Climate emergency and vocational education and training. Topic of scientific interest: A systematic review of the literature

Emergencia climática y formación profesional. Tópico de interés científico: una revisión sistemática de la literatura

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Abstract

Climate change, the main challenge of the 21st century, demands urgent educational responses and cultural changes. Vocational education and training (VET) is providing an invaluable opportunity to face the climate emergency and stimulate the socio-ecological transition. Therefore, it is necessary to investigate the extent to which the climate emergency constitutes a consolidated topic of study in educational research focused on VET. Using the PRISMA protocol, we have undertaken a systematic review of literature (2015-2024) indexed in SCOPUS, WOS, ERIC, TESEO and SciELO. Microsoft Excel has been used for the content analysis. Based on the categorization of the information, we have responded to nine research questions on contextual characteristics, the methodological framework and the interpretive evaluation of the studies. The results have revealed growing scientific production, especially in Europe and the global south, with a predominance of theoretical studies over participatory ones. Although the central theme has pointed towards critical frameworks and comprehensive solutions, most studies have adopted reformist approaches that minimize community participation. It has also become evident there is a greater concern for detecting problems rather than for clarifying key concepts, which are essential for effective implementation of sustainability. Furthermore, the preference for green knowledge and skills to the detriment of teacher training and collaboration networks could be hindering the integration of good practices and affecting educational quality. It has been concluded that most studies do not address the climate emergency from a holistic and transformative perspective that questions our cultural identity and promotes a new development paradigm in which ecological well-being and social aspects are placed as core issues.

Keywords: climate change, vocational training, socio-ecological transition, environmental education for sustainability, climate emergency, eco-social justice, SDG 13.

Resumen

El cambio climático, principal desafío del siglo XXI, exige respuestas educativas y cambios culturales urgentes. La formación profesional (FP) se presenta como un espacio valioso para enfrentar la emergencia climática y estimular la transición socioecológica. Por ello, es necesario conocer en qué medida la emergencia climática constituye un tópico de estudio consolidado en la investigación educativa centrada en la FP. Utilizando el protocolo PRISMA, se ha realizado una revisión sistemática de literatura (2015-2024) indexada en SCOPUS, WOS, ERIC, TESEO y SciELO. Para el análisis de contenido, se ha empleado Microsoft Excel. A partir de la categorización de la información, se ha dado respuesta a nueve cuestiones de investigación sobre las características contextuales, el marco metodológico y la evaluación interpretativa de los estudios. Los resultados han revelado una creciente producción científica, especialmente en Europa y el sur global, con predominancia de los estudios teóricos sobre los participativos. Aunque la temática central ha apuntado hacia marcos críticos y soluciones integrales, la mayoría de los estudios han adoptado enfoques reformistas que minimizan la participación comunitaria. También se ha evidenciado una mayor preocupación por detectar problemas que por aclarar conceptos clave, esenciales para una implementación efectiva de la sostenibilidad. Más aún, la preferencia por el conocimiento y las habilidades verdes en detrimento de la formación de profesorado y las redes de colaboración estarían dificultando la integración de buenas prácticas y afectando a la calidad educativa. Se ha concluido que la mayoría de los estudios no abordan la emergencia climática desde una perspectiva holística y transformadora que cuestione nuestras señas de identidad cultural y promueva un nuevo paradigma de desarrollo en el que se sitúen el bienestar ecológico y las cuestiones sociales como ejes centrales.

Palabras clave: cambio climático, formación profesional, transición socioecológica, educación ambiental para la sostenibilidad, emergencia climática, justicia ecosocial, ODS 13.

1. Introduction

Since the mid-20th century, the impact of human activities on the Earth's natural systems has become increasingly evident, of which the vast use of fossil fuels is a standout. The increase in emissions and concentration levels of atmospheric greenhouse gases (GHG) has raised global temperatures by 1.1 ºC, placing us close to the 1.5 ºC threshold, that once exceeded, experts warn, would lead us to a point of no return that would endanger the systems that maintain the Earth's balance and sustain humanity (Richardson et al., 2023). Extreme phenomena caused by climate change warn of the proximity of planetary boundaries (Rockström et al., 2009). We are facing what the scientific literature has begun to call *the anthropocene era* (Crutzen & Stoermer, 2000; Crutzen, 2002), a term coined by the biologist Eugene F. Stoermer and popularized in 2000 by the atmospheric chemist Paul J. Crutzen to define a new geological epoch in which human activity has become the main force of change in life on the planet, compromising the stability of the planet Earth and generating chain effects such as alterations in the water cycle, the melting of glaciers and polar ice caps, rising sea levels, changes in marine and terrestrial ecosystems, ocean acidification, deforestation or loss of biodiversity, with significant impact on food security and human health (Steffen et al., 2011). We have sufficient evidence to justify the declaration of a state of climate emergency (CE hereafter) with economic, social and environmental implications (Intergovernmental Panel on Climate Change [IPCC], 2023).

