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INTEGRATION OF EMERGING TECHNOLOGIES IN CHEMICAL ENGINEERING: INNOVATIVE PERSPECTIVES FOR EFFICIENCY AND SUSTAINABILITY IN INDUSTRIAL PROCESSES

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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 variables Emerging Technologies, Chemical Engineering and Industrial Processes. The purpose of the bibliometric analysis proposed in this document was to know the main characteristics of the volume of publications registered in the Scopus database during the period 2018-2023 with respect to the study of the aforementioned variables, achieving the identification of 78 publications in total. The information provided by this platform was organized through graphs and figures categorizing the information by Year of Publication, Country of Origin, Area of Knowledge and Type of Publication. Once these characteristics have been described, the position of different authors regarding the proposed theme is referenced through a qualitative

analysis. Among the main findings made through this research, it is found that China, with 17 publications, was the country with the highest scientific production registered in the name of authors affiliated with institutions in that nation. The Area of Knowledge that made the greatest contribution to the construction of bibliographic material related to the study of Emerging Technologies, Chemical Engineering and Industrial Processes was Chemical Engineering with 29 published documents, and the Type of Publication that was most used during the period indicated above was the Review Article, which represents 54% of the total scientific production.

Keywords: Emerging Technologies, Chemical Engineering, Industrial Processes.

1. Introduction

The effects of globalization, in addition to being benefits for large industrial processes and economic growth, this in turn brings with it great environmental, social and economic complications. These challenges are sought to be addressed urgently, therefore, with the arrival of sustainable development it is sought to ensure the security of the unlimited resources that we have at our disposal, to safeguard food security and mitigate the effects of social inequality. Environmental problems and effects of industrial processes, emphasizing the chemical industry, can be prevented if new paradigms are adapted in the production processes used by companies. To introduce new paradigms in production, it is necessary for industrial companies to provide safe and clean practices and, above all, to ensure the care of the environment and at the same time compete in national and international markets with the same quality conditions in the processes.

Based on this premise, it is important to talk about the importance of new technologies in chemical engineering, which hand in hand with sustainability can be carried out more environmentally friendly industrial processes. This overall contribution is based on the principles of sustainability, since the practices of chemical activity in industry are threatened by the limitation of the resources that we have available, such as raw materials, and by regulations that seek to save these resources, formulated for good management of these resources and an increasingly strict and expensive society.

The incorporation of technologies in the chemical industry improves research processes and laboratory management. According to these advances, they lie in the reduction of waste that is obtained at the time of carrying out any process, with this it is sought that it makes good use of these wastes and that they do not pollute the environment, in addition it is sought that researchers can gradually replace those materials, which due to their toxicity tend to be harmful at the time of implementation and thus cause less impact on the environment. Likewise, the use of renewable energies and the use of the circular economy base become key pillars for sustainability processes in chemical engineering. These major advances aim to foster a more competitive industrial environment where innovation in the global context companies are more competitive and are aware of the importance of sustainable development. (López, 2009)

In this scenario, the main challenge facing green engineering is based on disposing of elements considered toxic and finding a cleaner and safer substitute for them. But, like any process of development and change, it is not exempt from presenting a series of complications and challenges, since this development must be driven by scientific and technological collaboration of a legislative order. If the correlation of governmental, scientific and technological sources is successfully carried out, great environmental, social and economic benefits can be managed. Good management and

handling of chemical resources is expected from this, since a reduction of such waste will favor the care of the ecosystem. Considering the challenge faced by chemical engineers in the search for industrial sustainability, it is not surprising that such a feat requires the active participation of members of society, scientists, politicians and new technologies as it seeks to publicize the importance of sustainability in the medium term and benefits for the environment in the long term. For this reason, this article seeks to describe the main characteristics of the compendium of publications indexed in the Scopus database related to the variables Emerging Technologies, Chemical Engineering and Industrial Processes, as well. Such as the description of the position of certain authors affiliated with institutions, during the period between 2018 and 2023.

2. General objective

To analyze from a bibliometric and bibliographic perspective, the production of research works on the variables Emerging Technologies, Chemical Engineering and Industrial Processes in Scopus during the period 2018-2023.

