LEX LOCALIS-JOURNAL OF LOCAL SELF-GOVERNMENT
ISSN:1581-5374 E-ISSN:1855-363X
VOL. 23, NO. S4(2025)

LEARNING DERIVATIVES (MATHEMATICS) IN COLLEGE STUDENTS. A SYSTEMATIC REVIEW

Calachahuin Machaca, Jannet Roxana[1], Esther Yanet Yanapa Zapana[2], Diego Alonso Gutierrez Yanarico[3], Lizeth Gabriela Cruz Valdivia[4]

[1](orcid.org/ 0009-0007-6517-8642)
[2]orcid.org/0000-0003-3901-0516
[3]orcid.org/0009-0001-3321-7631
[4]0009-0007-5065-3068

jcalachahuinm@ucvvirtual.edu.pe[1]
eyanapa@ucsm.edu.pe[2]
dgutierrezy@ucsm.edu.pe[3]
Lizethcruzvaldivia@gmail.com[4]

Abstract

This study reviews several scientific articles from the last five years on the importance of learning derivatives in university students. The review was conducted using different academic search engines, including articles from Peru and other countries where there is also interest in this topic.The following question was formulated: How is the importance of learning derivatives in university students demonstrated? The objective of the present research is to carry out a systematic review of articles related to the learning of derivatives in university students. The information network was then utilized, encompassing all reviewed documents from indexed academic journals, encompassing both domestic and international studies. This approach was adopted to illuminate the multifaceted nature of the problem, encompassing diverse perspectives, approaches, challenges, solutions, and recommendations. the systematic review culminated in the revelation of the intricacies inherent in the learning of derivatives in university students, accentuating the conceptual and pedagogical challenges. It underscores the necessity for innovative teaching methodologies that foster profound comprehension and the integration of technological tools. Subsequent research endeavors should prioritize the formulation of efficacious interventions that take into account the distinct characteristics of students and their respective educational environments.

Key Words: Learning, Derivatives, College Students, Systematic Review.

Resumen

Este estudio muestra la revisión de diversos artículos científicos de los últimos 5 años sobre la importancia del aprendizaje de las derivadas en estudiantes universitarios, haciendo consulta en distintos buscadores académicos, entre artículos de Perú y otros países donde también existe el interés acerca de este tema. Se formuló la pregunta siguiente: ¿Cómo se muestra la importancia del aprendizaje de las derivadas en estudiantes universitarios? El objetivo de la presente investigación es realizar una revisión sistemática de los artículos relacionados con el aprendizaje de las derivadas en estudiantes universitarios. Entonces, se ha utilizado la información en la red científica, es decir, todos los documentos revisados son de revistas indexadas de carácter académico, desde estudios nacionales a internacionales para poder rescatar los distintos enfoques de esta problemática con los diferentes puntos de vistas, su planteamiento, la problemática, las soluciones y sus recomendaciones. En conclusión, la revisión sistemática revela la complejidad del aprendizaje de derivadas en estudiantes universitarios, destacando desafíos conceptuales y pedagógicos. Destacando la necesidad de estrategias de enseñanza innovadoras que promuevan la comprensión profunda y el uso de herramientas tecnológicas. Futuras

investigaciones deben enfocarse en el desarrollo de intervenciones efectivas que consideren las particularidades de los estudiantes y los contextos educativos.
Palabras Clave: Aprendizaje, Derivadas, Estudiantes Universitarios, Revisión Sistemática.

Introduction

Mathematics, as a universal language and a fundamental tool for understanding the world, encompasses several areas of study, among which differential calculus plays a crucial role. Differential calculus, and in particular the concept of the derivative, is a cornerstone in the education of university students in various disciplines, from science and engineering to economics and statistics. The derivative, understood as the instantaneous rate of change of a function, allows modeling and analyzing dynamic phenomena, optimizing processes and understanding the variability of complex systems (Stewart, 2018). Its mastery is essential for the development of critical thinking, problem solving and mathematical abstraction skills, fundamental skills in the 21st century. Despite its importance, learning derivatives represents a significant challenge for many college students.

Conceptual difficulties, lack of connection with practical applications and the diversity of pedagogical approaches can generate confusion and demotivation (Orton, 1983). In the Latin American context, and specifically in Peru, mathematics teaching in higher education has been the subject of attention and debate, with efforts to improve the quality and relevance of learning (MINEDU, 2019). Because of this, the learning of mathematics, and in particular of derivatives, is conceived as a constructive process in which students interact with concepts, develop problem-solving skills, and construct their own knowledge (Piaget, 1970).

