

# Mapping the Integration of Education for Sustainable Development (ESD) into Art Education: A Bibliometric Analysis of Research Evolution and Future Directions

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**Abstract:** With the advancement of the global sustainable development agenda, interdisciplinary research on Education for Sustainable Development (ESD) has gained increasing attention. Through a bibliometric analysis of 529 articles in the Web of Science Core Collection, this study analyzes the current status of the research and the trends in the area of the intersection of ESD and art education. Findings indicate that the increase in publications is significant after 2013. Co-citation and co-word analyses indicate that existing studies mainly focus on macro-level themes such as conceptual evolution, policy discourse, ecological ethics, and action competence, while art education remains weakly connected and lacks an independent research cluster. This is an indicator that the current research in art education on ESD remains in its early years with significant structural deficiencies. However, there are also new interdisciplinary connections, which show the potential for significant growth. By mapping the knowledge structure of the field, this study identifies theoretical foundations, research gaps, and future directions, offering insights for the systematic integration of ESD into art education.

**Keywords:** Education for sustainable development (ESD); Art education; Research status; Future directions; Interdisciplinary; Educational innovation; Bibliometric analysis

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## 1. Introduction

Sustainable development is fast becoming a pressing global issue with regard to increasing global environ-

mental and resource crisis compelling nations to reconsider and redefine their education practices <sup>[1]</sup>. As nations increasingly recognize the urgency of achieving the United Nations Sustainable Development Goals (SDGs): the role of Education for Sustainable Development (ESD) has gained greater attention <sup>[2,3]</sup>. Learning systems the world over are considering modalities of integrating the SDGs into curriculum reforms so as to enable learners to acquire sustainable spirits and functional skills <sup>[4]</sup>. ESD has often been perceived as a means to better critical thinking and building of essential competencies, making learners more independent in the decision-making process, and, therefore, more able to make a contribution to a sustainable society <sup>[5]</sup>. In addition to the concern about the learning content and learning outcomes, ESD also pays attention to interaction and practice-based learning, which is aimed at creating a global vision of students and a high level of responsibility, to be a responsible global citizen who sees the complexity of the world and works towards a better future <sup>[6-8]</sup>.

Meanwhile, ESD also requires interdisciplinary modes of thinking <sup>[9]</sup>. Art education is one of the most important in enhancing the quality of education in an era where there is a drive towards a more active education reform and the increased concerns on sustainability <sup>[10]</sup>. Art has the capability to pass information and values to the human mind in a direct and meaningful manner through its various expression forms <sup>[11-13]</sup>. The United Nations project named ESD: towards 2030 indicates the significance of the role of integrating sustainability into every learning phase and even the subjects that pertain to art in ensuring the development of a more complex picture about the issues and remedies to sustainability problems <sup>[14]</sup>. In this view, art education holds a lot of promise in how it could influence the awareness of the people to partake in sustainable ways of doing things as well as help individuals strive to meet the global sustainability objectives <sup>[13,15]</sup>. It gets much less consideration as compared to core subjects <sup>[16]</sup>.

Following the patterns of co-citation and co-occurrence of keywords, it can clearly map the current state of research and its future directions; this will give better guidance to the stakeholders and can have a better foundation in formulating future studies.

## 2. Literature review

As an illustration, Adefila *et al.* highlighted the importance of collaborative learning environments that use digital resources to support the sharing of knowledge and to strengthen citizens' participation in sustainability initiatives <sup>[17]</sup>. Hsiao *et al.* discovered that STEAM education implemented with virtual reality (VR) resulted in a high level of learning satisfaction and learning results among students, which has led to speculation that similar methods can be used in art education to enhance students' learning about the concepts of sustainability <sup>[14]</sup>.

