

ARTICLE

## GLOBAL VISIONS AND FUTURE PERSPECTIVES IN TEACHING SUSTAINABILITY IN ENGINEERING

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**ABSTRACT:** The purpose of this study is to map the current status of research in engineering education from the perspective of sustainability, bibliometrix and biblioshiny packages were employed to perform data mining and quantitative analysis of publications in this area of knowledge from 2012 to 2022 in the Web of Science database. The results showed that in the last 10 years, the number of articles on teaching sustainability in engineering has increased. The increase was gradual and can be divided into three stages, between 2012 and 2016 the publications ranged from 130 to 150, from 2017 to 2019 the publications went from 150 to 190 and from 2020 to 2021 it exceeded 200 articles. The top countries in terms of research development in the area of sustainability education in engineering are the United States, Spain, China, Australia, the United Kingdom, Germany, Canada, and Italy, as well as being the most important countries for international cooperation in this area. Sustainable development, engineering education, students, education, curriculum, teaching, and sustainability were the most frequently mentioned keywords in this field in the last 10 years. Within this field, the use of active methodologies, sustainable development, good pedagogical and sustainability practices, and the construction of competencies and skills are emerging as research topics. The teaching of sustainability in engineering is a relatively new theme, however, due to the urgency of the subject many studies have been developed and many others are unfolding, however, the complexity of the theme does not exhaust the gaps in the subject

**Keywords:** Sustainable development, Teaching sustainability in engineering. Evolution of engineering education, Sustainability

## AS VISÕES GLOBAIS E PERSPECTIVAS FUTURAS NO ENSINO DA SUSTENTABILIDADE NA ENGENHARIA<sup>1</sup>

**RESUMO:** A finalidade deste estudo é mapear a atual situação das pesquisas no ensino de engenharia sob a perspectiva da sustentabilidade, os pacotes de bibliometrix e biblioshiny foram empregados para realizar a mineração de dados e análise quantitativa de publicações nessa área do conhecimento entre 2012 a 2022 no banco de dados da *Web of Science*. Os resultados demonstraram que nos últimos 10 anos, o número de artigos sobre o ensino de sustentabilidade na engenharia aumentou. O aumento foi gradativo e pode ser dividido em três etapas, entre 2012 e 2016 as publicações oscilaram de 130 a 150, de 2017 a 2019 as publicações passaram de 150 a 190 e de 2020 a 2021 superaram os 200 artigos. Os principais países e regiões em termos de desenvolvimento de pesquisas na área de ensino de sustentabilidade na engenharia são os Estados Unidos, Espanha, China, Austrália, Reino Unido, Alemanha, Canadá e Itália, além de serem os países importantes para a cooperação internacional nessa área. Desenvolvimento sustentável, educação em engenharia, estudantes, educação, currículo, ensino e sustentabilidade foram as palavras-chaves mais citadas nessa área nos últimos 10 anos. Dentro desse campo despontam como temas de pesquisas o emprego das metodologias ativas, desenvolvimento sustentável, boas práticas pedagógicas e de sustentabilidade, além da construção de competências e habilidades. O ensino de sustentabilidade na engenharia é uma temática relativamente nova, entretanto, devido a urgência do tema muitos estudos foram desenvolvidos e muitos outros estão se desdobrando, todavia, a complexidade do tema não esgota as lacunas do assunto.

**Palavras-chave:** Desenvolvimento sustentável, Ensino de sustentabilidade na engenharia. Evolução do ensino de engenharia, Sustentabilidade.

## VISIONES GLOBALES Y PERSPECTIVAS DE FUTURO EN LA ENSEÑANZA DE LA SOSTENIBILIDAD EN LA INGENIERÍA

**RESUMEN:** El propósito de este estudio es mapear el estado actual de la investigación en educación en ingeniería desde la perspectiva de la sostenibilidad, se emplearon los paquetes bibliometrix y biblioshiny para realizar la minería de datos y el análisis cuantitativo de las publicaciones en esta área de conocimiento entre 2012 a 2022 en la base de datos Web of Science. Los resultados mostraron que en los últimos 10 años ha aumentado el número de artículos sobre la enseñanza de la sostenibilidad en la ingeniería. El aumento fue gradual y se puede dividir en tres etapas, entre 2012 y 2016 las publicaciones oscilaron entre 130 y 150, de 2017 a 2019 las publicaciones pasaron de 150 a 190 y de 2020 a 2021 se superaron los 200 artículos. Los principales países en cuanto al desarrollo de la investigación en el ámbito de la educación para la sostenibilidad en la ingeniería son Estados Unidos, España, China, Australia, Reino Unido, Alemania, Canadá e Italia, además de ser los países más importantes para la cooperación internacional en este ámbito. Desarrollo sostenible, enseñanza de la ingeniería, estudiantes, educación, plan de estudios, enseñanza y sostenibilidad fueron las palabras clave más citadas en este ámbito en los últimos 10 años. Dentro de este campo, el uso de metodologías activas, el desarrollo sostenible, las buenas prácticas pedagógicas y de sostenibilidad, así como la construcción de competencias y habilidades, surgen como temas de investigación. La enseñanza de la sostenibilidad en la ingeniería es un tema relativamente

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nuevo, sin embargo, debido a la urgencia del tema se han desarrollado muchos estudios y otros tantos se están desarrollando, sin embargo, la complejidad del tema no agota las lagunas del mismo.

**Palabras clave:** Desarrollo sostenible, Enseñanza de la sostenibilidad en la ingeniería. Evolución de la enseñanza de la ingeniería, Sostenibilidad.