3. Methodology

Quantitative analysis of the information provided by Scopus is carried out under a bibliometric approach on the scientific production related to the study of the variables Emerging Technologies, Chemical Engineering and Industrial Processes. Likewise, examples of some research works published in the area of study indicated above are analyzed from a qualitative perspective, from a bibliographic approach to describe the position of different authors regarding the proposed topic.

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

3.1 Methodological design

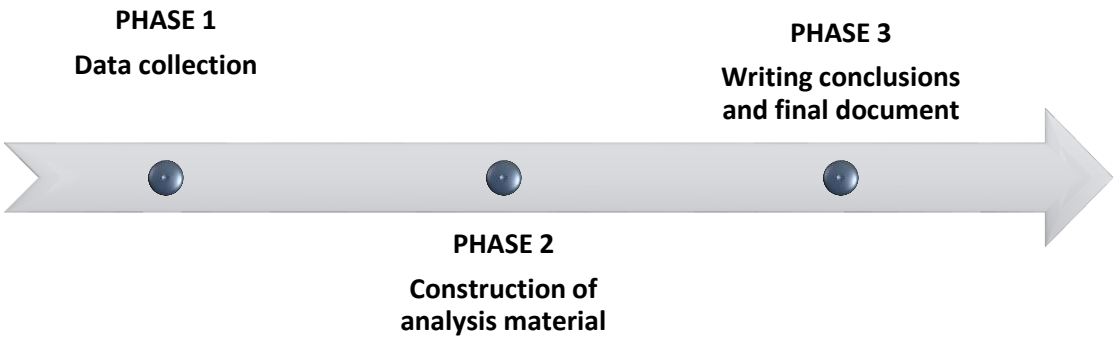

Figure 1. Methodological design
Source: Own elaboration

3.1.1 Phase 1: Data Gathering

Data collection is carried out through the Search tool on the Scopus website, through which a total of 78 publications are identified. To this end, search filters were established that consisted of:

TITLE-ABS-KEY (emerging AND technologies, AND chemical AND engineering, AND industrial AND processes) AND PUBYEAR > 2017 AND PUBYEAR < 2024

- ✓ Published documents whose study variables are related to the study variables Emerging Technologies, Chemical Engineering and Industrial Processes
- ✓ Without distinction of country of origin.
- ✓ Without distinction of area of knowledge.
- ✓ Without distinction of type of publication.

3.1.2 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.

- ✓ Co-occurrence of Words.
- ✓ Year of publication
- ✓ Country of origin of the publication.
- ✓ Area of knowledge.
- ✓ Post Type

3.1.3 Phase 3: Drafting of the conclusions and final document

After the analysis carried out in the previous phase, the conclusions are drafted and the final document is prepared.

4. Results

4.1 Word co-occurrence

Figure 2 shows the co-occurrence of keywords within the publications identified in the Scopus database.

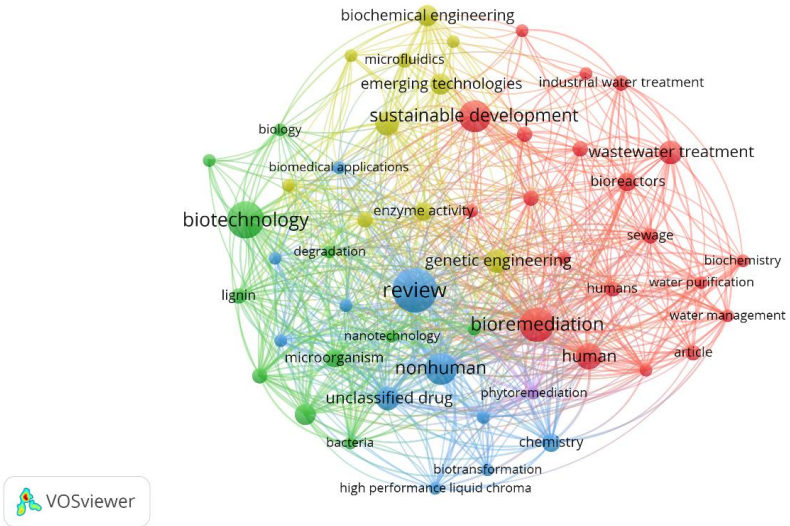

Figure 2. Word co-occurrence
Source: Own elaboration (2023); based on data provided by Scopus.