This worrying reality requires the coordinated action of society as a whole, and it is therefore imperative to take action that stimulates collective awareness and transforms the patterns that govern human behaviours within the time constraints that condition possible solutions (Yeves & Javaloyes, 2018). Specific actions and individual and collective commitments are required to preserve the environment and promote more sustainable socioeconomic models that allow

us to even rethink our relationship with nature. The 21st century must mark the beginning of a new era in which we recognize that we are eco-dependent and interdependent beings and, therefore, must aim for a new civic ethic that moves in the direction of eco-social justice. This implies redesigning a new development paradigm in which ecological well-being and social issues are placed at the core, embracing fairer and more democratic criteria that encourage citizen participation, transformative public policies, inclusion, human rights and adaptation and mitigation measures to climate threats resulting from socioeconomic structures (Chandramohan & Bhagwan, 2023; McGrath & Russon, 2023; Monk et al., 2023). In short, it is about questioning our cultural identity and promoting ways of feeling, thinking and acting that contribute to the care and protection of our planet, recognizing the potential of education as a transformative force for the global challenges humanity faces (VET Africa 4.0. Collective, 2023).

Since the first world conference on the environment in 1972, this issue has been present in political agendas and the media, with key milestones such as the Brundtland Report (1987) and the Rio Earth Summit held in Rio de Janeiro (1992). However, the potential of education as a catalyst for fairer lifestyles did not gain momentum until the millennium development goals (2000-2015) when education for sustainable development (ESD) gained recognition and relevance in the context of global development. The result of these interests has been different initiatives that take increasingly holistic approaches, highlighting the current Agenda 2030 adopted in 2015 by the United Nations General Assembly, which recognizes education for sustainability (EfS) as a determining factor for global balance. Since then, these issues have been the subject of growing interest in educational systems, reflected in initiatives such as the European Green Deal, that considers the role of education in moving towards a climate-neutral Europe (Comisión Europea, 2021); the European Framework of Competencies for Sustainability (GreenComp) (Bianchi et al., 2023); and, in Spain, the Action Plan on Environmental Education for Sustainability (PAEAS hereafter) (Ministry for the Ecological Transition and the Demographic Challenge [MITECO] and Ministry of Education and Vocational Training [MEFP], 2021), advocating a strategic approach aligned with environmental education for sustainability (EEfS, hereafter).

At a national level, and in the context of initial vocational training (IVET, hereafter), the context under study, the two ministries mentioned above (MITECO and MEEP), through the PAEAS (2021-2025), urge the promotion of different values and the generation of educational spaces that direct individual and collective concerns towards effective actions that modify the vision, the model and the social purposes regarding the CE and the environmental emergency. From this perspective, as López et al. (2022) suggest, it is essential to integrate the socio-ecological crisis transversally into education, both in the formal curriculum and in the promotion of extracurricular resources and initiatives that prioritize these issues in non-formal and informal socio-educational contexts. In this sense, although climate literacy (understood as the scientific knowledge necessary to understand the climate system) is essential to train technical personnel, professionals and other agents in making informed and responsible decisions, it is insufficient on its own, since it does not address the CE from all its dimensions. For this reason, a joint effort is necessary to complement this approach with social and civic cooperation that involves and activates the commitment of the entire community, prioritizing educational needs in the face of the urgency of the planetary emergency (López et al., 2022). Educational responses that must come from all stages and levels of education, among which is VET, contemplated in current Spanish regulations (Organic Law 3/2022, of March 31, on the Organization and Integration of Vocational Training) as *D* training level and which constitutes the educational level of reference in this systematic literature review (SLR).

VET, an educational level traditionally linked to unsustainable production models, shows limited commitment to socio-environmental well-being. Recently, awareness of the need for VET to address the CE has increased, although academic literature barely addresses this issue or does so from limited approaches that do not reconsider conventional perspectives; representing a significant challenge and opportunity to improve the relevance and impact of VET in this field (McGrath & Russon, 2023; Ramsarup et al., 2024).

Given this scenario, EEfS becomes an urgent requirement to promote social transformation and build a culture of environmental care in the educational community, forming a critical and participatory citizenship, capable of understanding problems, making decisions and acting accordingly. However, the urgent challenge requires renewing EEfS, strengthening themes such as eco-dependence, CE and eco-citizenship; reformulating methodologies and interventions, and promoting inclusive citizen participation (MITECO & MEFP, 2021). In this context, taking advantage of the global momentum and renewed attention resulting from the 2030 Agenda can be an added value to our efforts to address high-level issues such as climate change (CC hereafter) from a broader and more effective perspective. In this sense, vocational training stands out as the ideal setting from which to train professional profiles that will drive fairer economies, educating for an informed, committed and active citizenry, with a positive impact on quality of life, professional development, social equity and environmental protection.

The current management model and the traditional educational inertia, marked by obstacles and resistance to curricular innovation and renewal, limit the development of educational projects focused on EEfS, despite the regulatory advances supported by the 2030 Agenda. National and international reports point to poor results that prevent inclusion and social mobility (Parveva, 2020). Consequently, the focus of educational policies is on educational transformation and, in the educational context of VET, the PISA-VET initiative was born to evaluate professional skills and the quality of the educational system (Organization for Economic Cooperation and Development [OECD], 2024). For its part, the Organic Law 3/2022, of March 31, on the Organization and Integration of Vocational Training promotes the green economy and sustainability, highlighting the importance of Vocational Training in the ecological transition and the fight against CC. Thus, the new law encourages a combination of humanistic and professional training and underlines the need to develop eco-social skills to train professional profiles in regard to climate and social awareness.