## INTRODUCTION

The practice of the engineering professional must evolve in step with society's advances, aimed at providing a response compatible with the needs of humankind. Hence, engineering education must adapt in order to meet this demand? Currently, the new era of the knowledge-based economy, together with globalisation, requires a high level of competitiveness. Therefore, the education system must offer training that is in line with these requirements, i.e., the curriculum must be flexible and focused on developing students' competences and skills, among which we can cite learning how to learn, teamwork, systemic and critical thinking and among others (SUNTHONKANOKPONG, 2011).

Engineering education through the holocene approach loses relevance and promotes the need for an anthropocene and more integrated education (LEICHENKO and O'BRIEN, 2020). The professional performance of the engineer should be contemporary and endowed with resilience, citizenship, and performance from the perspective of sustainability (SEGALÀS; FERRER-BALAS; MULDER, 2010; SUNTHONKANOKPONG, 2010; QUELHAS ET AL., 2019).

Currently, the Higher Education Institutions have realised that the change should be integrated and focused on the training of the student, the improvements should not be seasonal, but permanent, especially in relation to curricular restructuring, modernisation of laboratories, among others. These improvements must come associated with a didactic-pedagogical planning well thought out and committed to the training of students (QUELHAS et al., 2019).

Students must be encouraged to construct their knowledge in an assertive and reflective manner. They must combine theoretical and practical basis with activities that are committed to sustainable development. Therefore, these professionals' training must be supported by ethical issues, social responsibility, citizenship, and provider of social solutions (YANG; SUN; LIU, 2017).

Systematic and bibliometric review articles are widely used to identify trends in research. Therefore, the study aims to outline the evolution of engineering education and its prospects, in addition to clarifying trends and even novelties in the variables under study (Yang; Sun; Liu, 2017). The research strategy of this study takes place through a specialized bibliometric with emphasis on the evolution of engineering education. The background of this article is to identify the main elements and advances achieved in the last decade and the main gaps to be unfolded in future studies.

## SYSTEMATIC LITERATURE REVIEW

Could engineering play a leading role in its own future? How can engineers make sustainable development compatible with social demands? How can future engineers be trained to provide solutions to globalisation-related problems without compromising society's wellbeing? Will engineering be seen as a knowledge area that educates politicised citizens, socially and environmentally responsible and providers of more creative, sustainable solutions??

Given these questions, a Systematic Literature Review (SLR) becomes relevant since it is a focused investigation that aims to synthesize evidence and correlations of the theme. The database used in this research was the Web of Science. Therefore, this SLR aims to present a thorough assessment of engineering education from the sustainability perspective.

The complexity in the analysis of the particularities of the knowledge areas demanded the design of several systematic reviews. Among these systematic reviews categories, we have meta-analysis systematic reviews, narrative systematic reviews; and meta-synthesis systematic reviews (SIDDAWAY; WOOD; HEDGES, 2019).

In this SLR, we used a narrative review, as it has the potential to analyse several methodologies, or different theoretical frameworks. Narrative reviews summarise outcomes of individual quantitative studies without a meaningful statistical reference. This approach allows for an understanding of the combination of various studies in the development of new theories. In addition, this category of review allows for the historical description of theory development (SIDDAWAY; WOOD; HEDGES, 2019).

However, researchers have increasingly sought to build a systematic literature review integrated with both quantitative and qualitative data. This blended research becomes relevant due to the lack of quantitative data to justify its results, therefore, the qualitative data complement and assist in the understanding of the results. Due to the complexity of the current situation, this more cooperative and integrated scientific positioning becomes a very assertive and important method for the development of science (SCHWANDT, 2007).

Subsequently to the choice of the narrative systematic review, the mixed sequential explanatory review was adopted. This review focuses on measuring the effects of actions, interventions or programs and seeks to explain the difference in their effects. In this modality, there is integration between the quantitative and qualitative stages, providing subsidies for a qualitative synthesis, in addition to providing understanding and justification for the findings in the two stages (SCHWANDT, 2007; CRESWELL E CLARK, 2011; GALVÃO, PLUYE E RICARTE, 2017).

The Mixed Methods Appraisal Tool was used in this research. It consists of a list of guiding issues that help to verify and validate the systematic review, reflecting the results obtained and their quality. The questions used in this research were extracted from the work of Galvão, Pluye and Ricarte (2017), described in Chart1.

**Chart 1 - Questions used in the Mixed Methods Appraisal Tool**

In this tool there are up to 40 items, for this study were adopted the following questions:
Does the study have a qualitative and a quantitative question, or an explicit mixed question?
Are mixed methods relevant to addressing the qualitative and quantitative questions and objectives of the study?
Is the integration of qualitative and quantitative data relevant to addressing the study objectives or questions?
Does the study present the limitations associated with this integration?
Does the study present the divergence of qualitative and quantitative data or results?
Note: This method consists of 40 items for various purposes, however, for this study these 5 were selected because they cover both qualitative and quantitative data.

Source: Elaborated by the authors (2022).

## Planning

Based on the article by Sampaio and Mancini (2007) and Galvão, Pluye and Ricarte (2017), the SLR planning stages are shown in Figure 1.

Was the focus of the systematic review the analysis of the teaching of sustainability in engineering? Were the articles evaluated of relevance and with an emphasis on the object of study? Did the results of the review create new interconnections, correlations, and advances? Was the integration of qualitative and quantitative components adequately interpreted? Did the components used in this research comply with the quality criteria of each method involved? Did future studies or questions leave gaps?