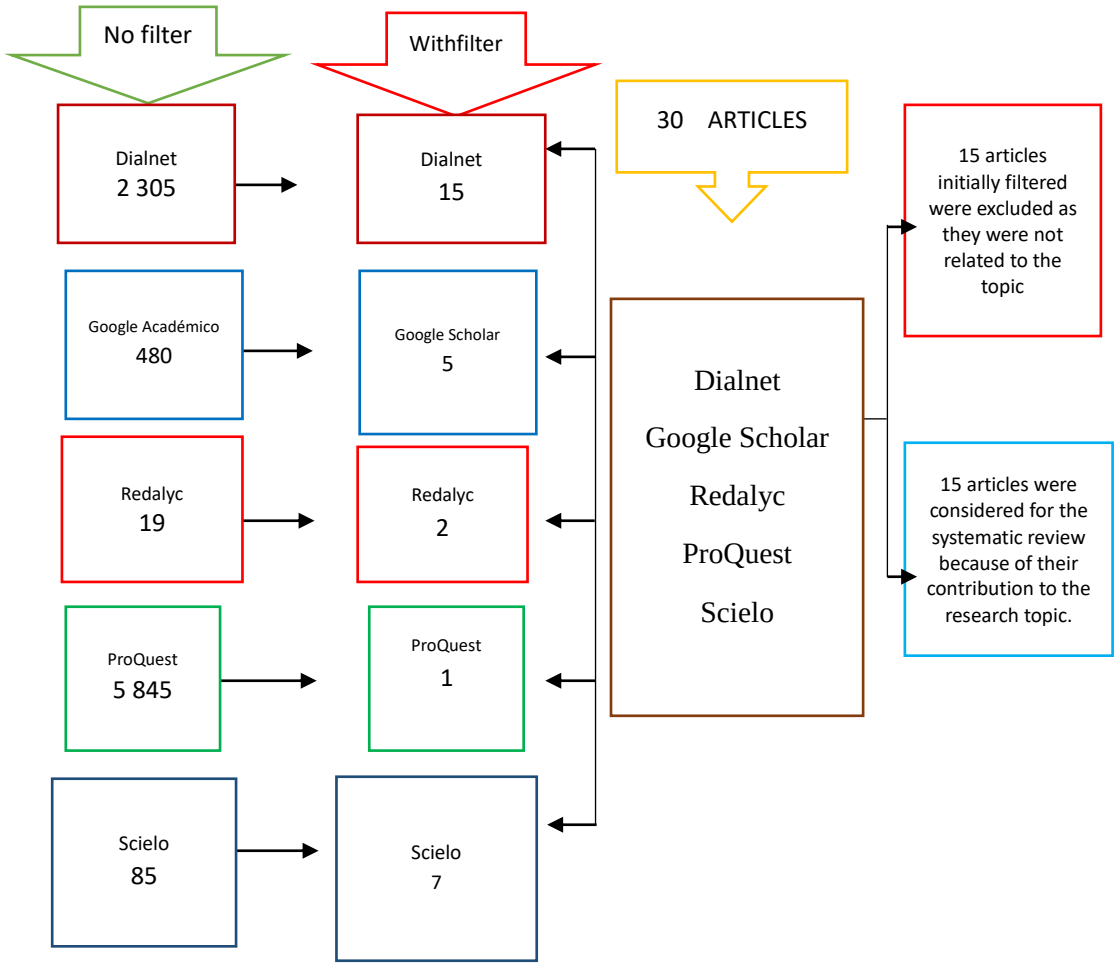
The present systematic review focuses on the analysis of the scientific literature of the last five years related to the learning of derivatives in university students. Several academic databases are explored, including research articles from Peru and other countries, with the aim of identifying trends, challenges, and effective pedagogical strategies in the teaching of derivatives. The analysis encompasses common student challenges, the impact of diverse teaching methodologies, the integration of technologies and learning tools, and the correlation between learning derivatives and success in higher-level courses.The objective is to furnish a contemporary synthesis of knowledge concerning the learning of derivatives in undergraduate students, with the aim of enhancing teaching practices and promoting the development of effective teaching and learning methodologies for this pivotal concept. It is anticipated that the research findings will be instrumental in informing the efforts of teachers, researchers, and educational policymakers who are interested in enhancing the mathematical education of university students and preparing them to meet the challenges of both the professional and academic worlds.