Regardless of the general awareness of the necessity of working on the ESD-art education connection, there are still a few challenges. A significant obstacle has been connected to the absence of a unified structure of how sustainability principles should be embedded in art education. Most educational institutions continue to consider ESD as an afterthought and not a component of the curriculum <sup>[18]</sup>. Meanwhile, a teacher can lack adequate preparation to deliver the ideas of sustainability with the help of an artistic approach <sup>[19]</sup>, and a significant number of art instructors might not know or understand concepts and practices of ESD <sup>[20]</sup>. Indeed, a study has revealed that Saudi Arabian students are relatively poorly informed about the concept of sustainability because there is little involvement of sustainability issues in the accounting curriculum <sup>[21]</sup>. The same can be said of the education in art, as the faculty might not have been properly trained on ESD-

related concerns<sup>[20]</sup>. Also, it should be mentioned that curriculum structure and lack of time in the classroom inhibit the implementation of ESD into art education. Art lessons usually already encompass many different conventional skills, the history of art, and principles of beauty<sup>[22]</sup>. The implementation of ESD can lead to significant modifications in the curriculum and demanding time, which can be challenging in the conditions of tightly established limits of educators who already work under severe time pressure.

On the other hand, most schools and art education do not have adequate resources and institutional backing to effectively incorporate the ESD concept<sup>[23]</sup>. There are also significant differences in the support available to different regions in implementing ESD. Developed nations have a higher tendency to follow more orderly methods to inculcate sustainability frameworks in education, whereas low- and middle-income nations pay more attention to the availability of practical solutions to address real-world issues<sup>[24]</sup>. It might be difficult to assess students in terms of their comprehension of the sustainability concepts and the capacity to implement these concepts in the artistic work<sup>[25]</sup>.

Indicatively, Gorski *et al.* sampled both the current and historical developments and trends in the ESD/ EfS (Education for Sustainability) literature and marked transformative learning and action-oriented teaching strategies as the key themes<sup>[9]</sup>. Nevertheless, the available bibliometric works indicate that the overlap between ESD and art education has been ignored in most cases. In order to explain this gap, the authors of Tao *et al.* referred to the bibliometric analysis to investigate the role of aesthetic education in quality education as viewed through the prism of sustainability, with such themes as integration of technology, educational innovation, social justice, and empathy in mind<sup>[10]</sup>. However, their discussion predominantly focuses on the importance of aesthetic education in enhancing the quality of education and fails to chart out the research space and new paths of the ESD art education area. In order to address these shortcomings, we establish the following two research objectives:

RO1: To evaluate historical and academic research on the topic of integrating ESD and art education using a co-citation analysis.

RO2: To determine the potential future research trends in ESD integration in art education using the co-occurrence of the keywords.

### **3. Methodology**

#### **3.1. Bibliometric approach**

Bibliometric analysis is usable to evaluate research work, academic activity, and publication impact in a given area<sup>[26]</sup>. Bibliometric analysis is a quantitative type of research as it is dedicated to the systematic study of the data of publications and citations<sup>[27-29]</sup>. It is a method in information science to systematically review the academic literature with statistical tools that allow the readers to better see the evolution of the field being reviewed, as well as its primary focus areas and the distribution of academic power<sup>[30]</sup>. Among bibliometric approaches, co-citation analysis and keyword co-occurrence analysis are two of the most widely used methods. These techniques can help to further understand a research domain by looking at the interactions between publications and the trend in co-use of keywords, as well as provide a point of reference in determining the progression of a specific domain and its future prospects<sup>[31]</sup>.

Co-citation analysis relies on the counting of the number of times that two documents have been cited together as well as on the count to determine similarities across publications, journals, and authors

<sup>[32]</sup>. When two works are frequently cited by the same later studies, it suggests that they are closely related within a particular research area <sup>[33]</sup>. As an example, we can examine the dependence of co-cited articles that provide information on the topography of the research networks and patterns of scholarly exchanges within a particular discipline <sup>[34]</sup>. The method of the analysis of keyword co-occurrence examines the occurrence of keywords in publications, and it assists in defining influential themes and topic correlations <sup>[35]</sup>. This method is particularly helpful in the fast-paced industries where it is necessary to find out the hotspots in research and probable future directions very fast <sup>[36,37]</sup>.

### 3.2. Study design and data collection procedure

**Table 1** depicts the search keywords and screening parameters that were implemented in this study. Web of Science (WoS) has been selected as a source to be used in bibliometric analysis since it is a high-quality source and it covers a wide range <sup>[38]</sup>. WoS is considered to be the most popular source of bibliometric research and analysis owing to its extensive scope of disciplines and academic importance <sup>[39]</sup>. It is stated by past research that bibliometric analyses can be based on one database only, which is regarded as one of the most reliable sources. This method also evades the possible error that can take place upon the manual amalgamation of data of varied types <sup>[40]</sup>.