Biotechnology was the keyword most frequently used within the studies identified through the execution of Phase 1 of the Methodological Design proposed for the development of this article. Chemical Engineering is among the most frequently used variables, associated with variables such as Genetic Engineering, Sustainable Development, Chemical Technology, Biomass, Renewable Resources, Engineering, and Chemical Industry. Chemical engineers work on optimizing industrial processes to maximize efficiency, reduce waste, and minimize energy consumption. This involves using advanced modeling and simulation tools to identify the most efficient operating conditions, including using safer and more sustainable chemicals, minimizing the use of hazardous materials, and reducing the generation of harmful byproducts. - Advances in catalysis and reaction engineering contribute to more sustainable processes by enabling the use of milder reaction conditions, reducing the need for high temperatures and pressures, and increasing the selectivity of desired products. By addressing these aspects, chemical engineering contributes significantly to creating more sustainable and environmentally friendly industrial processes, aligning with the global goals of reducing environmental impact and promoting a circular economy.

4.2 Distribution of scientific production by year of publication.

Figure 3 shows how scientific production is distributed according to the year of publication, taking into account that the period between 2018 and 2023 is taken.

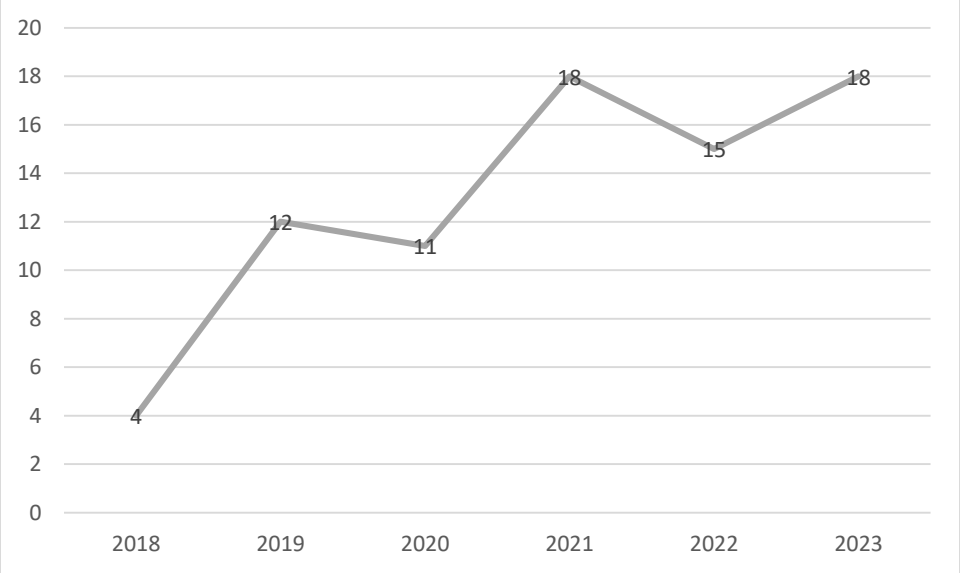

Figure 3. Distribution of scientific production by year of publication.
Source: Authors' elaboration (2024); based on data provided by Scopus.

Among the main characteristics evidenced by the distribution of scientific production by year of publication, an increase in the number of publications registered in Scopus during the years 2021-2023 is notorious, reaching a total of 18 documents published in journals indexed on this platform. The above can be explained thanks to articles such as the one titled "Open Source Software Development in Chemoinformatics: A Qualitative Analysis of the Fundamentals" The purpose of this article is to explore the fundamentals behind open source software development in cheminformatics. The knowledge gained is important to the field at large from an intrinsic perspective, but it is particularly interesting from a chemoinformatics education perspective. Through understanding the reasons why open-source development in chemoinformatics is taking place, the field can build educational goals through research-based knowledge. This qualitative research explored the

fundamentals of open source development in cheminformatics. The goal was to promote open science by mapping out and categorizing the reasons why open source development is taking place. This topic is important because chemoinformatics has industrial experience and open source is the key solution to promote the growth of cheminformatics as an independent academic field. The data consisted of 87 research articles that were analyzed using qualitative content analysis.(Pernaa, 2023)

4.3 Distribution of scientific production by country of origin.

Figure 4 shows how scientific production is distributed according to the nationality of the authors.