In this process of creating citizen awareness and reactivation, the commitment and training of VET teachers and placement supervisors are essential. However, training processes require changes such as increasing educational resources and creating a culture of collaboration between educational centres, companies and the community environment, which allow the exchange of ideas, collective reflection and mutual learning. It is through this social dialogue and democratic strengthening that knowledge can be generated and educational quality optimized, promoting identities committed to eco-social justice (MITECO & MEFP, 2021).

Despite the growing interest in integrating CC and EEfS in education and in rethinking approaches to VET, the scientific literature shows that there are very few studies that consider the link between VET, CC and EEfS as a relevant factor for a fair transition (McGrath & Russon, 2023). This reveals a gap in the comprehensive preparation of professional profiles, highlighting the urgency of greater research focus, and this is the premise on which this systematic review is based, the contribution of research in the field of educational sciences, which seeks to guide future research and educational policies and curricular practices in regards to how VET addresses the CE.

Given this scenario, the general objective of this study is to determine the extent to which the CE constitutes a consolidated topic of study in educational research focused on VET; a general objective that takes the following specific goals as a reference:

- Identify the context, the predominant themes and the reference methodological approaches in the scientific literature on climate emergency in VET,
- Investigate emerging topics and approaches and their evolution within the framework of the climate emergency in VET.

2. Method

2.1. Research methodology

Due to the large volume of scientific literature available digitally, the SLR method is crucial to effectively synthesize, interpret and evaluate existing information. For a review to be considered systematic, it must comply with methodological and transparency principles that ensure reliable answers to specific research questions (García-Peñalvo, 2022). The PRISMA (preferred reporting items for systematic reviews and meta-analyses) protocol is widely recognized and used as a reference in various disciplines. Therefore, given the complexity of the research problem, and in order to respond to the objectives set, we opted for a SLR on the state of the art under the methodological guidelines of the PRISMA 2020 statement, thus guaranteeing the rigor and quality of the review process (Page et al., 2021). The systematic review reflected in this work has been developed following distinct phases (Valverde-Berrocoso et al., 2022).

- Phase 1: research questions (RQ hereafter). These questions have been organized around three dimensions or variables: (1) contextual characteristics, which identify the distribution in time, geographic location and predominant themes of the reviewed studies; (2) methodological framework, which recognizes the methodologies, methodological designs, research techniques and sample profiles; and (3) interpretive evaluation, which determines the key findings and conclusions of the reviewed studies (Table 1).

TABLE 1. Research questions and their dimensions.

Dimension	Research questions
Contextual	**RQ1.** How are publications on the CE in VET distributed over time in percentage terms?
	RQ2. What is the geographical distribution of publications across different continents?
	RQ3. What are the predominant topics in the publications?
Methodological	**RQ4.** What methodologies are most frequently identified in the studies included in the review?
	RQ5. What type of study is most commonly used in the studies reviewed?
	RQ6. What research techniques are most prominent in the selected studies?
	RQ7. What profile do the samples most commonly used in research on the CE in the context of VET have?
Interpretative	**RQ8.** What are the most significant findings from the literature reviewed?
	RQ9. What are the key conclusions from the studies reviewed?

- Phase 2: search strategy and information sources. Document selection was undertaken using the SCOPUS, Web of Science (WOS), ERIC, TESEO and SciELO databases, using keywords in English and Spanish related to VET, CC and EEfS. The search was limited to open access scientific articles and academic papers published in the last ten years. To maximise the effectiveness of the search, Boolean operators (AND/OR) were used, treating compound terms as a single unit.

- Phase 3: eligibility criteria. Books, scientific articles and PhD theses focused on the environment, the CE, sustainability and/or the sustainable development goals (SDGs) in the context of VET were included. Studies outside the field of social sciences and education were excluded.

- Phase 4: study selection and data extraction process. The initial search identified 1734 documents, of which 1204 studies were analysed according to title and abstract, applying inclusion and exclusion criteria, resulting in the exclusion of 1160 documents. The remaining 44 were reviewed in full text, resulting in 14 articles being excluded for not meeting the minimum standards. Three articles were then incorporated, thus completing the final sample for the review ($n = 33$).

- Phase 5: coding and data synthesis. Microsoft Excel software was used to collect data and synthesize information, including identifying data of the source (author, title, year of publication, DOI, source) as well as keywords, summary and relevant research topics (context, topics, methodology, typology and research techniques, sample, findings and conclusions). For content analysis, we categorized the information, obtaining a series of categories and subcategories associated to the dimensions and research questions.

Each of these phases are discussed in detail below.