In this study, the WoS topic search function was used to identify articles published from the inception of the database up to December 5, 2025. Secondary screening was done to filter out any article that was not within the study area to ensure that the literature selected was very relevant to the research topic. Since ESD often consists of attitudes, behaviors, and environmental awareness, values, and responsibility, the category of social psychology was not eliminated in the course of the screening procedure <sup>[41,42]</sup>. Following this intensive selection, 529 articles that fit the inclusion criterion were retained to be analyzed.

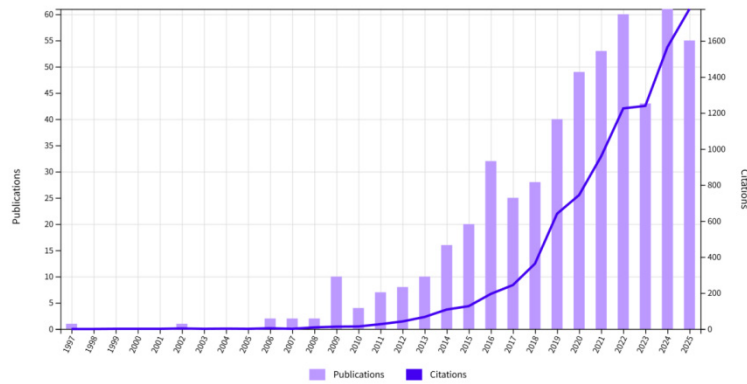
**Table 1.** Search string, inclusion, and exclusion criteria

WoS database	Web of Science core collection
Time period	Up to December 5, 2025
Search field	Topic
Search keywords	("education for sustainable development*" OR "sustainability education*" OR "sustainable education*" OR "ESD*") AND ("art education*" OR "aesthetic education*" OR "design education*" OR "art-based*" OR "art*")
Citation topics meso	("Social Psychology" OR "Education & Educational Research" OR "Sustainability Science" OR "Bibliometrics, Scientometrics & Research Integrity")
Document type	Article
Languages	English

## 4. Result

### 4.1. Trends in publication and descriptive analysis

The WoS database shows that the selected articles (n = 529) received a total of 9,376 citations, which reduces to 8,769 citations after excluding self-citations. The H-index is 47, and the average number of citations per article is 17.72. Although the earliest study in this field dates back to 1997, significant progress was not seen until 2006. Since then, the number of related publications has steadily increased. **Figure 1** presents the number of publications and citations from 1997 to December 5, 2025.



**Figure 1.** Number of publications and citations, 1997 to December 5, 2025 (Source: Web of Science)

## 4.2. Co-citation analysis

**Table 2** shows the top 10 articles in terms of co-citation and total link strength.

**Table 2.** Top 10 articles in terms of co-citation and total link strength

Rank	Authors	Title	Citations	Total link strength
1	Kopnina (2012)	Education for sustainable development (ESD): the turn away from ‘environment’ in environmental education?	12	73
2	Jickling and Wals (2008)	Globalization and environmental education: looking beyond sustainable development	9	58
3	Huckle and Wals (2015)	The UN Decade of Education for Sustainable Development: business as usual in the end	6	33
4	Sund and Öhman (2014)	On the need to repoliticise environmental and sustainability education: rethinking the postpolitical consensus	5	39
5	Ferreira (2009)	Unsettling orthodoxies: education for the environment/ for sustainability	5	38
6	Stevenson (2006)	Tensions and transitions in policy discourse: recontextualizing a decontextualized EE/ESD debate	5	31
7	González-Gaudiano (2005)	Education for Sustainable Development: Configuration and Meaning	5	29
8	Wals (2010)	Between knowing what is right and knowing that is it wrong to tell others what is right: on relativism, uncertainty and democracy in environmental and sustainability education	4	33
9	Bengtsson (2016)	Hegemony and the politics of policy making for education for sustainable development: A case study of Vietnam	4	29
10	MCKEOWN and HOPKINS (2003)	EE p ESD: Defusing the worry	4	28