Figure 1 - Outline of the SLR steps  
**RSL Planning Steps**



Source: Elaborated by the authors (2022).

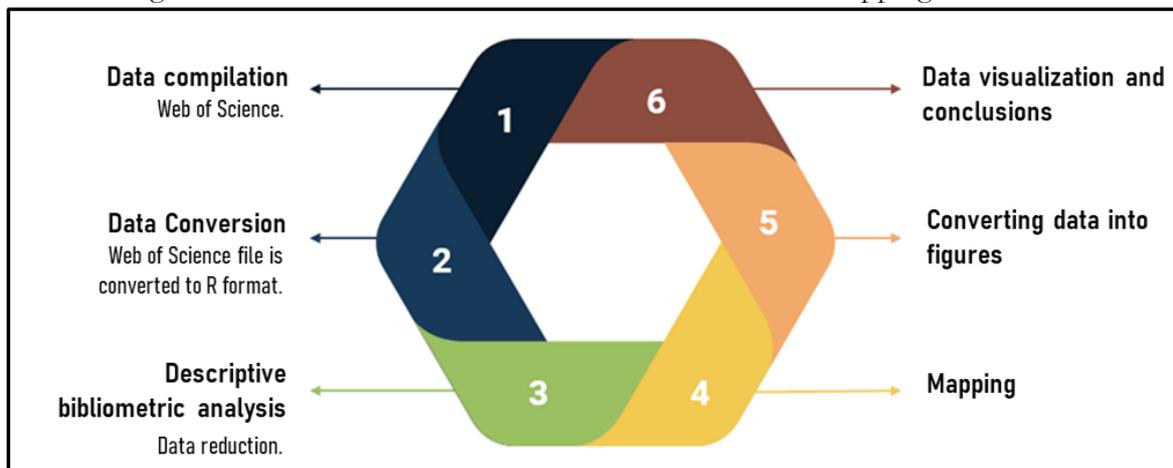
**Data source**

Web of Science is one of the most relevant and comprehensive databases in the world. The platform contains more than 11,000 recognized and high-impact academic journals in various areas of knowledge. This paper focused on using the Web of Science database as a source of data mining. This database tracks about 1.9 billion references in 171 million records. In addition, more than 9,000 academic institutions and researchers deposit their information and research advances in this database.

**Research method**

The strategy of the bibliometric analysis research method has five standard steps, these being (I) outline of the study, (II) data collection, (III) data analysis, (IV) data visualization and (V) interpretation (ZUPIC and CATER, 2014). The software used was the R Language, which has a range of packages that process the data, as well as calculate bibliometric indicators such as the index (h) was introduced by Jorge Hirsh in 2005, with it is possible to verify the visibility that the authors and articles present from the citations, having the purpose of quantifying the performance, quality, and productivity of researchers. The index (g) measures the citation performance of a set of articles, giving greater relevance to highly cited articles and among other functions (XIE et al., 2020). In Figure 2 we have the workflow outline and scientific mapping.

Figure 2 - Bibliometrix and the recommended scientific mapping workflow.



Source: Adapted from Xie et al., (2020).

The bibliometrix software is a bibliometric package developed by Professor Massimo Aria in 2017, is based on the R language. Whilst its versatility ranges from visual display, statistical analysis, data processing, co-citation analysis, coupling analysis, word analysis and cluster analysis on databases (Xie et al., 2020; Aria and Cuccurullo, 2017). Massimo Aria also developed biblioshiny which allows users to perform bibliometric and visual analysis in an interactive web interface.

The steps for installing and operating bibliometrix and biblioshiny are as follows:

(1) Download and install the R language software and the RStudio platform. (URL: <https://cran.r-project.org/> and <http://www.rstudio.com>).

(2) In RStudio type the command `<install.packages ("Bibliometrix")>` in the bibliometrix interface window to complete the installation.

(3) Type the command `<Library (Bibliometrix)>` to open the bibliometrix and biblioshiny programs.

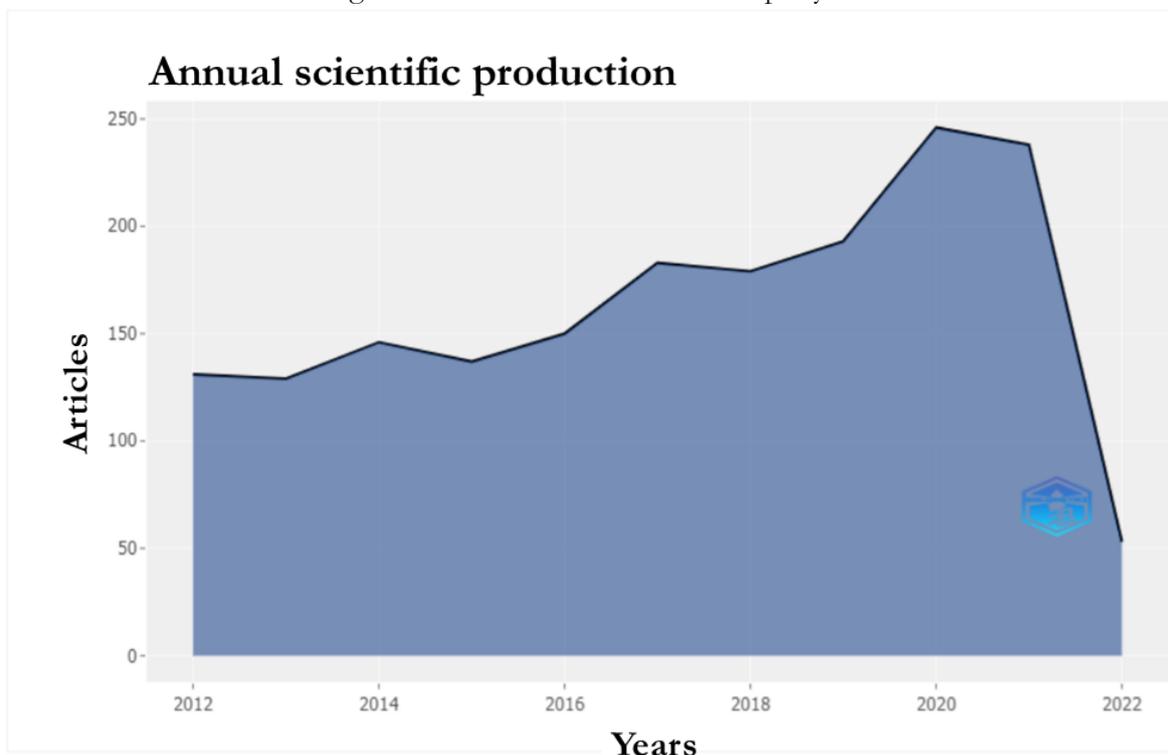
In this article, the bibliometrix and biblioshiny packages are used to analyse and visualize research trends in engineering education from the perspective of sustainability, based on annual documents, research power (author, journal and among others). The situation analysis of this field of knowledge starts from multiple perspectives such as historical citation, theme evolution and coupling analysis, providing references and suggestions for future research.