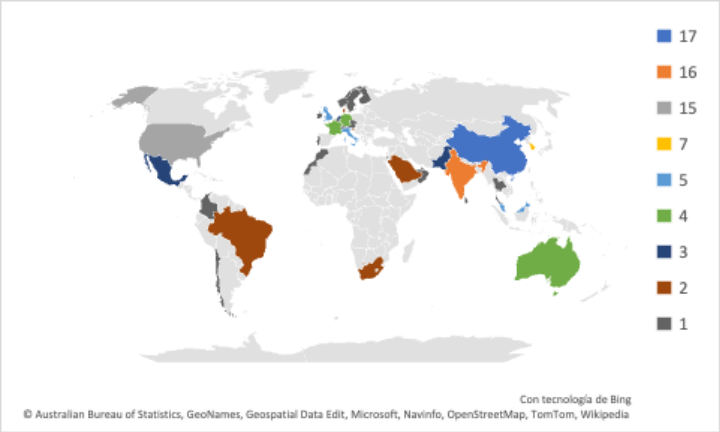

Figure 4. Distribution of scientific production by country of origin.
Source: Authors' elaboration (2024); based on data provided by Scopus.

Within the distribution of scientific production by country of origin, records from institutions were taken into account, establishing China as the country of that community, with the highest number of publications indexed in Scopus during the period 2018-2023, with a total of 17 publications in total. In second place, India with 16 scientific papers, and the United States in third place presenting to the scientific community, with a total of 15 papers, including the article entitled "Current Strategies for Real-Time Enzymatic Activation" conventional activation strategies, such as genetic engineering and chemical modification, They are generally irreversible for enzyme activity and also have many limitations, including complex processes and unpredictable results. Recently, near-infrared (NIR), alternating magnetic field (AMF), microwave, and ultrasound irradiation, as accurate, real-time activation strategies for enzyme analysis, can address many limitations due to their deep penetrability, sustainability, low invasiveness, and sustainability. and have been applied in many fields, such as biomedical and industrial applications and chemical synthesis. These spatiotemporal and controllable activation strategies can transfer light, electromagnetic, or ultrasonic energy to enzymes, leading to favorable conformational changes and improving the thermal stability, stereoselectivity, and kinetics of enzymes. In addition, the different mechanisms of activation strategies have determined the type of enzymes applicable and have manipulated protocol designs that immobilize enzymes in nanomaterials that respond to light or magnetic fields or directly influence enzymatic properties. To employ these effects to finely and efficiently activate enzyme activity, the physicochemical characteristics of the nanomaterials and parameters, including the frequency and intensity of the activation methods, must be optimized. Therefore, this review provides a comprehensive overview

related to emerging technologies to achieve real-time enzyme activation and summarizes their advanced features and applications.(Wang, 2022)

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.