Source: VOSviewer Co-citation: Cited references analysis

Kopnina (2012) noted a trend in which ESD is moving away from the ecological core of environmental education (EE): criticizing its weakening of environmental issues during the process of global policy adoption<sup>[43]</sup>. Cited 12 times, this study is among the most influential in discussions of the “conceptual shift”

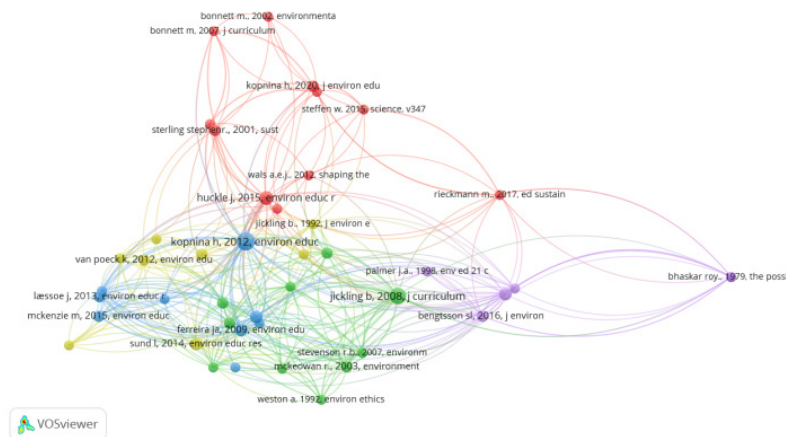
of ESD and offers important insights for reconsidering the value of ESD in art education. Coming through a globalization approach, Jickling and Wals (2008) criticized sustainability discourse with the argumentation that ESD has been significantly influenced by economic and governance logic [44]. Cited 9 times, this piece of work has remained influential in scholarly thinking on the core values of ESD and its contribution to education. Huckle and Wals (2015) pointed out that the United Nations’ “Decade of Education for Sustainable Development” lacked structural reform [45]. It was stressed by Sund and Öhman (2014) that the education should go back to interacting with conflict, opposing values, and deliberating democratically [46].

Ferreira (2009) proposed, based on the philosophy of education, the creation of an educational paradigm that is more analytical and reflective [47]. Stevenson (2006) reviewed the contradictions and shifts involved in EE/ESD in policy discourse, but how the educational policies can redefine the initial definition of ESD by re-contextualizing it [48]. The conceptual and meaning framework of ESD proposed by González-Gaudio (2005) was cited five times and provides a framework for organizing ideas and bringing together theory, which can be very useful when conducting research in art education [49]. Wals (2010) also addressed the questions of relativism, value conflicts, and democratic education in ESD [50]. Bengtsson (2016) applied the case study of Vietnam and examined the hegemonic spaces of the ESD policy and emphasized the role of international development agencies in the process of policymaking [51]. McKeown and Hopkins (2003) illuminated disputes of EE and ESD [52].

All in all, it can be concluded that all these 10 publications make the theoretical background of the study on ESD, displaying the multifaceted and multidimensional nature of the concept of ESD through the lenses of conceptual developments, policy government, value conflicts, and meaning-making. Though these highly-cited papers do not discuss directly how ESD can be incorporated into art education, it gives a strong theoretical foundation of interdisciplinary application of the latter in this field.

### 4.3. Co-citation analysis by clusters

We also performed a co-citation cluster analysis in VOSviewer based on the information accessed in the WoS database. All the clusters were built on the basis of key word co-occurrence and publications representative of the cluster. **Figure 2** visualizes the co-citation relationships, showing how studies are connected through shared citations. The co-citation analysis of the intersection between ESD and art education identified five main clusters (**Table 3**).



**Figure 2.** Co-citation analysis (VOSviewer visualization)

Cluster 1 (red) contains 11 publications and is titled “philosophical foundations of ESD, ecological boundaries, and future-oriented education.” The articles included in this cluster are theoretical. The representative studies include interdisciplinary discourse (between philosophy and policy critique as well as scientific structures).