## RESULTS ANALYSIS

### Distribution of annual Papers

The evolution analysis of the annual scientific production can be followed through time series, or different stages. This annual distribution of papers reflects the general situation and future trends in research. From 2012 to 2022, despite small fluctuations in the number of published articles, the general trend continued to expand, as we can see the behaviour in Figure 3.

Figure 3 - Number of cited articles per year



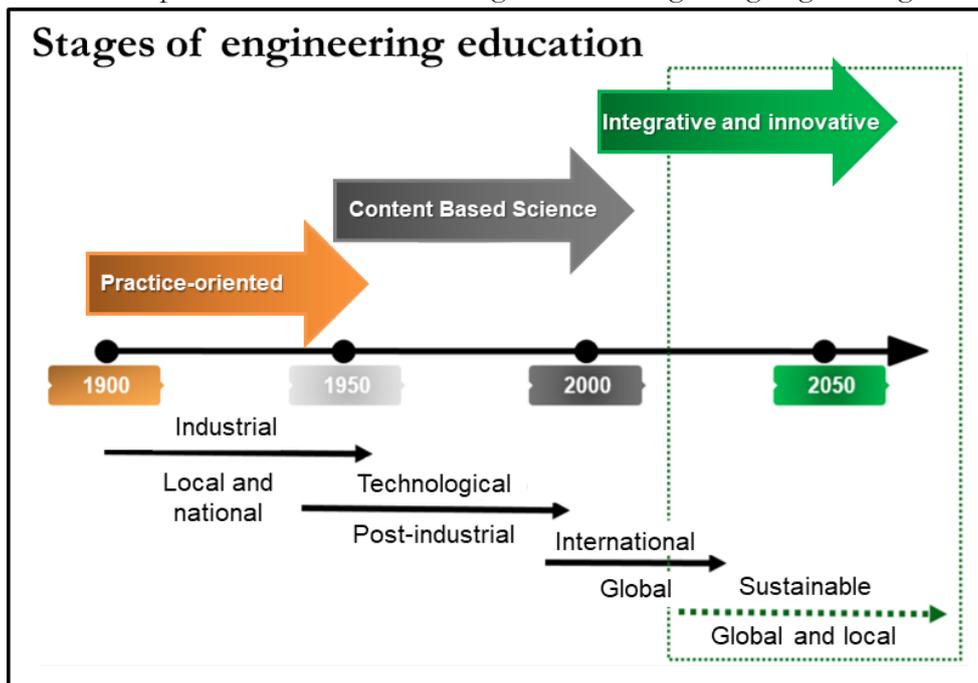
Source: Elaborated by the authors (2022).

The 2030 Agenda agreement between world leaders, signed in 2015, contributed to the significant increase in publications on sustainable development. In view of this, the postgraduate

programs, research lines and higher education institutions focused on developing new studies in this theme (VALDÉS et al. 2018).

Accordingly, engineering had to adapt to this new reality. The trend is that new researches and studies are carried out in this area of knowledge, due to the phases as shown by Sunthonkanokpong (2011) in Figure 4. From 2020 to 2050 we will be immersed in the sustainability age, and the engineering solutions will be focused on global and local solutions.

Figure 4 - conceptual framework of future global visions guiding engineering education



Source: Adapted from Sunthonkanokpong (2011).

Figure 4 shows that between 1900 and 1950, engineering education was practice-oriented, i.e., geared towards industrial production. The performance of the engineering professional, at that time, was focused on a local and national scale. From 1950 to 2000, with the technological advances, the scale of solutions moves to the international level. From 2000 onwards, the engineer's work enters the post-industrial age, when engineering demands become global in scale. And from 2020 to 2050 we have the sustainability age due to the collateral effects of global warming and high levels of environmental impacts. Therefore, the performance of the engineer, with sustainable posture in the development of solutions more thoughtful, clean and with socio-environmental responsibility becomes more relevant and evident in the labour market.