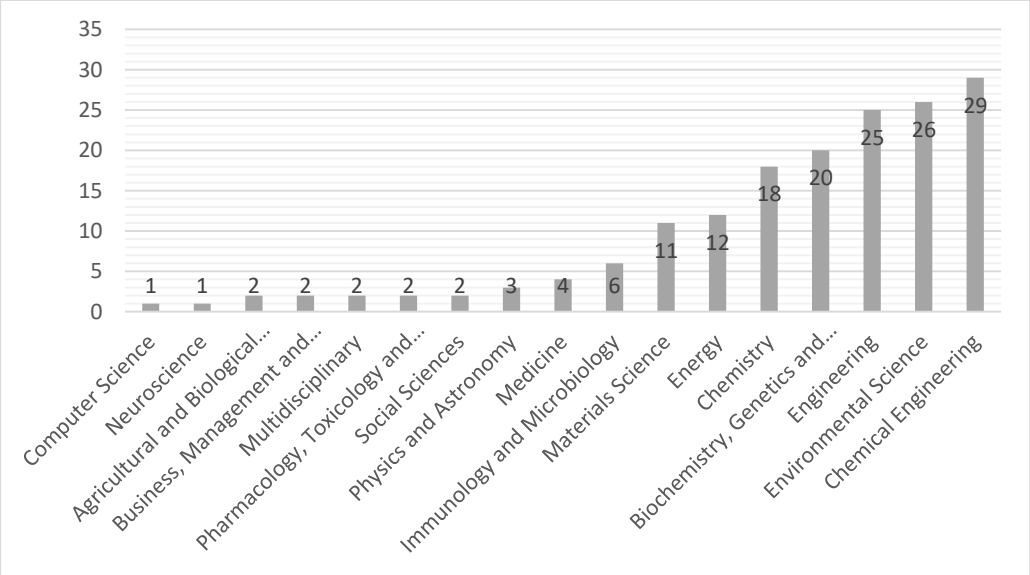

Figure 5. Distribution of scientific production by area of knowledge.
Source: Authors' elaboration (2024); based on data provided by Scopus.

Chemical Engineering was the area of knowledge with the highest number of publications registered in Scopus with a total of 29 documents that have based their methodologies on Emerging Technologies, Chemical Engineering and Industrial Processes. In second place, Environmental Sciences with 26 articles and Engineering in third place with 25. The above can be explained thanks to the contribution and study of different branches, the article with the greatest impact was registered by Ingeniería Química entitled "Laccase-assisted biosensing constructions: robust modalities to detect and eliminate environmental pollutants" This review highlights the relevance of lacasa-assisted signals to detect and eliminate emerging contaminants (EC). ECs are distributed in environmental matrices due to various industrial practices and anthropogenic inputs. The discharge and long-term persistence of ECs, such as micropollutants, endocrine disruptors (EDs), pharmaceutical compounds, hormones, and industry-related pollutants, are environmental hazards and considerable risks to both wildlife and humans. Therefore, strategic measures need to be implemented, as traditional wastewater treatment technologies are inefficient in detecting and removing a variety of EC. Today's technological and engineering growth offers the potential to design biocatalytic and biosensing devices for various applications. These prototypes can help monitor environmental pollutants from different industrial sectors in situ and in real time. In addition, real-time monitoring can reduce the overconsumption of hazardous chemicals before they are released into the environment. Laccase-assisted biocatalytic signals have attracted attention as an excellent candidate for quantification, tracking, and removal of contaminants.(Villalba-Rodríguez, 2022)

4.5 Type of publication

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

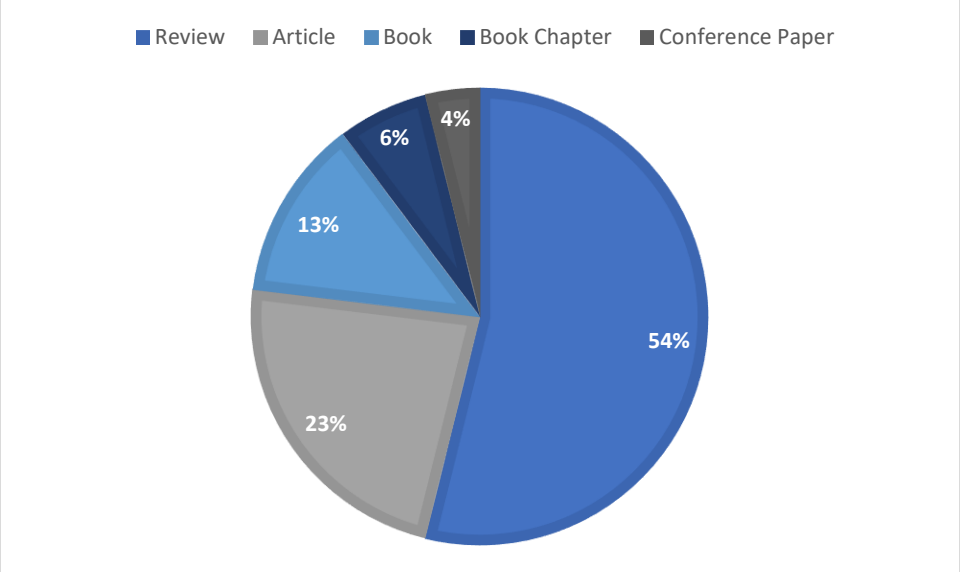

Figure 6. Post Type
Source: Own elaboration (2023); based on data provided by Scopus.