As an illustration, Bonnett (2002, 2007) argued that most official ESD/EE policies lack sufficient focus on nature, as such, and dominant discourses tend to revolve around the needs of humans in setting educational aims. He is a proponent of an education that will make learners critically analyze and become continuously aware of the connection between humans and nature <sup>[53,54]</sup>. In a study conducted by Grund and Brock (2019): the quantitative research revealed that hope and optimism are associated with sustainable behaviors and intentions to take part in ESD, and low future expectations among the population can contribute to the lack of sustainable behavior. This indicates why ESD must take into account both the emotional and the cognitive levels <sup>[55]</sup>. Steffen *et al*, (2015) suggested and revised the so-called planetary boundaries (PB): which offer a scientifically-founded, functioning sense of sustainable, and proposed that these macro-level Earth system thresholds form a baseline of what students should know <sup>[56]</sup>.

Cluster 2 (green) comprises 10 publications and is titled “policy, values, and practical reflections in environmental and sustainability education.” This cluster focuses on policy research and methodological reviews in the field of ESD/EE, examining the temporal and geographical distribution of policy studies, how policy discourses are adopted and adapted across different countries or regions, and gaps in the existing research, such as regional underrepresentation and methodological biases. The literature mainly consists of systematic reviews, policy critiques, and discussions on the positioning of educational goals.

For example, Aikens *et al*, (2016) conducted a systematic review, combining quantitative and qualitative analyses of 215 policy studies, and identified uneven geographical coverage, as well as gaps in methods and topics, recommending more critical policy theory and research on climate education policy <sup>[57]</sup>. Jickling and Wals (2008) accentuated the restructuring of EE through globalized discourse and claimed that the conceptual shifts would require consideration through the prisms of educational purpose and democratic participation <sup>[44]</sup>. Vare and Scott (2007) and McKeown and Hopkins (2003): among others, came up with two supplementary ways of practice-based ESD in which policy and practice must not be confined to the argument over terminology, but should instead look at a localized action and cooperation <sup>[52,58]</sup>.

Cluster 3 (blue) consists of 9 publications and has the heading of “policy and discourse transformation from EE to ESD.” This body of literature mainly utilizes the critical theory and discourse analysis and is contemplative of the norms, dominant discourses, and orthodox perspectives that are experienced in bringing EE to ESD. It also challenges scholars to constantly challenge the commonly accepted assumptions, as well as to exhibit a skeptical attitude towards the premises underlying their own assumptions. The researchers are concerned with both theoretical considerations and practice.

According to Kopnina (2012): the ecological ethics shift might be marginalized in the name of the ecological shift, who warns that promoting a variety of interpretations cannot be down to the cost of ecological knowledge or ecocentric values <sup>[59]</sup>. McKenzie *et al*, (2015) and Læssøe *et al*, (2013) diversified on the topic of discourse transfer and research to policy interaction by considering the flow and reconstruction of sustainability discourse in various situations, situated in a neoliberal context <sup>[60,61]</sup>.

Cluster 4 (yellow) consists of 8 publications and is titled “action competence, key competencies, and educational practice in ESD.” This category focuses on studies involving the concept of action competence

and key competencies, whereby the focus of learning should be oriented towards equipping students to be able to act and participate actively socially. The literature addresses the process of transforming the competency-based goals into classroom instruction and evaluation models and defines it through the conceptual outlining of quality criteria and working exemplification in teaching.

To put it into the perspective of action competence developed by Jensen and Schnack (1997): students need to be able to outline their problems, communicate about them, and do something about them, whereas the distinction is made between the terms action and change of activities or behavior, as well as some future research directions are proposed<sup>[62]</sup>. Based on a systematic review, Wiek *et al*, (2011) suggested the so-called key competencies of the sustainability framework, which can be applied to degree programs and curriculum development<sup>[63]</sup>. Sund and Öhman (2014) and Van Poeck and Vandenabeele (2012) emphasized teaching sustainability issues as public matters from a repoliticization and civic engagement perspective, promoting citizen participation and democratic spaces<sup>[46,64]</sup>.

Cluster 5 (purple) consists of 7 publications and is titled “integrating theory and practice in ESD.” This cluster is concerned with the approach of integrating the theory and practice, how ESD is built and shaped by policy in various cultural and political settings.

