on this subject by teachers, so it is necessary to promote training in this regard, for its correct application and thus, generate new scenarios of meaningful learning, which shows the role that ICT can have in the motivation of physics teaching. Therefore, it is important to know in terms of bibliographic resources, the current status of research on the development of motivational strategies for teaching physics in Latin America, so it is proposed a bibliometric analysis of scientific production recorded in Scopus database during the period 2015-2020 to answer the question: How has been the production and publication of research papers related to the study of the variable development of motivational strategies for teaching physics in Latin America during the period 2015-2020?

2. General Objective

To analyze from a bibliometric and bibliographic perspective, the production of high impact research papers on the variable Elaboration of motivational strategies for physics teaching in Latin America during the period 2015-2020.

3. Methodology

3.1 Method

The educator at the beginning of his teaching work, will motivate the student's interest in understanding, learning and analyzing the phenomena that occur in nature, presenting real life experiences, so that the student finds the similarity with the subject to be treated For this, it is proposed to develop motivation techniques for each subject, which can be:

- Photographs related to specific topics.

- Figures related to the topic, virtually or in person.

- Students' search for photos and figures related to specific topics as feedback.

- Biographies of famous scientists who contributed to science.

- Videos of scientific experiments related to basic physics and laboratory topics to support the teaching-learning process.

Finally, at present there are countless articles, theses, reports, projects, etc. that could be shown to university students which would help to understand and find the relationship of basic physics courses and laboratories with the research work developed by researchers in different areas, which are strongly focused on solving various problems that occur daily, in the community especially at the local level (Chambi L., 2018; RÍOS et al., 2018; Mayhua Choque, 2019; Chambi L, 2021) where the aim is to solve or make real problems known.

These aspects would awaken in the students a spirit of research and innovation, which is one of the purposes of a university.

In this way, the aim is to raise the level of the teaching-learning process in the development of the different teaching activities, in order to dynamize student participation and better understanding of the topics under study.

Physics laboratory practices can help the student, besides developing basic skills and tools of experimental Physics and data processing, to handle basic concepts, to understand the role of direct observation in Physics and to distinguish between the inferences made from theory and those made from practice, to highlight the process: observation of the phenomenon - obtaining experimental data - analysis of the results - conclusions and applications.

The laboratory practices can be developed in such a way that the student is in physical contact and can manipulate the elements, devices and instruments required for the experiment (real laboratory) this requires self-preparation by the students, through bibliographic material, electronic, etc.

3.2 Type of research

Quantitative analysis of the information provided by Scopus is performed under a bibliometric approach on the scientific production related to the development of motivational strategies for teaching physics. Also, from a qualitative perspective, examples of some research works published in the area of study mentioned above are analyzed from a bibliographic approach to describe the position of different authors on the proposed topic.

The search is carried out through the tool provided by Scopus and the parameters referenced in Table 1 are established.

3.2.1 Methodological design

Table 1. *Methodological design.*

	PHASE	DESCRIPTION	CLASSIFICATION
PHASE 1	DATA COLLECTION	Data was collected using the Scopus web page search tool, through which a total of 80 publications were identified.	Published papers whose study variables are related to the development of motivational strategies for teaching physics. Research papers published during the period 2015-2020. Limited to Latin American countries. Without distinction of area of knowledge. Without distinction of type of publication.
PHASE 2	CONSTRUCTION OF ANALYSIS MATERIAL	The information identified in the previous phase is organized. The classification will be made by means of graphs, figures and tables based on data provided by Scopus.	Word Co-occurrence. Year of publication Country of origin of the publication. Area of knowledge. Type of publication
PHASE 3	DRAFTING OF CONCLUSIONS AND FINAL DOCUMENT	After the analysis carried out in the previous phase, we proceed to the drafting of the conclusions and the preparation of the final document.	

Source: Own elaboration (2021)

4. Results

4.1 Co-occurrence of words

Figure 1 shows the co-occurrence of keywords within the publications identified in the Scopus database.