From 2012 to 2016, the scientific production of articles in the teaching area of sustainability in engineering presented a relevant publication rate. From 2017 to 2019, there was a gradual increase in the number of articles published in this period, this may have occurred due to the needs of studies for the development of actions that contribute to sustainability, since the 17 Sustainable Development Goals have quite audacious targets. From 2020 to 2021, more specifically within the sustainability age, the number of published studies increases, a possible justification for this is the need to train engineers capable of a more sustainable professional performance, which is consistent with the current age. In 2022, the number is still low since the analysis was conducted in the first quarter, but the trend is that it will equal that of 2020 or 2021 or exceed these years in publications.

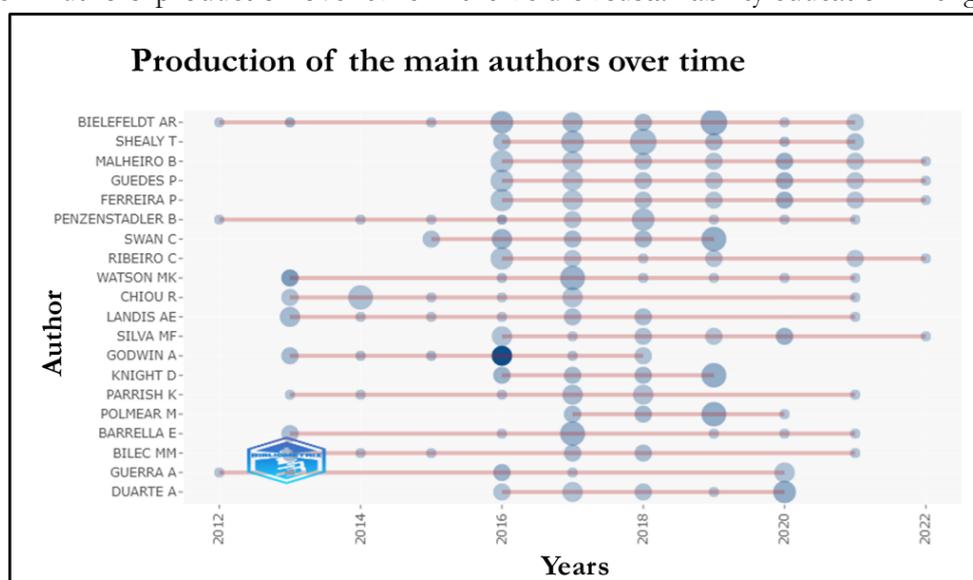
## Distribution of annual documents

This study analysis comprised 1785 articles of the most diverse authors and nationalities. From a number of published articles standpoint (Figure 5), the top five being Bielefeldt A.E., Shealy T., Malheiro B., Guedes P. and Ferreira P., with 21, 17, 16, 15 and 14 articles respectively. In the teaching area of sustainability in engineering, Bielefeldt stands out due to the volume of published articles and its "h" index of 8.

With highly relevant and quality publications in the area, Bielefeldt A.E. is a reference and very influential in the subject of sustainability in engineering. In Figure 5, the circle dimension represents the number of documents, and the colour shade represents the amount of citations. Bielefeldt A.E. has constancy of publications in the area since 2012, its average citation frequency increases considerably from 2016.

The outcomes show that from 2016 onwards all authors have an increase in citation frequency. The most cited author is Godwin A. in that same year. Hence, from 2016 to 2022 the authors Shealy T., Malheiro B., Guedes P. and Ferreira P. have similar numbers of studies produced and citations.

Figure 5 - Authors' production over time in the field of sustainability education in engineering.



Source: Elaborated by the authors (2022).

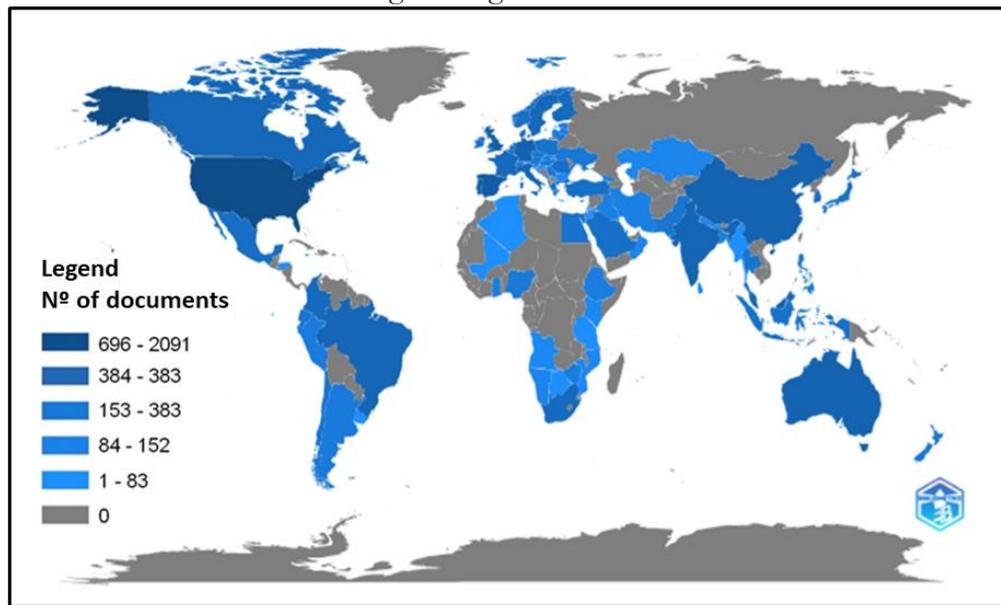
## Analysis of the distribution characteristics of the main research countries/regions

The worldwide publication of articles can be interpreted as relevant and important for the different nationalities in the field of teaching sustainability in engineering. As can be seen in Figure 6, we have the top 20 countries and regions, being 12 from Europe (Spain, United Kingdom, Germany, Italy, Netherlands, Denmark, Sweden, Romania, Finland, Poland, Switzerland, Portugal and Lithuania), three Asian (China, Singapore and Saudi Arabia), from North America we have two representatives (United States and Canada) and one from South America (Brazil).