2.2. Search strategy and information sources.

The search process began with the definition of the criteria for selecting the documents to be analysed. The experience of the authors responsible for this study, the topics covered by it (CC and VET) and the descriptors marked by the search engines and databases used have been the references used in the definition of the search criteria shown in Table 2.

TABLE 2. Search criteria for the selection of documents in the SLR.

Criteria	Definition
Tipology	Books, scientific articles, and academic papers indexed in relevant bibliographic databases for educational research and positively valued by the scientific community, such as SCOPUS, Web of Science (WOS), Educational Resources Information Center (ERIC), and TESEO. Additionally, the electronic library for scientific dissemination, SciELO, is used.
Search descriptors	The search terms were *VET*, *TVET*, *vocational training*, *vocational education* or *professional training*; *climate change*; *climate emergency*; *climate action*; *global warming*; *greenhouse effect*; *curricular greening*; *environment*; *green skills*; *sustainability*; *environmental education*; *greening*; *green transition*; *socioecological transition*; *global challenges*; *SDG-13*.
Availability	Open access, free, and available in full text.
Timeframe	Limited time frame to the last ten years, covering the period from 2015 to 2024, both years included.
Language	Spanish and English.

Several key decisions were made to carry out the search. The selection of databases was determined by their thematic breadth and national and international relevance in the educational field and other disciplines, thus ensuring a complete and detailed compilation of the relevant literature on the topics of interest. The keywords used in the searches were chosen with the idea of accurately and exhaustively reflecting the relevant topics of the study,

with synonyms also incorporated to broaden the search. With this information, specific search equations were designed to obtain a relevant set of primary sources in the databases (García-Peñalvo, 2022). Boolean connectors (AND/OR) were used to create formulas, combining keywords in such a way that they formed an effective search strategy in the selected search engines, in accordance with the guidelines of each database (Table 3).

TABLE 3. Advanced search equations in databases.

Database	Equation
SCOPUS	TITLE-ABS-KEY("climate change" OR "climate emergency" OR "climate action" OR "global warming" OR "greenhouse effect" OR "curricular greening" OR "environment" OR "sustainability" OR "environmental education" OR "greening" OR "green transition" OR "green skills" OR "socioecological transition" OR "global challenges") AND TITLE-ABS-KEY("VET" OR "TVET" OR "vocational training" OR "vocational education" OR "professional training")
WOS	ALL=(("climate change" OR "climate emergency" OR "climate action" OR "global warming" OR "greenhouse effect" OR "curricular greening" OR "environment" OR "sustainability" OR "environmental education" OR "greening" OR "green transition" OR "green skills" OR "socioecological transition" OR "global challenges") AND ("VET" OR "TVET" OR "vocational training" OR "vocational education" OR "professional training"))
ERIC/SCIELO	("climate change" OR "climate emergency" OR "climate action" OR "global warming" OR "greenhouse effect" OR "curricular greening" OR "environment" OR "sustainability" OR "environmental education" OR "greening" OR "green transition" OR "green skills" OR "socioecological transition" OR "global challenges") AND ("VET" OR "TVET" OR "vocational training" OR "vocational education" OR "professional training")

2.3. Eligibility criteria

Deciding which documents should be reviewed and which ones should be excluded required the definition of eligibility criteria (Table 4); these criteria were established based on the topics under study (CC and FP) and the scientific nature of the document.

TABLE 4. Definition of inclusion criteria.

Criteria	Definition
Context	Books, scientific articles or PhD theses directly applicable to the context of VET
Object of study	Topic focused on the environment, the climate emergency, sustainability and/or the sustainable development goals (SDGs)
Field	Studies within the disciplinary field of social and educational sciences

2.4. Data selection and extraction process

Data extraction has been carried out in three screening stages. The first stage, identification, has pivoted on the initial search for documents in the specialized databases WOS, SCOPUS, ERIC and TESEO using the core terms of the research, both in English and Spanish: *vocational*

training, *climate change*, *climate emergency*, *environmental education*, *environment*, *sustainability* and *curricular environmentalization*. Additionally, the SciELO scientific electronic library has been reviewed, expanding the search with new concepts in both languages: *green skills*, *green transition*, *socio-ecological transition*, *climate action*, *global warming*, *greenhouse effect*, *greening*, *global challenges* and *SDG 13*, also in both languages. For a correct query, different combinations of all the keywords and synonyms have been made, posing specific search equations following the logic of the Boolean operators (AND/OR). This systematic search has been carried out over the months of March, April and May 2024. As a result, 1734 studies were identified, leaving a total of 1204 records for screening.

During the second screening stage, after an initial analysis based on the reading of titles and abstracts of the documents, 1160 publications were excluded as they did not specifically address VET linked to environmental issues or sustainability, and that were outside the field of social and education sciences. After applying the first filter, we examined the full text of these 44 sources, resulting in the exclusion of 14 studies.

Finally, during the third stage of inclusion, 3 additional studies have been added, completing the final sample of documents for the SLR ($n = 33$). The addition of these investigations has enriched and completed the review; one of them is a key source in the reviewed literature, and the other two works meet the inclusion criteria.