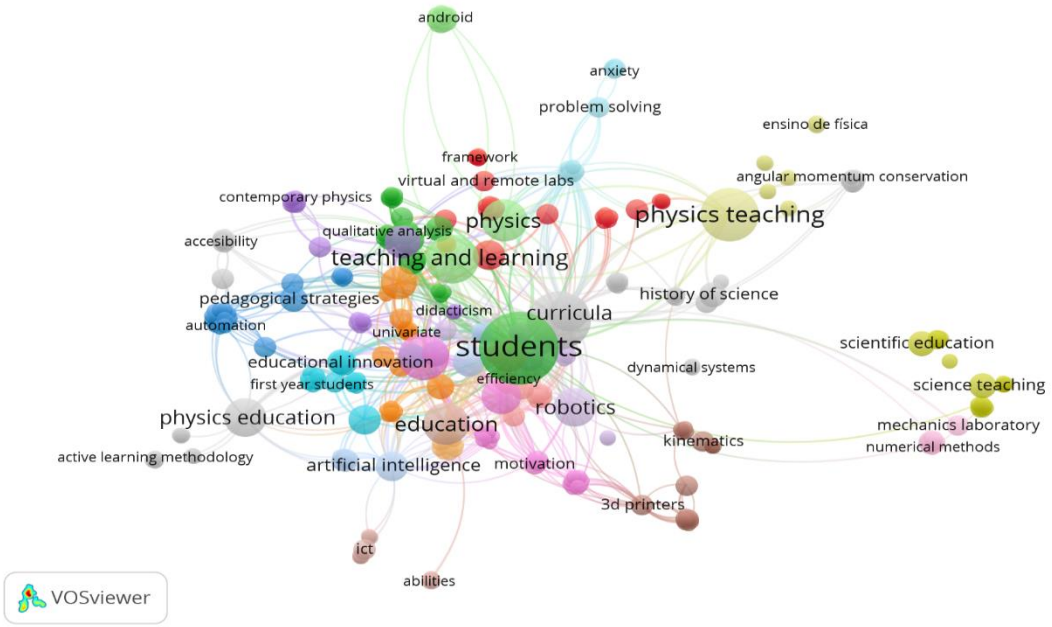

Figure 1. *Co-occurrence of words*

Source: Own elaboration (2021); based on data provided by Scopus

Students is the key word most used in the research related to the variables under study, which is the population studied first in the Elaboration of motivational strategies for teaching physics, since they are the target audience for these techniques designed to encourage the acquisition of knowledge in physics. Recurrent keywords such as teaching and learning, pedagogical strategies, physics teaching and problem solving are found, which are directly related to the production of new physics study techniques that encourage students to build their own knowledge through the understanding of topics related to this subject. On the other hand, keywords such as artificial intelligence, 3D printers, robotics, kinematics, active learning methodology and numerical methods are identified, which are different strategies that have been used in the researches found to increase the learning of students using technological tools, taking into account that the new generation, being born in the digital era, may have some affinity in using technological resources in the pedagogical processes, which can generate a greater interest and therefore a greater understanding of physics.

4.2 Distribution of scientific production by year of publication.

Figure 2 shows how the scientific production is distributed according to the year of publication, taking into account the period from 2015 to 2020.

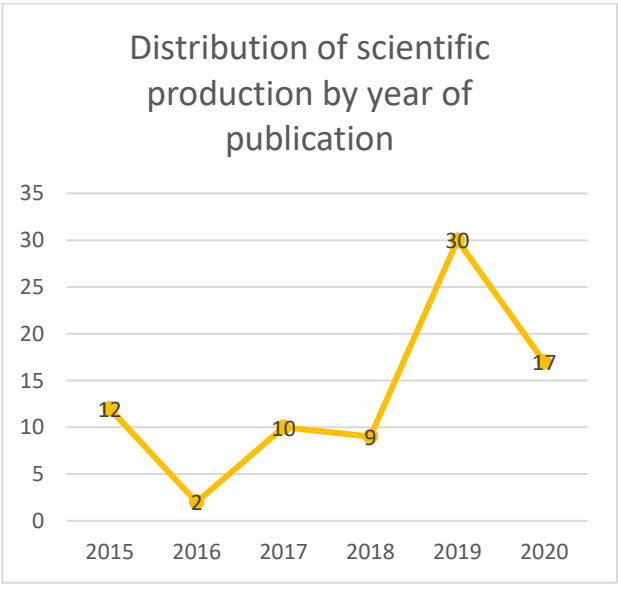

Figure 2. *Distribution of scientific production by year of publication.*

Source: Own elaboration (2021); based on data provided by Scopus.