The top five countries that produced the most papers, in descending sequence, are the United States, Spain, China, Australia and the United Kingdom. Figure 6 shows that publications are concentrated mainly in developed countries, as in North America and in most of the countries and regions indicated in Europe, this evidence reinforces that these countries lead the field of research on the teaching of sustainability in engineering.

Theoretically, teaching sustainability in engineering has greater impact in developing countries due to the lack of basic infrastructure and social vulnerability, however, it is the developed countries that lead the researches. This is linked to several factors, including the scarcity of financial resources for research, in addition to low level of science and technology in these countries and regions (CAVALCANTE and FAGUNDES, 2007; SOUZA et al. 2020)

Figure 6 - Distribution of scientific production by country in the field of sustainability education in engineering.



Source: Elaborated by the authors (2022).

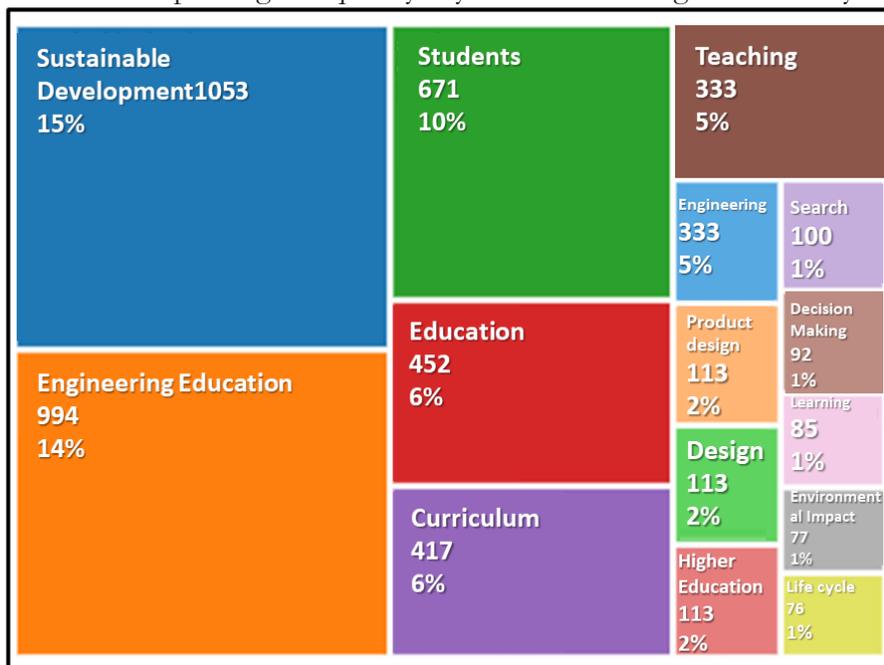
## KEYWORDS ANALYSIS

### Analysis of keywords and their occurrence

Keywords are a fundamental part of a scientific article, as these constitute the summarization and the fine-tuning of the article's core. The crossover between keyword analysis and cluster analysis, added to the multiple correspondence analysis in the article, reflects the essay writing path in teaching sustainability in engineering in a more robust and concise manner (XIE et al., 2020). (XIE et al., 2020).

Data mining and statistical analysis of high frequency keywords in publications can be compiled and analysed by the software package biblioshiny. The keywords with the highest frequency of words greater than or equal to 10 are selected and plotted as a Word TreeMap, as per Figure 7. The most frequent keywords are sustainable development, engineering education, students, education and curriculum, with 15%, 14%, 10%, 6% and 6% respectively.

Figure 7 - Word TreeMap of high frequency keywords in teaching sustainability in engineering



Source: Elaborated by the authors (2022).