Methodology

Systematic reviews (SRs) are secondary studies that seek to answer a research question by conducting exhaustive searches of the available evidence—that is, studies that have previously answered the research question—and synthesizing the results found in these investigations (Fernández et al., 2019).A bibliographic level research was conducted, taking into account a variety of scientific articles oriented to the study variables. The search was conducted using the bibliographic databases from the years 2019 to 2024, encompassing the most recent five-year period, to gather updated data relevant to the subject under

investigation.The systematic review was conducted using prominent academic search engines, including Google Scholar, Scielo, ProQuest, Dialnet, and Redalyc.These databases were selected due to their reputation for providing access to scholarly literature. The search yielded numerous articles from scientific journals that addressed the significance of sustainable tourism in Peru. The search terms employed were "learning of derivatives" and "derivatives in university students."

Figure 1. Flowchart of the inclusion and exclusion criteria used for the systematic review.



Note: Dialnet, Google Scholar, Redalyc, Proquest and Scielo databases.

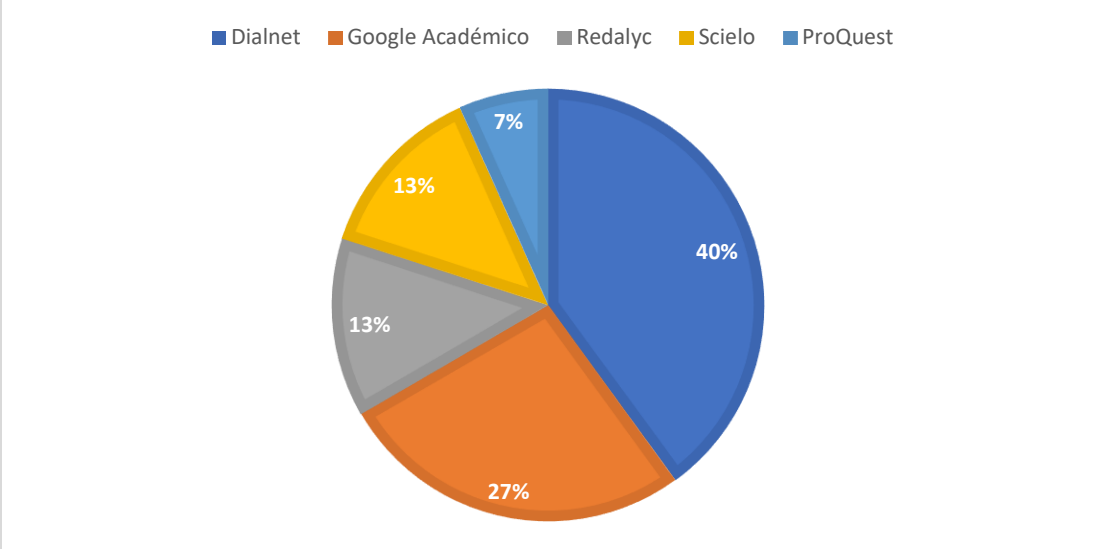
Results

The results of the research are presented below. The bibliographic analysis was carried out through the academic network, that is, using virtual resources, but in reliable pages for scientific searches. The following search engines were used: Dialnet, Google Scholar, Redalyc, Proquest and Scielo, in that order. The articles are current, no less than five years old; on the other hand, important articles in Spanish were found. The terms for this search were “Learning of derivatives” and “Derivatives in university students”, yielding results very similar to the research problem.

Figure 1 shows the information search process. At the beginning, by entering the search terms without any filter, results were shown with numerous articles: Dialnet 2305, Google Académico 480, Redalyc 19, Proquest 5845, Scielo 85. Applying language filters (Spanish), age not less than five years, specifying that they are only articles from scientific journals, a smaller number of articles were obtained. It is also worth mentioning the personal choice, discarding articles that are not related to the application of the topic in regular basic education. Thus, the search is as follows: Dialnet 15, Google Scholar 5, Redalyc 2, Proquest 1 and Scielo 7.