The type of publication most frequently used by the researchers referenced in the body of this document was the one entitled Journal with 54% of the total production identified for analysis, followed by Journal Articles with 23%. Book are part of this classification, representing 13% of the research papers published during the period 2018-2023, in journals indexed in Scopus. In the latter category, the one entitled "Near-zero liquid recovery and discharge process based on electrodialysis metathesis for high-salinity wastewater with high fouling potential" stands out. This study describes an emerging technology for near-zero liquid discharge (ZDD) desalination and salt recovery using electrodialysis metathesis (EDM) to treat high-salinity wastewater with high fouling potential. The response surface methodology was employed to determine the optimal conditions for the EDM-based ZDD process, and an experimental design from the Box-Behnken center was used to quantify the effects of surface velocity, applied voltage, and volume ratio of dilute/concentrate streams (Vc/Vd) on the salt removal ratio and current efficiency. These parameters influenced the result with the following impacts: surface voltage > velocity > Vc/Vd, and the interactions were generally weak. The concentration of liquid salts of type Na and Cl reached 200 and 170 g/L, respectively, after seven batch operations without the risk of fouling. In addition, the two concentrate streams could be combined to precipitate CaSO4 with approximately 60% Ca2+ removal by producing a solid byproduct. Alkali-assisted precipitation of the residual stream demonstrated efficient recovery of Mg2+ resources. In addition, the purified solution could be further used to recover chemical resources (NaCl and Na2SO4) through a partial crystallization process.(Chen, 2022)

5. Conclusions

Through the bibliometric analysis carried out in this research work, it was possible to establish that China was the country with the highest number of published records for the variables Emerging Technologies, Chemical Engineering and Industrial Processes. With a total of 17 publications in the Scopus database. In the same way, it was possible to establish that the application of theories framed in the area of Chemical Engineering, They were used more frequently in the implementation of emerging technologies in sustainable chemical engineering, since with the above it can be concluded that industrialization processes characterized by sustainable development must be executed by responsible companies that adapt to these new industrial paradigms and not leave behind their competitiveness in the markets. For the production of chemical productions, certain innovative processes must be used; that is, more efficient designs must be incorporated into their production processes, with this it is sought that companies have an optimal management of their resources and good waste management, this so that they govern by sustainable development, successfully execute these processes a reduction that does not affect and pollute the environment is expected, that hand in hand with technologies, it is expected to implement new innovative strategies that gradually replace toxic and harmless substances, as well as products and by-products derived from the chemical and pharmacological industry. According to which he tells us that green chemistry helps to save and preserve resources such as reducing water use and energy consumption, reducing the impact produced by the chemicals used and obtaining benefits to create a healthier environment, in sustainable industrial processes it is expected to integrate mitigate the limited use of resources and provide employment of renewable resources. However, the chemical industry's biggest challenge is to find ways to minimize its dependence on non-renewable resources, such as petroleum and its derivatives, however, at present biomass is the only renewable energy source that can become an excellent alternative source to liquid fuels. To conclude, the growth of green chemistry has increased at an accelerated pace, since the twelve principles of this sustainable engineering are taken into account, it is expected to achieve routes that help reduce the negative impact of this industry and have chemical production processes that are more friendly to the ecosystem. (Edwin O. Vargas Afanador, 2007, págs. 29-32)

Bibliographic references

Chen, Q.-B. T.-F. (2022). *Near-zero liquid recovery and discharge process based on electrodialysis metathesis for high-salinity wastewater with high fouling potential.* CHINA.

Edwin O. Vargas Afanador, L. P. (2007). *GREEN CHEMISTRY IN THE TWENTY-FIRST CENTURY; CHEMISTRY.*

López, J. L. (2009). *Biotechnology for green chemistry.*

Pernaa, J. T.-R.-J.-B. (2023). *Open Source Software Development in Quiminformatics: A Qualitative Analysis of the Fundamentals.* FINLAND.

Villalba-Rodríguez, A. M.-A.-G.-S. (2022). *House-assisted biosensing constructs: robust modalities for detecting and removing environmental pollutants.* CHINA, MEXICO .

Wang, F. L. (2022). *Current strategies for real-time enzyme activation.* CHINA.