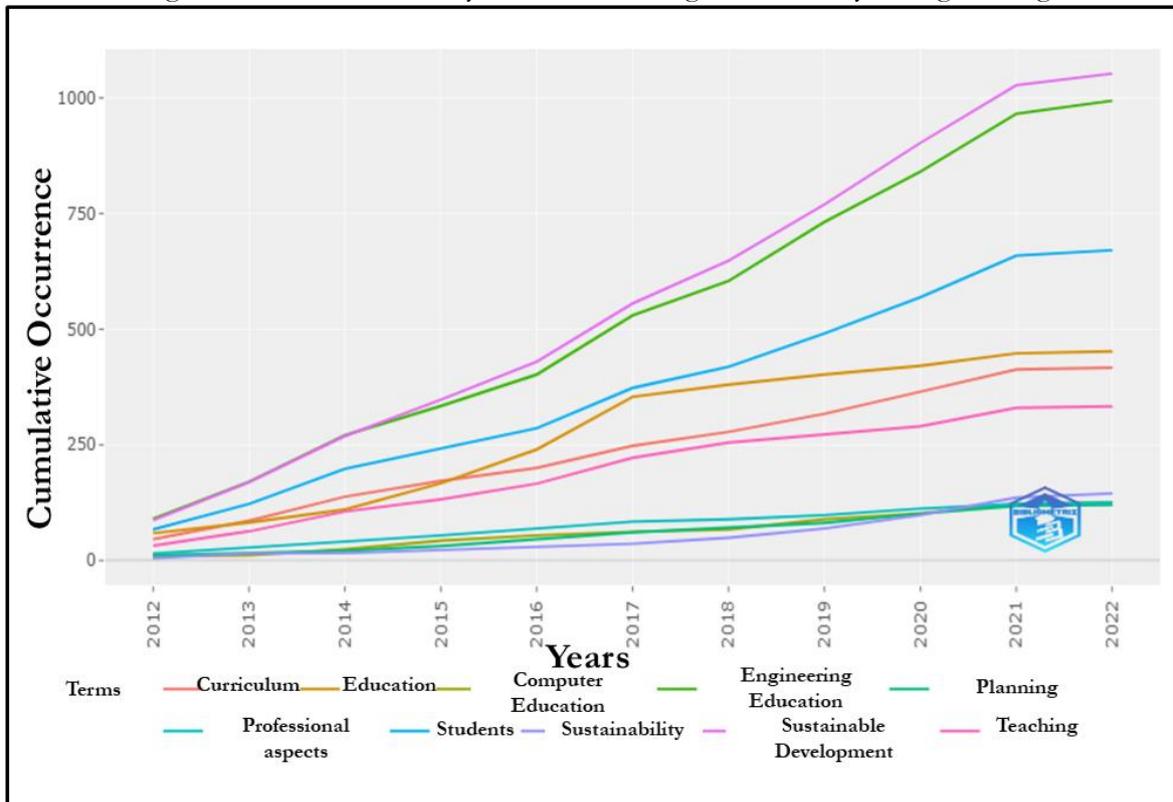
The teaching of sustainability should be at the centre of educational policies due to its emergence, stated Staniski and Kalilute (2016). The concept of sustainable development enables the new concept of responsibility in engineering to assist in the construction of a more ethical professional performance, endowed with values and compatible with social, economic, and environmental demands (PALACIN-SILVA; SEFFAH; PORRAS, 2018). The path is the (re)construction of a curriculum focused on the engineering student and linked to the new demands of an education that encourages the promotion of more sustainable and equitable solutions.

This (re)construction is a comprehensive process and is intrinsically linked to complex themes such as public policy issues, income distribution, environmental impacts, globalization, social vulnerability, among others. Figure 8 shows the evolution of keywords over the last 10 years. There was a clear growth in the number of keywords as of 2015, which may have been driven by the adoption of the UN 2030 Sustainable Development Agenda in September of that year.

Research on sustainable development and engineering education emerges due to the various obstacles. Within these difficulties we have the lack of infrastructure and resources suitable for teaching sustainability. An aspect that also gains relevance is the cognitive dissonance of the curricular components, which are not integrated or complementary and are not focused on the training of the student (SCHNEIDER; LEYDENS; LUCENA, 2008; SHIELDS, VERGA; ANDREA BLENGINI, 2014; ZABANIOTOU; BOUKAMEL; TSIROGIANNI, 2021).

Given the global demand for economic growth compatible with sustainable development, the 2030 Agenda becomes a guide for world governments to orient their actions and public policies towards the common good, the promotion of social justice and equity. The well-being of the world population must be at the centre of the political agendas of each nation so that the most vulnerable have opportunities and their quality of life assured.