For this study, an attempt was made to collect articles from different academic search engines, in order to obtain different results, although it is noteworthy that, as shown in Figure 2, the presence of articles related to the topic is more abundant in the academic search engine "Dialnet", being interesting when we observe that most of the articles, as shown in Figure 1, are from the search engine "ProQuest". It should be noted that, in the latter mentioned, the searches through the filter discarded many results, in addition to the personal selection, highlighting that, although the search terms were precise, results with little relation to the research topic were found. On the other hand, in "Dialnet", articles similar to the research topic were shown, giving the possibility of taking several interesting articles.

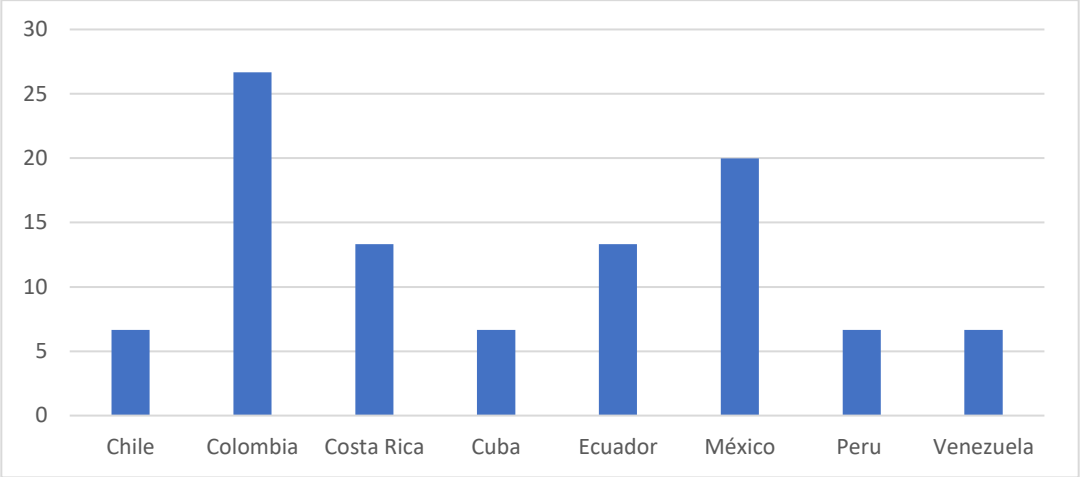
Figure 2. Percentage distribution of articles by academic search engine.



Note: Dialnet, Google Scholar, Redalyc, Proquest and Scielo databases.

On the other hand, the origin of the researches has been rescued in order to make a comparison in terms of countries that have studied this problem. Colombia stands out in this opportunity, in this research 35.7% are Colombian articles.

Figure 3: Percentage distribution of articles by country.



Note: Dialnet, Google Scholar, Redalyc, Proquest and Scielo databases.

Some of the articles selected in the research provide more general results. For example, Manjarrez Ponton, C. A., & Romero Rincón, Y. J. (2022). concluded that the most used strategies are pre-instructional and the least used are co-instructional, both by teachers and students. Likewise, the most used by teachers and students are the objectives, as a strategy to plan the scope and approach of the new content for the improvement of learning achievement in students, which serves as a guide for them, and as a way to clarify the goal to be achieved for the achievement of learning.
Among all this, the following table (Table 1) shows the most important contributions of each research to solve the question posed about the importance of learning derivatives in university students:

Table 1: Articles by author and contribution.

N°	Authors	Contributiontothestudy
1	Manjarrez Ponton, C. A., & Romero Rincón, Y. J. (2022).	It is highlighted that the teaching learning strategies used by the teacher for the significant learning of the derivative of functions of a variable, in engineering students of the Popular University of Cesar, it is concluded that the most used strategies are the pre-instructional ones and the least worked on are the co-instructional ones, both by teachers and by students. Likewise, the most used by teachers and students are the objectives, as a strategy to carry out the planning of the scope and approach of the new content for the improvement of the learning achievement in students, which serves as a guide to