These filtering stages, aligned with the general phases of the SLR process, are illustrated in the flowchart presented in Figure 1. The identification stage corresponds to the application of the search strategy and selection of initial information sources. The screening stage refers to the application of the eligibility criteria to determine the relevance of the studies. Finally, the inclusion stage coincides with the final selection of studies and the extraction of data for data coding and synthesis.

FIGURE 1. PRISMA 2020 flowchart for SRL.
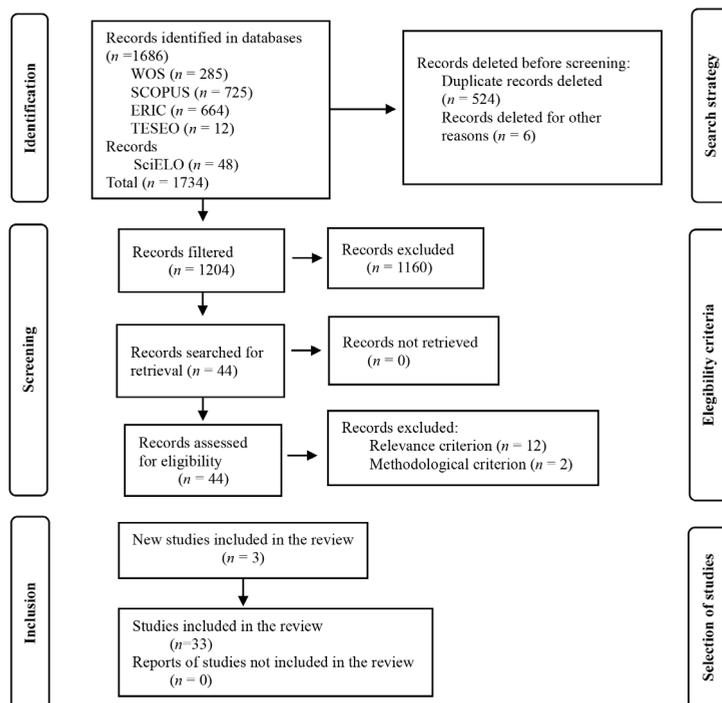
Source: adapted from Page et al., 2021.

After selection of the final studies for our review (33), we developed a template using Microsoft Excel software to synthesize the information and facilitate content analysis, including identifying data of the source (author, title, year of publication, type of document, nature of the data) as well as keywords, textual quotes or relevant research topics.

2.5. Data coding and synthesis

Regarding the analysis of qualitative information from the reviewed documents, a content analysis has been carried out that has allowed us to interpret the data by categorizing or coding the information, from which a series of categories have been obtained, organized in three main dimensions: (1) contextual (Table 5); (2) methodological (Table 6), and; (3) interpretive (Table 7), directly linked to the research questions.

TABLE 5. Definition of categories linked to the contextual dimension.

Code	Category	Meaning	Subcategory
TD	Temporal distribution	Classification of documents by year of publication to detect increases or decreases in the number of studies published per year	2015-2016-2017-2018-2019-2020-2021-2022-2023-2024
GL	Geographic location	Classification of publications by continent to identify the number of studies published in each region	Europe (EU) – Africa (AF) – Asia (AS) – America (AM) – Oceania (OC)
T	Topics	Study topics and areas of interest in research on CC and VET	Green campus (GC) – Curriculum/ Training (CT) – Community/ Businesses (CB) – Research (R) – Institutional culture (IC) – Skills (S)

TABLE 6. Definition of categories linked to the methodological dimension.

Code	Category	Meaning	Subcategory
M	Methodology	Methodological approach adopted in the research	Quantitative (QUAN) – Qualitative (QUAL) – Mixed (MX)
TY	Typology	Design or set of methods used to approach the study	Theoretical (TH) – Applied (AP) – Field (F) – Instructional (I) – Descriptive (DE) – Exploratory (EX) – Explanatory (EP) – Evaluative (EV) – Case studies (CS)
TC	Techniques	Set of tools and instruments used to collect information and analyze data	Documentary (DO) – Observational (OB) – Participatory (PA) – Survey (SV)
S	Sample	Documents or part of the population with which the research is carried out	Students (ST) – Teachers (T) – Management staff (MS) – Experts (EXP) – Companies (CM) – Educational community (EC) – Organizations and governments (OG) – University (U) – Social agents (SA) – Research staff (RS) – Documents (D)

TABLE 7. Definition of categories linked to the interpretive dimension.

Code	Category	Meaning	Subcategory
H	Findings	Results obtained in the reviewed studies, including data, patterns, and relevant observations	Definition (DEF) – Barriers (BA) – Good practices (GP) – Action proposals (AP) – Teacher protagonism (TP) – Technological innovation (TI) – Importance/Contribution to SDGs (ODSC)
C	Conclusions	Interpretations, judgments and recommendations derived from the findings of the reviewed studies, highlighting the relevance and potential applications of the results	VET reform (VET R) – VET research (VETRS) – VET training (VETT) – VET networks (VET NET) – Green jobs (GJ)

The independent participation of all researchers in entering, verifying and contrasting information has guaranteed accuracy and the absence of bias that can appear in individual studies.