As part of the study of hegemonic problems in ESD policy making, Bengtsson (2016) applied the case of Vietnam, which demonstrates that global discourses are not completely determining and still leave the possibility of argument and resistance in the local practices<sup>[51]</sup>. González-Gaudiano (2005) examined the formation and structure of ESD, and the way the macro-level initiatives including the UN Decade of ESD influenced the sphere of EE<sup>[49]</sup>.

**Table 3.** Co-citation cluster

Cluster	Cluster label	Number of publications	Representative publications
1 (Red)	Philosophical foundations of ESD, ecological boundaries, and future-oriented education	11	Bonnett (2007); Bonnett (2002); Grund and Brock (2019); Huckle and Wals (2015); Kopnina (2020); Steffen <i>et al</i> , 2015)
2 (Green)	Policy, values, and practical reflections in environmental and sustainability education	10	Aikens <i>et al</i> , 2016); Jickling & Wals (2008); Kopnina (2016); Mckeown & Hopkins (2003); Stevenson (2007); Vare and Scott (2007); Wals (2010); Weston (1992)
3 (Blue)	Policy and discourse transformation from EE to ESD	9	Ferreira (2009); Kopnina (2012); Læssøe, Feinstein and Blum (2013); McKenzie, Bieler and McNeil (2015); Mogensen and Schnack (2010); Stables and Scott (2002); Stevenson (2006); Van Poeck <i>et al</i> , 2014)
4 (Yellow)	Action competence, key competencies, and educational practice in ESD	8	Jensen and Schnack (1997); Jickling (1992); Stevenson (2007); Sund and Öhman (2014); Van Poeck and Vandenabeele (2012); Wiek <i>et al</i> , 2011)
5 (Purple)	Integrating theory and practice in ESD	7	Bengtsson (2016); González-Gaudiano (2005); Palmer (1998)

Source: author interpretation from VOSviewer

#### 4.4. Co-occurrence of keyword

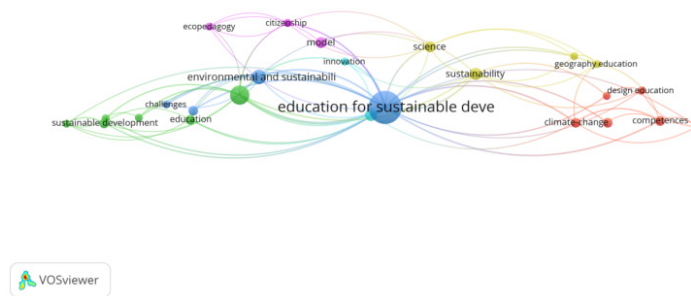
Among the 276 keywords identified, each appeared at least twice. Based on the co-word analysis, the study found that “education for sustainable development” was the most frequently used keyword, appearing 40 times with a link strength of 67. This was followed by “environmental education” and “environmental and

sustainability education,” which appeared 13 and 7 times, with link strengths of 30 and 10, respectively. **Table 4** lists the top 15 co-occurring keywords in this research field. **Figure 3** presents a network visualization of keyword co-occurrence. The characteristics of each cluster are shown in **Table 5** and discussed below.

**Table 4.** The 15 most frequent keywords in the co-occurrence analysis

Rank	Keyword	Occurrences	Total link strength
1	Education for sustainable development	40	67
2	Environmental education	13	30
3	Environmental and sustainability education	7	10
4	Sustainability	5	13
5	Policy	5	11
6	Science	4	10
7	Model	4	4
8	Climate-change	3	8
9	Competences	3	8
10	Sustainable development	3	7
11	Education	3	6
12	Teacher education	3	4
13	Transformative learning	3	3
14	Geography education	2	7
15	Hegemony	2	7

Source: keyword co-occurrence from VOSviewer



**Figure 3.** Co-word analysis (VOSviewer visualization)

Cluster 1 (red) includes six keywords and is summarized under the theme “building climate and sustainability capacities in design education.” Such keywords as climate change, SDGs, transformative learning, and literacy imply that this field of study is not confined to training technical design skills. Design is seen as a foundation of all art forms <sup>[65]</sup> and a formative activity that can actively shape the ecological environment <sup>[13]</sup>. In design education, sustainability issues are often addressed through practical work such as material choices, life-cycle thinking, and social design, showing the action-oriented role of art education

in promoting sustainable ways of living. Simultaneously, it indicates the necessity to connect education with psychological consciousness in terms of climate change, such that the ecological anxiety can be transformed into positive interaction <sup>[66]</sup>.