		them, and in order to clarify the goal to be achieved for the achievement of learning.
2	Fúneme-Mateus, C. C. (2019).	It is evident that the important aspect found in this experience is that under the flipped classroom methodology, ICTs take on the role of a transmission instrument, since social networks and tools are used with the sole objective of developing a class in which information is given to the student and there are no major pedagogical implications in this role that they assume. A possible context of application more propitious for this methodology is distance education, which occupies a significant space today in the educational sector of some countries, since the elements present in this methodology can enrich the way in which communication between teachers and students takes place. To conclude, it can be said that, although this new trend in teaching can be useful in different aspects, it still needs to be thought through in greater depth so that it really addresses the needs and difficulties that students face in their learning processes, since until now greater emphasis is placed on how to teach and not on how to learn.
3	Garcés-Córdova, W., & Font-Moll, V. (2022).	It shows that mathematics teachers from engineering courses participating in this study assign relatively less weight in the implementation of their differential calculus classes to the criteria of epistemic and cognitive suitability, since they sacrifice mathematical rigor, relevant processes of mathematical activity, as well as high cognitive demand, for ecological and mediational issues, as can be seen in the results of this research.
4	Velázquez, R. V., García, W. A. M., Zúñiga, K. M., &Landin, A. L. C. (2021).	The results obtained in the research show that the PBL methodology was well received by the engineering students. One of the points that all the students agreed on was changing their role in the classroom, moving from a totally passive attitude, in which not speaking was a virtue, to an

		active attitude in which even the depth with which the topics are discussed is up to them to establish. Another of the motivating points that they considered was that the teacher got rid of his aura of omnipotence, by accepting both criticism and other possible solutions to the problems raised in the classroom, so that the students participated more in the discussions.
5	Prieto, J. L., & Arredondo, E. H. (2022).	The key findings highlight the concept of the activity adopted that allowed the training activity to be projected as a legitimate space for raising awareness of SACEG, in its disciplinary and professional aspects. An advantage of the proposed training activity is the possibility of being partially or totally integrated into the dynamics of the operation of the Mathematics Pedagogy courses in the country, either as an optional course, a learning unit or an improvement activity. Finally, the path taken offers an approach to what it means to assume some principles of the Theory of Objectification to design a learning environment aimed at future mathematics teachers, thereby establishing a bridge between initial training and the world of teaching.
6	Reyes, L. S. B., & Pita, I. G. A. (2021).	He concludes that mathematics is important since it is one of the most important sciences in student training. Currently, teachers have had to innovate to apply knowledge to their students, this is due to the Covid-19 pandemic. The inverted class method is a method whose learning tool involves the student, by giving them part of the responsibility in the stages of learning, and arises as a strategy for teachers when applying a teaching model for a particular subject. Therefore, the application of this educational method is recommended for student training, in order to involve the student in the learning processes, and create a sense of belonging

		and responsibility for the study.
7	Taipe, C. (2019).	It concludes that, when applying the entrance exam to the second semester students of the Professional School of Textile and Clothing Engineering, it is observed that the final average of the grades of the linear kinematics of a particle evaluation is deficient, since the majority is in the deficient category. That is, the low grades obtained in the entrance exam explain the lack of commitment between the elements that participate in the process, students with little knowledge of differential calculus and teachers with few teaching strategies. At the end of the learning process using the MATLAB software, it was found in the exit test that there are significant differences between the experimental group and the control group in the learning level of linear kinematics of a particle, according to the results obtained the experimental group has a higher academic performance on kinematics since its highest percentage is in the regular category (55%) and a percentage in the very good category (9%), while in the control group its highest percentage is in the regular category (64%) and a percentage on the very good scale of 0%, at a confidence level of 95%.
8	López, M. J. C., Castillo, A. L., Maldonado, A. A. P., & Casados, J. C. (2020).	In order to achieve a quality academic performance in the student, the information presented must be coherent and congruent with his/her perception system. The neurolinguistic programming model considers that the way in which this information is received through the senses of sight, hearing and touch is fundamental in the preferences of learning styles. The human mentally represents information through three major preferential systems: visual, auditory and kinesthetic, with the latter prevailing as the main one. With respect to learning strategies, these lead to better results, motivate self-study and