As shown in Figure 2, in the analyzed period the year with the highest number of publications is 2019 with a total of 30 publications registered in Scopus within which is "Action learning oriented assessment: impact on engineering physics students" (González & Trevino, 2019) In this study, interactive teaching techniques such as Flipped Learning and Self and Peer Assessment are proposed as strategies that provide the quality of empowering students with the responsibility of their own learning process, which depends on the development of strategic and autonomous learning. In this research, 157 physics students from the campus of Tecnológico de Monterrey in Puebla were studied combining these two strategies to determine the advantages of these techniques in promoting learning in physics; as a result, the convergence of these interactive techniques became a reality as an instructional design with the main objective of improving the performance of students in the application of concepts to solve physics problems.

2020 was the second year with the second highest number of publications registered with a total of 17 papers within which we identified "Pedagogical strategies for teaching and learning processes in mathematics and physics to strengthen ethical values in students" (Barrera, Gallardo, & Vergel, 2020). This research studies the pedagogies that help to strengthen ethical values and encourage learning in physics and mathematics using them in the classroom and having an impact on its social projection by implementing the physical-mathematical knowledge previously obtained.

4.3 Distribution of scientific production by country of origin.

Figure 3 shows the distribution of scientific production according to the nationality of the authors.

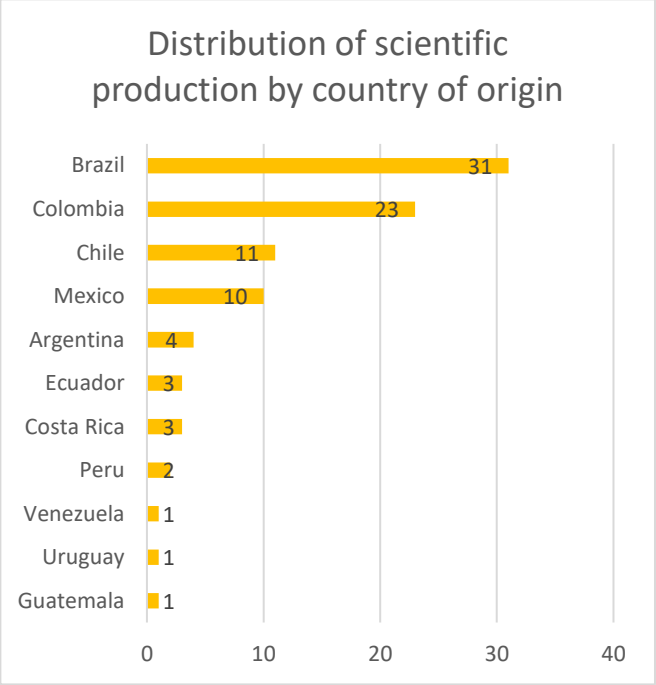

Figure 3. *Distribution of scientific production by country of origin.*

Source: Own elaboration (2021); based on data provided by Scopus.

Brazil is the Latin American country with the largest number of registered publications related to the development of motivational strategies for teaching physics, among these documents is "Use of a set of questions and answers as a way to problematize and motivate the teaching of physics in high school" (F.B., 2020). The objective of this study is to develop and apply a strategy that involved a "question and answer game" to introduce the study of mechanics in a differentiated and more attractive way for students starting from the lack of interest of students in learning physics through a formulation of questions and answers; Through the students' responses, it was observed that the degree of satisfaction was relatively high and that they liked the game itself and the change in the classical and plastered way in which the content was worked developing their physical-mathematical knowledge.

At this point, it is worth noting that the production of scientific publications, when classified by country of origin, presents a special characteristic and that is the collaboration between authors with different affiliations to both public and private institutions, and these institutions can be from the same country or from different nationalities, so that the production of an article co-authored by different authors from different countries of origin allows each of the countries to add up as a unit in the overall publications. This is best explained in Figure 4, which shows the flow of collaborative work from different countries.