Cluster 2 (green) consists of 6 keywords and it revolves around the theme of “values and power in EE.” The keywords like environmental ethics, hegemony, power, and sustainable development are characterized by a great emphasis on the ideological aspect of educational material. The role of teachers in providing effective EE in a classroom is critical, and the systematic training of teachers has a direct influence on the sustainability awareness of students and their practical skills <sup>[67]</sup>. Visual art, film, and installation can be used to reveal and explore a range of issues including environmental injustice, ecological oppression as well as unequal resource allocation. The cluster consequently gives emphasis to the fact that more research on cultural and cross-cultural environments is required so that integration of ESD and art education may be shifted to fit other environments <sup>[1]</sup>.

Cluster 3 (dark blue) will involve four keywords, and the theme that can be summarized will be “teacher education challenges in ESD and environmental and sustainability education.” The common keywords tend to include challenges, teacher education, environmental, and sustainability education. For example, in art education, teachers may lack the training and subject knowledge needed to teach sustainability concepts through artistic practice <sup>[68]</sup>, which makes it difficult to effectively integrate ecological, social, and economic dimensions of sustainability into creative teaching. Related studies show that teacher training and professional development programs can help educators revise their curricula to better support the United Nations 2030 Agenda and its SDGs <sup>[69]</sup>.

Cluster 4 (yellow) includes four keywords and is summarized under the theme “building sustainability and systems thinking in geography and science education.” Although this cluster is mainly situated in geography and science education and may appear to have only a weak direct link to art education, it in fact reflects a broader trend toward interdisciplinary integration. Arts-based educational activities are known to support creativity and divergent thinking, and art plays an important role in strengthening ESD <sup>[70]</sup>.

Cluster 5 (purple) contains four keywords and is represented by such a theme as “globalization and model building in ecological citizenship education.” This cluster refers to the theoretical bodies and empirical procedures of ecological citizenship education at a global scale. According to Hnatyuk *et al.*, (2024): education can transform people into environmentally responsible citizens by influencing the acquisition of values, skills, and decision-making skills <sup>[71]</sup>.

There are two keywords in cluster 6 (light blue): which are then summarized by the theme of “innovation in education policy.” This cluster is rather small and focuses on the keywords: policy and innovation.

**Table 5.** Co-occurrence analysis on ESD in art education

Cluster	Cluster label	Number of keywords	Representative keywords
1 (Red)	Building climate and sustainability capacities in design education	6	Climate-change, competences, Design education, literacy, sustainable development goals, transformative learning
2 (Green)	Values and power in EE	6	Education, environmental education, environmental ethics, hegemony, power, sustainable development
3 (Deep blue)	Teacher education challenges in ESD and environmental and sustainability education	4	Challenges, education for sustainable development (ESD): environmental and sustainability education, teacher education

4 (Yellow)	Building sustainability and systems thinking in geography and science education	4	Geography education, science, sustainability, systems thinking
5 (Purple)	Globalization and model building in ecological citizenship education	4	Citizenship, ecopedagogy, globalization, model
6 (Light blue)	Innovation in education policy	2	Innovation, policy

Source: author interpretation from VOSviewer

## 5. Discussion

### 5.1. Synthesis of key findings

(1) ESD has developed into an independent and well-established theoretical field, yet research on its application in art education remains very limited. The co-citation results show that core works form the knowledge foundation of ESD, but only rarely extend their analysis to art education.

(2) Art education occupies a peripheral position in the keyword network and has not formed an independent research cluster. Current research hotspots are concentrated on core ESD topics such as policy, values, action competence, environmental ethics, and systems thinking.

(3) Interdisciplinary integration is still restricted to possible associations and does not have a systematic theoretical basis. As an illustration, design education is found in the co-word network, but the strength of the relationship is not very strong (link strength = 4).