		enhance the learning capacities of students, since, knowing the student's communication channel, it is easier to understand, comprehend, analyze, relate and synthesize, without forgetting the emotional component, or the scenario where it takes place, thereby generating better academic, conceptual, procedural and attitudinal performance.
9	Pineda Izasa, W. B., Hernández Suárez, C. A., & Avendaño Castro, W. R. (2020).	Regarding the computer aspects, the results indicate that Derive is an appropriate software to support the learning of derivatives. It is easy to access and easy to use. It offers students adequate interactivity and a user-friendly interface. It speeds up calculations, allows them to respond to exercises that require a large number of operations and facilitates the construction of new ways of solving the problematic situations posed. It is a tool that requires little time for proper use. During its use, it promotes the completion of the activities proposed in the subject of derivatives and facilitates the understanding of the different topics thanks to the graphical visualization it offers. Finally, this allows for an improved attitude, increased motivation and enjoyment of learning mathematics. In addition, the incorporation of Derive serves, on the one hand, as support for the teaching work in the introduction and management of concepts and rules specific to the subject of derivatives, and on the other, provides a path in the learning of the derivation of algebraic functions.
10	Romero-Sánchez, D., & Barrios, D. (2023).	It highlights that digital literacy has been extended for some time in various academic dynamics of students, demanding from them the rapid acquisition of capacities and strategies that process and contribute effectively to the demands of their educational environment, such as staying informed, the ability to communicate, the use of technology and

		the organization of their work. This is an area of constant transformation that also requires someone to adapt and find solutions to the large amount of information available. University students with a high capacity for information employ the use of search engines using keywords that facilitate access to information and its storage in the electronic device, to then use it in the development of academic tasks. The communication capacity of students is determined by the use of collaborative platforms that allow the editing and correction of texts, the use of multimedia elements and the subsequent reception and sending of information. The use of technology is defined by the integrated management of electronic devices, the updating and configuration of the system and the identification of operating problems for their subsequent solution. Finally, the capacity for organization is determined by the management, order and planning of knowledge for use in educational activities.
11	Ruiz Ledesma, E. F. (2019).	It is proposed that the Technopedagogical scenario constitutes a support for the student to handle with greater ease and prior understanding the formulas involved in some problem-solving strategies. The integration of productive technology in teaching needs to consider the three aspects (Content, pedagogy and technology) not in isolation, but within the complex of relationships in the system defined by the three key elements.
12	Campo-Meneses, K. G., & García-García, J. (2020).	It is stressed that it is still necessary to continue exploring the mathematical connections associated with these functions that university students, as well as in-service teachers, are able to establish in order to have a better overview of this problem. In this sense, future research can study the mathematical connections

		associated with the exponential and logarithmic functions promoted by the teacher or the official curriculum, so it is possible to find new types of connections. In short, we consider that the line of research on mathematical connections is a little-explored field, but with growing interest in the literature, mainly international.
13	Castillo-Sánchez, M., Gamboa-Araya, R., & Hidalgo-Mora, R. (2020).	Based on the data obtained, it can be pointed out that the main problem with the General Mathematics course was dropout and, secondly, failure. Aspects related to students such as sex, area of origin, stratum, type of school or institution in which they attended secondary education, year of entry to university education, average secondary education grades, entrance exam grade, category of entry to the course, course schedule enrolled and degree course are variables that could help to characterize and identify students at risk of presenting any of these conditions. There is a general assessment, both by students and teachers, that the knowledge acquired in secondary school is not sufficient to face the General Mathematics course, due to two main reasons: in secondary school not all the contents of the course are covered and there is no adequate management of what was studied at this educational level. In addition to the above, there are differences in terms of methodology and approach at both educational levels.
14	Rojas-Ospina, T., & Valencia-Serrano, M. (2021).	In conclusion, aspects of the classroom environment related to the interaction between teachers and students in the classroom seem to play an important role both in the motivation of mathematics students towards academic activities and in the kind of strategies that students use to maintain and increase their motivation. Thus, although students are interested in raising their motivation and in having good

		performances in class, this is insufficient if they cannot make use of strategies that allow them to truly identify the importance of academic content and activities, and, to this extent, work towards better learning. Hence the importance of the accompaniment of the teacher as an expert in his area of knowledge to help the student in this task; an aspect that should be an essential part of the teaching process.
15	González-Hernández, L. (2019).	In the specific case of teaching and learning mathematics, special attention must be paid to the cognitive resources of each student, involving them in the construction of their own knowledge and enhancing their reasoning through the formulation and resolution of problems associated with their daily lives. When designing and implementing this pedagogical tool, it was crucial to investigate the prior knowledge of the target group, as well as the biological, social and economic variables that they considered influential in their learning process.

Note: Dialnet, Google Scholar, Redalyc, Proquest and Scielo databases.