3. Results

Based on the categorization of the information, we present the results organized according to the previously established dimensions, in order to answer the nine research questions about the contextual characteristics, the methodological framework and the interpretive evaluation of the 33 studies reviewed (Figure 2).

FIGURE 2. Authors and year of the different documents analyzed for the SLR.

3.1. Contextual characteristics in educational research on the CE and VET

RQ1. How are publications on the EC in VET distributed over time in percentage terms?

Regarding the year of publication, the analysis has revealed an increasing trend in the number of publications, going from 3.03% in 2015 and 2016 to 27.27% in 2023. In 2024, publications reached 18.18%, a percentage that has also been recorded in 2020. Other less notable years were 2022 with 12.12%, as well as 2021, 2019, and 2018, all with an identical

percentage of 6.06%. In contrast to the results in those years, no publications on the subject were recorded in 2017.

RQ2. What is the geographical distribution of publications across the different continents?

In relation to those places where research was carried out, five continents have been identified, with Europe ranking first, with the largest contribution (32.43%), followed by Asia (29.73%) and Africa (24.32%). America (8.11%) and Oceania (5.41%), showing a lower contribution in the production of documents.

RQ3. What are the predominant topics in the publications?

Regarding the topics, it has been shown that the category with the greatest presence is *research* (39.13%), while the least present is *green campus* (4.35%). This finding underlines a clear tendency towards the generation of scientific knowledge that supports sustainable educational practices that are beneficial for the educational community and society, instead of focusing on the specific environmental management of the campus infrastructures and services. Secondly, the topic *curriculum*, (17.39%) regarding the integration of sustainability into the curriculum, has stood out. Thirdly, the *competencies* (15.22%) necessary to face CC and promote socio-environmental balance; followed by *community and companies* (13.04%), referring to the necessary collaboration between educational institutions, companies and community to connect theory with practice; and *institutional culture* (10.87%), concerning the integration of sustainability in institutional culture and promotion of good practices in all areas and decisions of institutions.

3.2. Methodological framework in educational research on CE and VET

RQ4. What methodologies are most frequently identified in the studies included in the review?

It has been observed that qualitative methodology (53.33%) is widely used, followed by mixed approaches (36.66%). In contrast, quantitative methodology has been used less frequently, with a presence of 10% across all reviewed studies.

RQ5. What type of study is most commonly used in the reviewed studies?

Theoretical research works (34.01%) were those most frequently found in the review, followed by field studies (25.77%), which included interviews, questionnaires, observations and ethnographic studies, and studies applied to specific contexts (14.43%), which also included participatory action research and expansive learning. On the other hand, there was a higher frequency of research based on case studies (10.31%) and instructional designs (6.18%) compared to descriptive (3.09%), evaluative (3.09%), exploratory (2.06%) and explanatory (1.03%) designs.

RQ6. What research techniques are most prominent in the selected studies?

Regarding the most commonly used techniques, surveys have stood out (42.17%), including interviews and questionnaires. In second place are documentary techniques, which include content, comparative, reflective and mapping analyses, and equate to 40.96%. At a greater distance are participatory techniques (12.04%), which integrate focus groups, community cafes, art programs, workshops, among others; and finally, observational techniques make up only 4.82% of the total.

RQ7. What is the profile type that the samples most commonly use in research on the CE in the context of VET?

Regarding the sample used, the category *teaching staff* appears more frequently in non-theoretical studies (15.28%), in the same way that *documentation* is equally predominant in theoretical studies (15.28%). Other categories that have stood out are *students* and *educational community*, with 12.5% respectively. *Companies* (11.11%) as well as *organizations and governments* (9.72%) have also been widely used. However, with less representation we have found *experts* (5.56%), *community* (5.55%), *research staff* (5.55%) and *managerial staff* (4.54%), with *university* (3.03%) being the least common category amongst the studies.

3.3. Interpretive assessment in educational research on the EC and VET

RQ8. What are the most significant findings from the literature reviewed? Most of the findings from the documents analysed have focused on *barriers* (32.91%), shortcomings or problems that hinder or prevent the development of sustainable practices. Notwithstanding, great weight has also been given to the *action proposals* (27.85%) that are necessary to include the climate emergency in VET and make EEfS effective, and to the study of *good practices* (16.45%), referring to success stories that have proven to be effective and successful in addressing sustainability in VET and can serve as a model or reference for sustainable VET. To these trends has been added *teacher protagonism* (7.59%), which explores the role of teachers in the implementation of changes and improvements in VET; *technological innovation* (6.33%), focused on skills and technologies in teaching for green innovation; and *importance and contribution of the SDGs* (6.33%) in VET. Finally, 2.38% focused on the *definitions* or image associated with the terms CE and sustainability.

RQ9. What are the key findings of the reviewed studies?