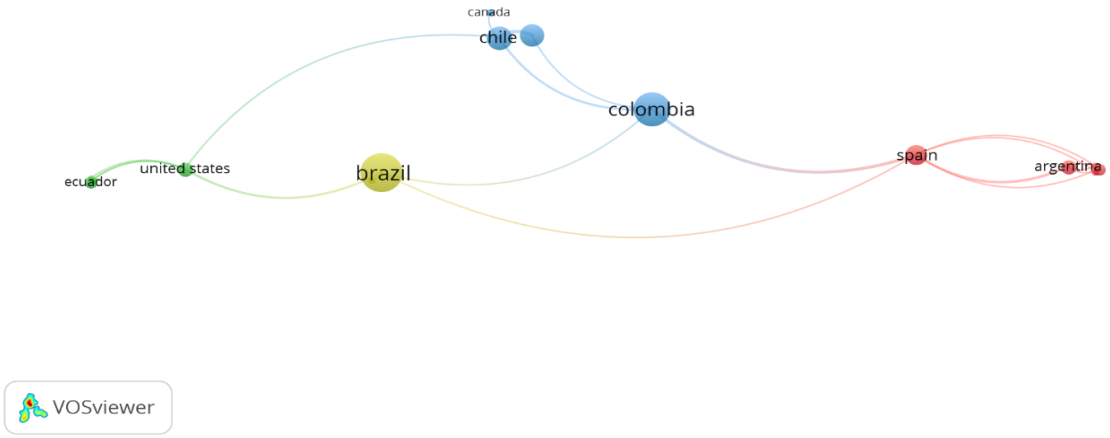

Figure 4. *Co-citations between countries.*

Source: Own elaboration (2021); based on data provided by Scopus.

Brazil, as mentioned above, is the country with the largest contribution in research related to the variables under study, co-authored with countries that do not belong to Latin America, providing a broader vision of the studies with countries such as the United States and Canada. In second place is Colombia with 23 publications, with collaboration of authors affiliated to countries such as Spain, Argentina and Brazil mainly, among which is "Pedagogical practices of physics teachers in the region of Catatumbo, Colombia" (Gallardo, Vergel, & Villamizar, 2020). In this study, the authors analyze the skills of physics teachers in the schools of Catatumbo which is a place permeated by violence and social situations that make education in general less attractive, so the influence of their training as teachers in the implementation of new pedagogies in the motivation of physical-mathematical learning laboratories and teaching strategies used in the training of students by physics teachers is studied.

4.4 Distribution of scientific production by area of knowledge

Figure 5 shows how the production of scientific publications is distributed according to the area of knowledge through which the different research methodologies are executed.

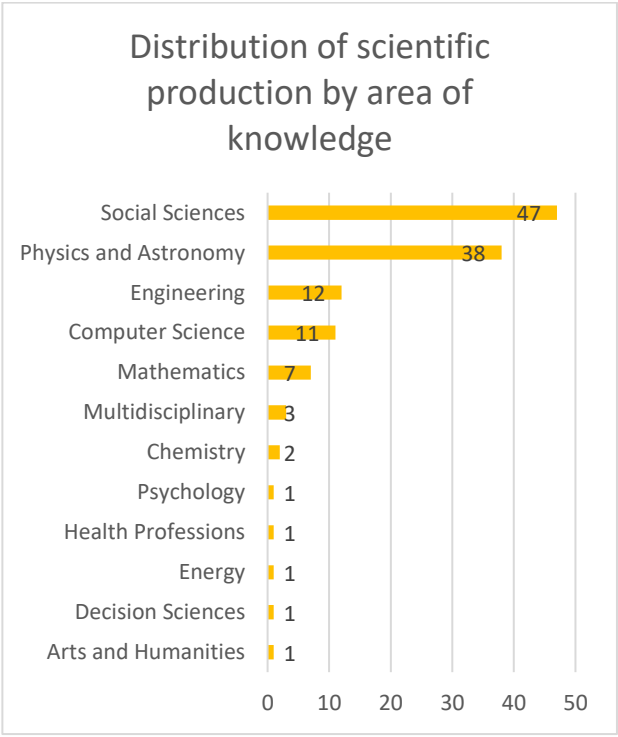

Figure 5. *Distribution of scientific production by area of knowledge*

Source: Own elaboration (2021); based on data provided by Scopus.

Social sciences is the area of knowledge with the greatest contribution to research related to the development of motivational strategies for teaching physics with 47 documents registered in Scopus, among which we identified "Solving poorly structured problems as a process of didactic-scientific modeling in physical education" (Oliveira, Araujo, & Veit, 2020). The objective of this research is to present a theoretical articulation between the central elements of the process of solving ill-structured problems and Didactic-Scientific Modeling, as a way to assist in the development and implementation of didactic strategies that help to face ill-structured problems, thus helping to promote the learning of physics and through these problems the student can develop a broader set of skills, cognitive, meta-cognitive and procedural resources.

Physics and astronomy is the second area of knowledge with the second highest number of publications presents registered in Scopus referring to the Elaboration of motivational strategies for teaching physics with a total of 38 documents, within these is the title "How to motivate interest in physics to engineering students without dying in the attempt?" (Luna, Talavera, & Chong, 2018). This study aims to integrate students in an active participation to build their knowledge and develop their skills, the pilot test was implemented in the Physics course belonging to the careers of Commercial Engineering and Information Engineering. The different didactic strategies and pedagogies used by teachers do not necessarily guarantee the success of the attention and much less the learning of students belonging to the generation of digital natives, so it seeks to involve students in their learning process with new educational methodologies, face different projects and encourage new challenges in the teaching-learning process in the study of physics.