The 15 articles that make up this systematic review have served to demonstrate the importance of learning derivatives in university students. Each study has provided a key piece to understand this topic, and together, they corroborate the need for specialized and continuous training for mathematics teachers in Peru, and in general in Latin America. Mathematics education professionals need to acquire skills in areas such as the teaching of derivatives, the common difficulties that students face in learning this concept, the use of different pedagogical approaches and technological tools, and the connection of derivatives with practical applications in various disciplines. By training mathematics teachers, it can be ensured that the teaching strategies implemented are effective and contribute to improving the understanding of derivatives in university students, while promoting their success in higher courses and their development in areas with greater need.

Discussion

The results of this review indicate a clear necessity for specialized and continuous training for mathematics teachers in Peru and throughout Latin America. This training should encompass the didactics of derivatives, the common difficulties students encounter in learning this concept, the utilization of diverse pedagogical approaches and technological tools, and the connection of derivatives with practical applications in various disciplines.

The implementation of adequate training programs is imperative to ensure effective and quality teaching of derivatives and to fortify the mathematical education of university students.

For instance, as demonstrated in the study by González-Hernández, L. (2019), in the context of mathematics education, particular emphasis should be placed on the cognitive resources of each student, ensuring their active involvement in the construction of their own knowledge and enhancing their reasoning through the approach and resolution of problems that are relevant to their daily lives.

An intriguing finding emerged from the research conducted by Campo-Meneses, K. G., & García-García, J. (2020), which underscored the ongoing necessity to delve deeper into the mathematical underpinnings of these functions. This exploration, crucial for a comprehensive understanding of the subject, is particularly pertinent for university-level students and in-service teachers. In this vein, future research can examine the mathematical connections associated with the exponential and logarithmic functions promoted by the professor or the official curriculum, thereby identifying novel typologies of connections.

Conversely, Manjarrez Ponton, C. A., & Romero Rincón, Y. J. (2022) underscored that the teaching-learning strategies employed by the instructor for the substantial learning of the derivative of functions of one variable in engineering students of the Universidad Popular del Cesar revealed that the most prevalent strategies are the pre-instructional ones, while the co-instructional ones are utilized less by both teachers and students. Furthermore, the objectives emerge as the most prevalent strategy employed by both teachers and students in planning the scope and approach of new content, with the aim of enhancing learning outcomes in students. This strategy functions as a guide for students, providing clarity on the objectives to be achieved to facilitate learning.

To conclude, Reyes, L. S. B., & Pita, I. G. A. (2021), concludes that mathematics is important because it is one of the most important sciences in student education, currently teachers have had to innovate for the application of knowledge to their students, this is due to the pandemic of covid-19. Emphasizing the inverted class method whose learning tool involves the student, giving him part of the responsibility in the stages of learning, and emerges as a strategy for teachers when applying a teaching model of any particular subject. Therefore, the application of this educational method is recommended for student training, in order to involve the student in the learning process, and create a sense of belonging and responsibility for the study.

Conclusions

A recent systematic review of the learning of derivatives in university students has revealed the intricacies and significance of this subject matter. Despite the abundance of existing studies, challenges persist in the realm of derivatives teaching and learning. These challenges include conceptual difficulties, a lack of motivation, and the necessity to integrate diverse pedagogical approaches. These aspects necessitate further investigation and attention. Future research should prioritize the development and evaluation of innovative teaching strategies that promote a deep understanding of derivatives, facilitate the meaningful use of technological tools, and establish connections with practical applications across various disciplines.Additionally, it is imperative to consider the unique characteristics of students and educational contexts to design effective interventions.This systematic review provides a substantial foundation for future research and may be

beneficial for teachers, researchers, and educational policymakers interested in enhancing the teaching and learning of derivatives in undergraduate students.

Bibliographic references

Anco, R. J. A., & de la Cruz, H. N. F. (2021). Aplicación de algoritmos etnomatemáticos en el aprendizaje significativo de estudiantes universitarios. *INNOVA ResearchJournal*, *6*(1), 195-215.

Campo-Meneses, K. G., & García-García, J. (2020). Explorando las conexiones matemáticas asociadas a la función exponencial y logarítmica en estudiantes universitarios colombianos. *Educación matemática*, *32*(3), 209-240.