The categories *VET research* and *green jobs* have been identified as the main findings (23.91%). This suggests a predominant trend towards the development of academic research and educational policies to address global challenges with an eco-social perspective, as well as towards the promotion of green skills and environmental technologies to support a greener industry. Another significant conclusion was *VET reform* (21.74%), focused on changing traditional educational practices in favour of comprehensive curricular models and educational approaches. On the contrary, the least frequent conclusions were *formative VET*, referring to the training and professional development of teachers and companies, and *VET networks*, which highlights the importance of participation and collaboration between institutions, companies and communities for equity and eco-social justice, both with 15.22%.

4. Discussion

Taking as a reference the object of study, which was to uncover the extent to which the CE constitutes a consolidated topic of study in educational research focused on VET, we conclude that, although there is a growing interest and greater attention being paid to these topics in academic research, the literature shows that studies that explore the link between CC and VET are still scarce (McGrath & Russon, 2023). This results in highlighting that it is especially rare to find research works that address CC from a holistic and transformative perspective, which question our cultural identity and point in the direction of eco-social justice (VET Africa 4.0. Collective, 2023).

Regarding the research questions on the contextual characteristics of the documents, the SLR has indicated a growing increase in research on VET and sustainability since the approval of the 2030 Agenda in 2015, with a clear intensification of academic interest from 2020 onwards, most likely due to the impact of the health crisis caused by the covid-19 pandemic, which brought with it a series of changes in the Earth's human and natural systems that drove the production of new research topics. The decrease in 2021 probably reflected the adaptation and reorganization process of the scientific community in the academic field, while the rebound since 2022 could be explained by the consequences that covid-19 had on ecosystems and the renewed commitment to environmental issues (López-Feldman et al., 2020). This increase has been particularly evident in European countries and in the global south. According to McGrath and Yamada (2023), this is due to the fact that countries in the north have greater funding, which often perpetuates dynamics of external leadership and extractivism that influence the direction and focus of research agendas. However, there are recent efforts to promote more responsible and socially engaged participation from developing countries; a trend that would explain the growing visibility of countries in the global south in academic publications on skills, theoretical and methodological approaches, probably due to their high vulnerability to the impacts of CC (Monk et al., 2023), data which are consistent with the research by Persson

et al. (2023), who also point out "a rapid growth of research on VET and a green transition in the so-called Global South and European countries" (p. 373).

Despite these data, the research priorities in these studies have been diverse. While it is true that the predominant theme of theoretical studies points towards the generation of scientific knowledge that supports sustainable educational practices that are beneficial for the educational community and society, in practice, more than half of the research adopts reformist approaches focused on specific areas (Ramsarup et al., 2024), such as the curriculum, identified in numerous documents as the best solution to address CC; competencies for sustainability; collaboration between institutions, communities and companies; the creation of ecological institutional culture, and; specific environmental management in campus infrastructures and facilities. This reality has revealed a significant gap between academic interest in greening VET and its effective implementation in this context, which currently tends towards fragmented responses rather than systemic or transformative ones (McGrath & Russon, 2023; Chandramohan & Bhagwan, 2023; Monk et al., 2023).

Regarding the questions related to the methodological framework, the results indicate that qualitative methodology is the most used, followed by mixed methodology, and quantitative methodology is barely present, consistent with the findings by Trott et al. (2023). Furthermore, theoretical studies and field research prevail over applied and participatory studies, with case studies being more frequent than instructional, descriptive, evaluative, exploratory and explanatory designs. Consequently, the most commonly used research techniques have been surveys and documentary techniques, as opposed to participatory and observational techniques. This distribution suggests that there is a disconnect between theoretical knowledge and its practical application, which is limiting action and, therefore, the capacity of studies to generate sustainable practices (Ramsarup et al., 2024).

Regarding the study sample, we observed that the research tends to focus on documents, teachers or students, with less presence of community participation, and almost no university involvement. These findings have corroborated the conclusions by VET Africa 4.0 Collective (2023), in regard to VET not adequately addressing the EC, since the different intervention perspectives are not being considered nor is the inclusive participation of citizens, necessary for a balanced and lasting future, being promoted. Likewise, they also highlight the fundamental role of universities in developing skill ecosystems and promoting social mobilization. Along these lines, Monk et al. (2023) argue that adopting a new approach to effectively address CC requires integrating the social context and diverse knowledge perspectives so as not to leave anyone behind (López et al., 2022).

The answers obtained in this study to the research questions on interpretive assessment highlight the barriers and/or problems that hinder or prevent the development of good practices stand out. In this sense, the problems that stand out are training challenges, such as "the infrastructure, the equipment", (Muwaniki et al., 2024, p. 439), "the syllabuses/curricula" (Legusov et al., 2021, p. 10) and/or "the shortage of qualified personnel […], which negatively impacts the competence of students at the end of the training and their employment prospects". Economic challenges, such as "the high cost of education, which affects disadvantaged students" (Legusov et al., 2021, p. 13). Cultural challenges, referring to "core beliefs in productivism, industrialization and economic growth"; and/or "to deeply rooted educational and sociocultural routines, such as the student as learner, alienation from problems, a bias toward cognitive knowledge, and rapid 'problem solving'" (Weijzen et al., 2024 p. 331). And institutional challenges, related to the organization and internal structure of institutions, including educational policies, regulations, rules, bureaucracy, among others. Improvements have been proposed to overcome these barriers, such as curricular updating, the establishment of an evaluative framework, the integration of political economy and skills ecology (Ramsarup et al., 2024), and success stories to green VET. A prominent example has been the German INEBB project as an effective transfer mechanism to integrate the SDGs into business VET (Lambini et al., 2021).