4.5 Type of publication

Figure 6 shows how the bibliographic production is distributed according to the type of publication chosen by the authors.

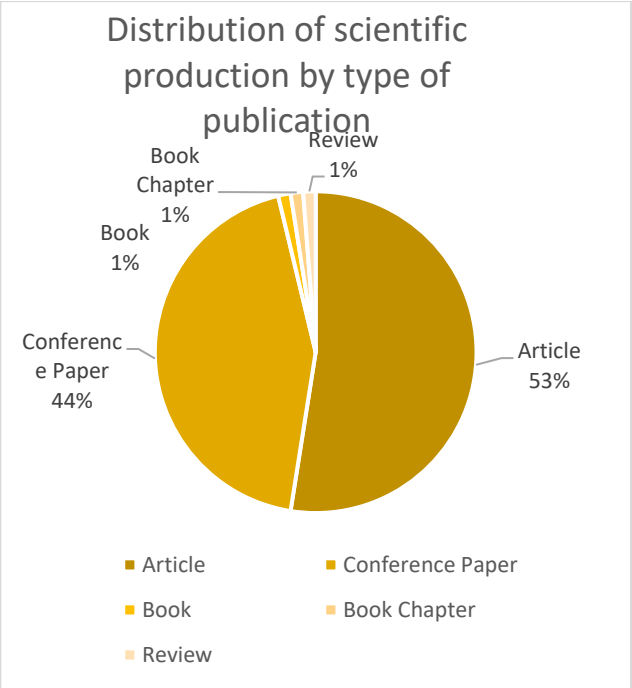

Figure 6. *Distribution of scientific production by type of publication.*

Source: Own elaboration (2021); based on data provided by Scopus.

As shown in Figure 6, within the different types of publications, 53% of the total number of documents identified through Phase 1 of the Methodological Design, correspond to Journal Articles, conference proceedings represent 44% of the total number of documents among which is the one entitled "Student's perception on the implementation of a teaching strategy based on Just in Time mediated learning and the use of information and communication technologies in the physics and laboratory course" (Pinzón, Lizcano, Martínez, Patiño, & Miranda, 2019). This study analyzes the perception of students about Just in time pedagogy in physics I laboratory courses and therefore it was concluded from the increase in the percentage of students who expressed difficulties in handling laboratory tools and devices (3.0% in 2016/I to 29% in 2018/I).

Reviews, book chapter and book represent 1% of the total number of publications registered in Scopus, in the type of publication books we can identify “Improving physical education to meet the needs of society” (Pietrocola, 2019). This book conducts an investigation of the teaching and learning of physics related to the main educational scenarios, making revisions to the physics curricula in an attempt to address the changing needs and expectations of society using information and communication technologies. Thus, it is concluded that new teaching and learning strategies and the bias against girls in physics classes are issues that need to be addressed in the implementation of methodologies that foster learning and appropriation of physics-mathematical knowledge in the knowledge.

4.6 Analysis and results of the development of motivational strategies for teaching physics

Figure 7 analyzes the difficulties that students face when solving application problems through surveys of students in the first years of the different academic careers at the Universidad Nacional de San Agustín de Arequipa using the following ABP strategy.