Castillo-Sánchez, M., Gamboa-Araya, R., & Hidalgo-Mora, R. (2020). Factores que influyen en la deserción y reprobación de estudiantes de un curso universitario de matemáticas. *Uniciencia*, *34*(1), 219-245.

Fúneme-Mateus, C. C. (2019). El aula invertida y la construcción de conocimiento en matemáticas. El caso de las aplicaciones de la derivada. *Tecné, Episteme y Didaxis: TED*, (45), 159-174.

Gallego, F. A., Rojas, C. A., Valencia, O., & Granados, H. (2024). Asociaciones entre autoeficacia, dominio e interés en la tecnología en matemáticas en estudiantes universitarios de Colombia. *Formación universitaria*, *17*(1), 59-68.

Garcés-Córdova, W., & Font-Moll, V. (2022). Criterios que guían la práctica del profesor de matemáticas en cursos de ciencias básicas para ingeniería. *Uniciencia*, *36*(1), 66-81.

González-Hernández, L. (2019). El Aula Virtual como Herramienta para aumentar el Grado de Satisfacción en el Aprendizaje de las Matemáticas. *Información tecnológica*, *30*(1), 203-214.

López, M. J. C., Castillo, A. L., Maldonado, A. A. P., & Casados, J. C. (2020). Estrategias para potenciar el aprendizaje y el rendimiento académico en estudiantes universitarios. *Revista Venezolana de Gerencia: RVG*, *25*(90), 579-594.

Manjarrez Ponton, C. A., & Romero Rincón, Y. J. (2022). Análisis de las estrategias instruccionales utilizadas para el aprendizaje significativo de la definición de derivada de funciones de una variable. *Revista de Ciencias Humanísticas y Sociales (ReHuSo)*, *7*(3), 112-125.

MINEDU (2019). Currículo Nacional de la Educación Básica. Ministerio de Educación del Perú.

Orton, A. (1983). Students' understanding of calculus. EducationalStudies in Mathematics, 14(1), 61-68.

Pineda Izasa, W. B., Hernández Suárez, C. A., & Avendaño Castro, W. R. (2020). Propuesta didáctica para el aprendizaje de la derivada con Derive. *Praxis & Saber*, *11*(26).

Piaget, J. (1970). Science of education and the psychology of the child. OrionPress.

Prieto, J. L., & Arredondo, E. H. (2022). Diseño de un entorno de aprendizaje del saber docente acerca de las construcciones euclidianas con GeoGebra. *Educación matemática*, *34*(2), 7-38.

Reyes, L. S. B., & Pita, I. G. A. (2021). Análisis del método de aprendizaje de clase invertida, como estrategia de enseñanza para las matemáticas. *Polo del Conocimiento: Revista científico-profesional*, *6*(5), 479-495.

Rodríguez, A. (2021). Estrategia didáctica para el Proceso Enseñanza-Aprendizaje contextualizado de matemáticas discretas en Tecnologías de la Información. *Serie Científica de la Universidad de las Ciencias Informáticas*, *14*(1), 69-83.
Rojas-Ospina, T., & Valencia-Serrano, M. (2021). Estrategias de autorregulación de la motivación de estudiantes universitarios y su relación con el ambiente de clase en asignaturas de matemáticas. *Acta Colombiana de Psicología*, *24*(1), 47-62.
Romero-Sánchez, D., & Barrios, D. (2023). Modelo de ecuaciones estructurales para la evaluación de competencias tecnológicas en estudiantes universitarios. *TecnoLógicas*, *26*(56).
Ruiz Ledesma, E. F. (2019). Estudio sobre las dificultades que tienen estudiantes de nivel superior en la resolución de problemas de cálculo, y empleo de un Escenario de aprendizaje tecnopedagógico como apoyo en el trabajo del aula. *Nova scientia*, *11*(23).
Stewart, J. (2018). Calculus: Early Transcendentals. Cengage Learning.
Taipe, C. (2019). Aplicación del software MATLAB en el aprendizaje de la cinemática lineal de una partícula en estudiantes universitarios de ingeniería. *Revista Innova Educación*, *1*(3), 281-287.
Velázquez, R. V., García, W. A. M., Zúñiga, K. M., &Landin, A. L. C. (2021). Metodología del aprendizaje basado en problemas aplicada en la enseñanza de las Matemáticas. *Serie científica de la universidad de las ciencias informáticas*, *14*(3), 142-155.