Figure 8 - Evolution of keywords in teaching sustainability in engineering

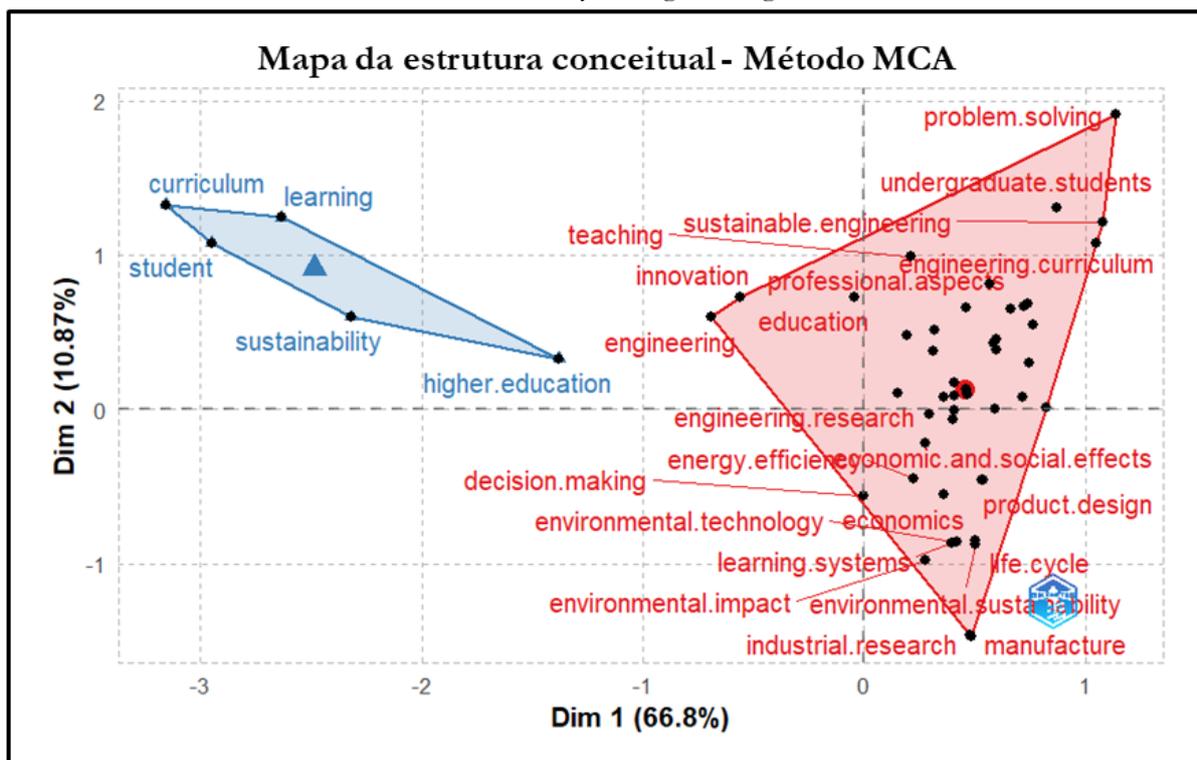


Source: Elaborated by the authors (2022).

## Cluster analysis and multiple correspondence analysis of high frequency keywords

In bibliometrics, cluster analysis is based on the frequency of two simultaneously occurring words, using statistical methods to simplify the relationship of the network of keywords into relatively smaller groups (Ding, 2011; Xie et al., 2020). Multiple correspondence analysis (MCA) which is a sociological approach was used in this paper. This tool compacts large data into variables in a low-dimensional space to form a two-dimensional or even three-dimensional graph that uses distance from the plane to reflect similarities between terms. Keywords closer to the centre have received greater attention in recent years. The closer to the edges, the narrower the theme or very close to the transition of the theme. In Figure 9, we have the MCA analysis.

Figure 9 - Multiple correspondence analysis (MCA) of high frequency keywords in teaching sustainability in engineering



Source: Elaborated by the authors (2022).

The first cluster has the presence of sustainability linking curriculum and learning to the Higher Education. Indeed, postgraduate programs are the driving force of research focused on teaching sustainability in engineering in other areas (SEVERINO, 2006; STANISKI and KALILUTE, 2016; PUNITHAVATHI et al., 2019). Customarily, major innovations arise within academic research, go through numerous research until they extrapolate the walls of universities and reach industries and society (SCHWARTZMAN, 2008; GIBNEY, 2015; BORGES, 2016; ANDRADE, 2019). Therefore, this cluster shows that many studies are in early stages or are case studies and preliminary actions.

The second cluster has more specific research and themes of teaching sustainability in engineering. Research has been developed in teaching mainly in undergraduate engineering, part of these studies was dedicated to investigating active methodologies such as Problem Based Learning (PBL) (Cabedo et al., 2018; SMITH; TRAN; COMPSTON, 2019). Dancz, Bilec, Landis (2018) state that active learning assists in the assimilation of engineering concepts and knowledge focused on sustainability (Chan et al., 2017; Rampasso et al., 2018).

Other researchers have focused on understanding practical issues and good practices within Universities. Among the topics widely addressed we have energy efficiency, social, economic aspects, environmental technologies, among many others (Rampasso et al., 2018; SEGALÀS; FERRER-BALAS;

MULDER, 2018; PUNITHAVATHI et al., 2019; JOSHI; DESAI; TEWARI, 2020). In addition to unravelling the education of the engineer and the building of competencies and skills applied to sustainability (Quelhas et al., 2019; Nyemba et al., 2019).

## CONCLUSIONS AND FUTURE PROSPECTS IN THE TEACHING OF SUSTAINABILITY IN ENGINEERING

Using the Web of Science database, a mapping of specialized literature with an emphasis on teaching sustainability in engineering was built within a timeframe ranging from 2012 to 2022, with support from bibliometrix and biblioshiny software to mine and treat this analysed data. In the end, the following characteristics and future perspectives of this theme can be concluded.

The trend is that the number of publications continues to grow, especially after 2016, due to the relevance and need for sustainable development. Subsequently, after that year there was a gradual increase in publications and in 2020 another leap occurred demonstrating an increase in the volume of publications. In 2022, even being in the first quarter of the year, it has already reached 25% of the publications of the years 2020 and 2021, which are the years that had most studies published. From the point of view of citations, the period with the highest frequency comprised 2016 to 2020. A priori, the attention paid to the theme of teaching sustainability was gradually increasing over the years.

The most influential countries in this area are the United States, Spain, China, Australia, and the United Kingdom. China is a hybrid nation <sup>2</sup>-developing and developed at the same time- among the countries that top the ranking. There are already global partnerships such as the Agenda Transforming our world: the 2030 Agenda for sustainable development, published by the United Nations (UN) in 2015, so cooperation for sustainable development tends to intensify due to the common good and the global emergencies on the subject (UN, 2021a).

The most frequent keywords in teaching sustainability in engineering are sustainable development, engineering education, students, education and curriculum, with 15%, 14%, 10%, 6% and 6% respectively. It is concluded through the cluster analysis of keywords that the (re)construction of curricula of higher education courses, the development of competencies and skills applied to sustainability, energy efficiency and the use of active methodologies are important windows for future research.

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<sup>2</sup> NT: The U.S. House of Representatives recently voted unanimously that China should no longer be considered a “developing country.” A major motivation is to deny China the preferential treatment it receives as a developing country under the World Trade Organization, the U.N. climate framework, and other international arrangements. <<https://www.reuters.com/world/us/us-senate-panel-approves-measure-strip-china-developing-status-2023-06-08/>>

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#### **DECLARATION OF CONFLICT OF INTEREST**

The authors declare that there is no conflict of interest with this article.