Ramos, A., Aguirre, S. D., Godínez, C. L., & Espinoza, G. A. (December 2020). Proposal of indicators to assess the sustainability of Ecuadorian universities. Industrial Engineering, p.41(3). Retrieved from Proposal for Sustainability Assessment Indicators of Ecuadorian Universities

Latin American Network of University Cooperation. (2012). A theoretical approach to the concept of university social responsibility. In R. L. Universitaria, Responsabilidad social de las universidades (pp. 175-189). Buenos Aires: RLCU.

RICOY, C. (2005). The press as an educational resource. Revista Mexicana de Investigación Educativa, v. 10, n. 24, p. 125-163.

RICOY, C. (2006). Contribution on research paradigms. Revista do Centro de Educação, 31 (1), 11-22.

Rodríguez, N. (2019). Soil pollution: a hidden reality. Retrieved from http://www.fao.org/3/I9183ES/i9183es.pdf

Ruiz, L. (January 2019). Institutional sustainability indicators. Case study of a private university in Ecuador. Espacios Magazine.

Sáenz, O. (2014). University, Environment and Sustainability. Vol 1. Retrieved from http://www.pnuma.org/educamb/documentos/GUPES/Informe_sobre_FOROS_UNIV_2013.pdf

Sáenz, O., Plata, Á., & Holguín, M. (2018). Universities and Sustainability Experiences of higher education institutions in Colombia. Bogota. Retrieved from https://www.iau-hesd.net/sites/default/files/documents/universidades_y_sostenibilidad.pdf

Schütz, S. H. (2010). Main conceptual frameworks applied for the assessment of environmental health through indicators in Latin America and the Caribbean. Rev. Panam Salud Pública, 30.

Semblantes, R. (2015). Scielo. Retrieved from http://www.summitamericas.org/publications/advancing_in_the_americas/spa_desarrollosostenible.pdf

Sierra Bravo, R. (1994). Social Research Techniques. Madrid: Paraninfo, Spain.

Tapia, E. J. (2016). "Ecological regeneration of the Salache Experimental Center. Repository of the Technical University of Cotopaxi, 1-28

Tapia, L. (2015). Official Registry. Official Registry. 387. Quito: Ministry of the Environment.

Tipán, H. (2016). "Energy consumption of the Faculty of Chemical Sciences of the Central University of Ecuador and proposal to achieve energy efficiency". [Central University of Ecuador]. http://www.dspace.uce.edu.ec/bitstream/25000/7738/1/T-UCE-0005-009-2016.pdf

Torres, R. (April 2016). Diagnosis on the Inclusion of Environmental and Sustainability Considerations in Universities. Ibero-American University Journal in Environment, Society

and Sustainability, 1(2), 101-119. Retrieved from file:///C:/Users/Usuario/Downloads/2016-06_ambiens_reporte_de_ecuador.pdf

UNESCO. (1998). World Declaration on Higher Education in the Twenty-First Century: Vision and Action. Higher Education and Society, 9(2), 97-113.

UNESCO. (2016). Retrieved from https://www.redalyc.org/jatsRepo/5606/560659011001/html/index.html

Vallaeys, F. (2008). University Social Responsibility: a new philosophy of ethical and intelligent management for universities. Higher Education and Society / New Epoch, 13(2), 191-220.

Valbuena, K. (2016). Environmental responsibility as a factor of sustainability in companies. Retrieved from Universidad Santo Tomás: https://repository.usta.edu.co/bitstream/handle/11634/2823/2016valbuenakarol.pdf?sequence=1

Vaquero, B. (2020, MARCH 12). The socio-environmental responsibility of universities. Retrieved from Science Horizon: https://revistas.uncp.edu.pe/index.php/horizontedelaciencia/article/view/59

Zapata-González, L, Quiceno-Hoyos, A. & Tabares-Hidalgo, L. (2016). Sustainable university campus. Journal of Architecture, 18(2), 107-119. doi:10.14718/RevArq.2016.18.2.10

Zarta, Ávila. (2018). Sustainability or sustainability: a powerful concept for humanity. 28, 409-423. https://www.redalyc.org/jatsRepo/396/39656104017/html/index.html

Zúñiga, C. (n.d.). Ecological Footprint of the Campus. State Technical University of Quevedo. Retrieved from https://repositorio.uteq.edu.ec/bitstream/43000/3085/1/T-AMB-UTEQ-