The priority given to barriers, proposals for action and good practices suggests that current practices focus more on overcoming immediate obstacles and seeking specific practical solutions, despite the fact that teacher commitment and training are crucial for raising awareness and citizen reactivation, as well as establishing a solid conceptual basis to effectively address CC (MITECO and MEFP, 2021).

In relation to the key findings, the need to advance academic research and develop policies "and flexible regulations to balance changing market needs" has been highlighted (Pavlova, 2019, p. 155). In addition, the importance of environmental skills and technologies has been highlighted to create a qualified workforce that promotes the conscious use of natural resources and renewable energy, with a positive impact on CC. This is consistent with Persson et al. (2023), who emphasize technological innovations and green skills education, and with Li et al. (2023), who argue that green technology in vocational training is essential to foster sustainable awareness, knowledge, attitudes, practices, skills and values.

On the other hand, it has been considered urgent to reform conventional educational practices of VT towards ecosocial models, through specific proposals that try to promote equity and social justice. This includes, according to Lotz-Sisitka et al. (2024), the incorporation of political-economic-ecological debates, as well as giving voice to local communities. For their part, McGrath and Powell (2016) propose replacing productivism (VET) with a post-productivist vision that promotes "a vision of work that is decent, solidary [that supports student action], gender-conscious, environmentally sensitive and intergenerational, addressing poverty, inequality and injustice" (p. 18) Furthermore, Moldovan (2015) points out the need to prioritise the implementation of a new assessment framework, policies and action plans to green the organisational culture while considering the participation of specific recipients to ensure inclusion (Yilmaz, 2024). These results are in line with previous studies by Paryono (2017), who highlights the importance of humanistic and social values to achieve transformative and sustainable approaches for the benefit of people, communities and the planet; and by Powel (2012), who points out that VET can significantly contribute to human development and the social changes needed to fight CC and poverty.

Although teacher and business training and professional development, along with the creation of collaborative networks between institutions, communities and/or businesses, have been less common in the reviewed literature, Janhonen-Abruquah et al. (2018) point out the importance of teacher training to ensure sustainable educational practices. Likewise, Ramli et al. (2022) show that networking is the most influential factor in learning, which favours teacher training in VET.

5. Conclusions and future lines of research

The results of this study allow us to assert that, while it is true that there is a growing interest in these topics in scientific research, the principles of ecosocial justice are barely present in most of this scientific production. The CE is not approached from a holistic and transformative perspective that questions our cultural identity and promotes a new development paradigm (Chandramohan & Bhagwan, 2023; SAJEE, 2023; VET Africa 4.0. Collective, 2023); rather it is worked on from transitional approaches focused on research into specific areas or subsystems within society (Persson et al., 2023). As suggested by authors such as McGrath and Powell (2016) and Lotz-Sisitka et al. (2024), evidence suggests that incorporating political, economic and ecological debates, and adopting a post-productivist vision of work are essential steps to respond to the demands of the CE. Although these measures are critical, they are insufficient on their own for a comprehensive approach that requires large-scale changes; changes linked to transformative transitional approaches aimed at human, supportive and sustainable development (Persson et al., 2023). In this sense, it is not only crucial to opt for research that promotes sustainability (United Nations Educational, Scientific and Cultural Organization, and International Centre for Technical and Vocational Education and Training [UNESCO-UNEVOC], 2017), but it is also necessary to strengthen and direct research activity towards study topics such as eco-dependence, planetary boundaries or the CE and eco-

citizenship; and towards educational aspects that allow reformulating teaching methodologies, encouraging citizen participation (MITECO and MEFP, 2021) and promoting inclusive and transformative public policies.

In hindsight, the SLR has been useful to determine to what extent the CE constitutes a consolidated topic of study in educational research focused on VET, as well as to contextualize the perspectives employed to address it in the literature. However, some of the limitations of the study should be noted. The main one could be related to the linguistic scope and the sources of information used, since local studies with a more specific level of indexing at a regional level or less visible in scientific databases have not been considered, which may have limited the representation of all ongoing research.

The results obtained could guide future research agendas that prioritize the identified gaps and underexplored areas in the field of vocational training and CE, allowing for an increase in scientific production, as this is an emerging topic. In this context, it would be advisable to explore how the findings of the review can contribute to the formulation of educational policies and curricular practices, offering a framework to address the CE in VT and promoting the training of professional profiles demanded by citizens competent in sustainability.

Finally, as a future line of work complementary to the study carried out, we suggest that a SLR based on the gender perspective be carried out, as scientific production in this field increases. The incorporation of these approaches will be essential to advance the study of the CE and the VT, favouring a holistic and transformative understanding.

Authors' contributions

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Artificial Intelligence (AI) Policy

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