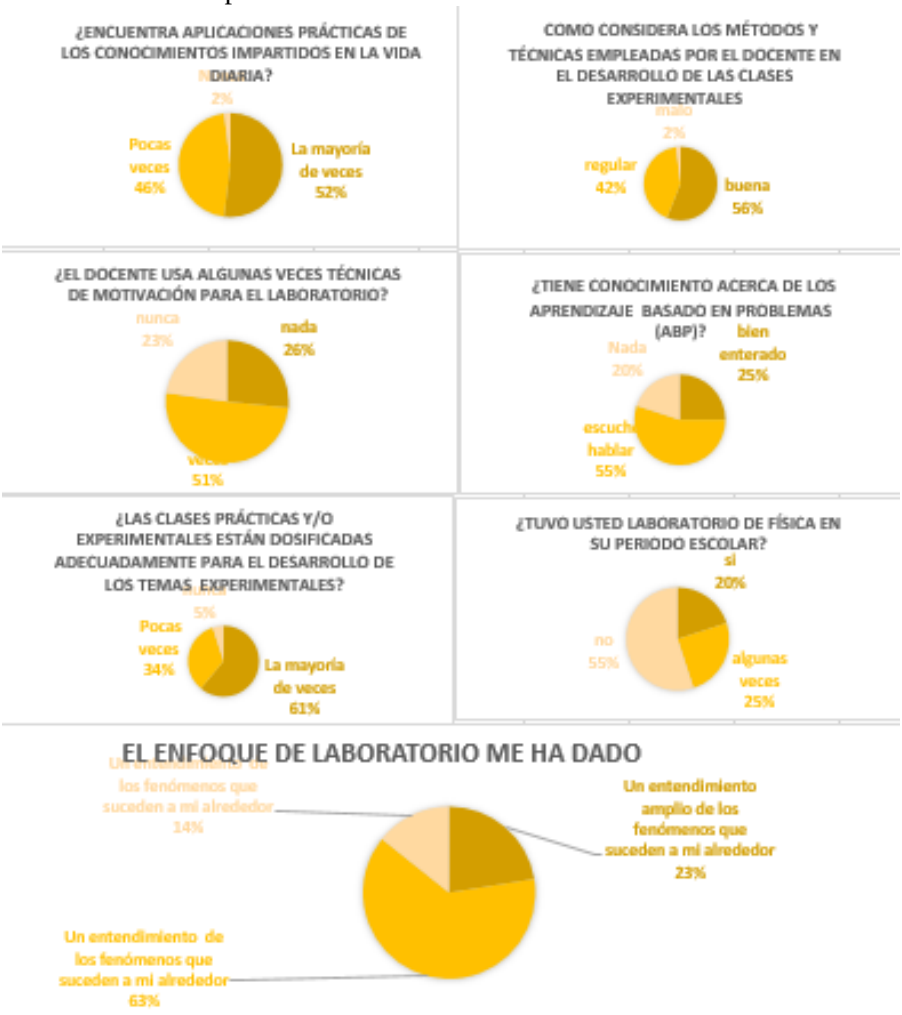

Figure 7: *Analysis and results of physics teaching strategy study.*

Source: Own elaboration through the project “elaboration of motivational strategies

For the teaching of experimental physics in a classroom setting in basic physics laboratories”.

Figure 7 shows that the student finds practical applications in daily life, indicating that the techniques used are adequate. The student finds in experimentation a support to reinforce the knowledge given in theory. Most of the students have not had a laboratory in their

educational centers, which is why they arrive at the university with a low level with respect to experimental practices. By using these teaching-learning strategies, it was possible to raise the students' level of understanding and relate it to everyday life.

5. Conclusions

Thanks to the bibliometric analysis proposed in the present research, it can be determined that Brazil is the Latin American country with the highest number of bibliographic records in Scopus database during the period from 2015 to 2020 with a total of 31 documents. The Elaboration of motivational strategies for teaching physics, has presented a significant growth during the above period, from 12 publications in 2015 to 17 units in 2020, being 2019 the year with the highest number of published documents with a total of 30 publications, i.e. a great increase was achieved in the creation of bibliographic records in a period of 5 years, This indicates the importance that the development of motivational strategies for the teaching of physics represents in students as a way to promote the development of physical-mathematical knowledge by implementing new pedagogies that help students to awaken interest in the teaching of physics.

The study of physics is of great importance to understand the phenomena present in everyday life, and is even more important for students with careers related to the exact sciences, but there are difficulties in the appropriation of knowledge. These difficulties are related to the lack of motivation in learning physics, so it is necessary to implement different strategies that motivate students to develop basic knowledge of this science to help them raise the level of understanding of the knowledge provided in the academy. One of the most used strategies to encourage students to be educated in topics related to physics is the problem-based learning (PBL) since it is based on an autonomous construction of knowledge from previously acquired concepts, allowing the student to obtain lasting knowledge. It also highlights the need to implement information and communication technologies (ICT) in the development of strategies that motivate the study of this science, being immersed in the digital age and being the digital methodologies the ideal ones to promote the study in a didactic way in students who begin the study of physics. All of the above allows this article to conclude, highlighting the importance of knowing the theory or bibliographic resources that seek to awaken interest in educational institutions in the implementation of new tools that motivate students to learn physics. It is for this reason that the need for studies such as the one presented in this document is highlighted, which make a tour of those texts that address the aforementioned topic, in order to give the reader a broad view of the current situation of the literature on the development of motivational strategies for teaching physics.

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