(4) The subject of teacher education and policy drivers has been referred to several times, indicating that scholars appreciate their importance in promoting interdisciplinary integration.

### 5.2. Theoretical insights

(1) This research is the first one to reflect a systematic gap in the research at the cross-site of ESD and art education. This gap in the research is evident in the mapping results.

(2) The study clarifies possible theoretical paths for further integrating ESD into art education. Although current cross-field research is limited, the literature shows that the philosophical foundations of ESD (such as ecological ethics and views of nature): critical pedagogy, action competence theory, and competence frameworks all offer potential support for future integration with art education.

(3) The study proposes a staged view of theoretical development described as “potential overlap–weak connection–yet to be developed.” Based on visual mapping, this study suggests that the integration of ESD into art education is currently at the first stage of this process. This stage-based view helps clarify the current state of theoretical development and provides a clear framework for positioning future research.

### 5.3. Practical contributions

(1) This research provides sufficient direction to the policy makers, the design of the curriculum, and art teachers by defining the knowledge structure, gaps in research, and potential areas of overlap to prevent blindly or patchy implementation.

(2) It also determines the main obstacles to the implementation of ESD in art education that can help to understand the way to improve it practically. The analysis of the keywords indicates inadequacy in teacher preparation, interdisciplinary instructional ability, a contrived non-policy environment, and inadequate

curriculum-related resources.

(3) It proposes themes and directions of practice that can guide future change in art education. In the context of sustainable development, education goes beyond simple knowledge transfer and increasingly focuses on developing students' critical thinking, creativity, and social engagement <sup>[72]</sup>.

(4) This research can offer evidence that may enable education administrators to ensure the policy-level investment and curriculum integration and collaboration across the field.

#### **5.4. Limitations**

The analysis is based on the WoS core collection. This has made the recent research and non-English research not fully captured. Nevertheless, WoS is generally admitted to be one of the most comprehensive and trusted sources of bibliographic information and can be efficiently used to guarantee the quality of the articles gathered as a whole <sup>[73]</sup>. Second, the threshold settings applied to conduct a scientific mapping analysis, which were also established by the authors and, thus, are somewhat subjective. Moreover, the bibliometric analysis is unable to substitute for in-depth textual analysis as done in systematic reviews.

#### **5.5. Future directions**

Although integrating ESD into art education offers many benefits, it also faces several challenges. These include limited resources, outdated curricula, insufficient teacher development, and unequal resource distribution <sup>[74,75]</sup>.

(1) Develop more theoretical studies on the relationship between ESD and art education, placing more focus on the non-Western situation and comparison across cultures. Europe and North America continue to control the current knowledge base, and further interdisciplinary studies in Asia, Africa, and Latin America are essential to finalize a range of educational and cultural environments.

(2) Use actual art classroom practice as the basis of conducting more empirical studies. Current studies have been leaning more towards theory and policy, but the stable classroom models, teaching experiments, and outcome evaluations of learning are fewer.

(3) Maintain Interdisciplinary curriculum development. This type of approach is capable of assisting in better comprehension of the complexity of the issue of sustainability <sup>[76]</sup>. The studies in art should be changed to incorporate the themes of sustainability and provide the means to student to investigate the issues of the environment by applying their artistic skills. This could include the project-based learning that will involve solving the challenges of sustainability in the locality, where students will participate in the work of the community as they learn their artistic talents <sup>[77]</sup>. Moreover, emerging technologies warrant further investigation in ESD-oriented art education.

(4) Enhance teacher training systems research, such as beliefs and professional identity development of teachers, alongside altering the nature of teaching practice over time. Teachers can be provided with the tools and skills applied in ESD-centered workshops to effectively introduce sustainability into the teaching practice <sup>[78]</sup>.

(5) The involvement of students in community activities with the help of art projects that support sustainable development can also add to the experience of the students. This not only enables students to use their skills in applications to actual real-world situations, but also encourages a feeling of responsibility and a concern about the environment <sup>[74]</sup>.

## 6. Conclusion

In this study, research on ESD is observed to have grown exponentially in the last twenty years, but has an extremely scanty relationship with art education, which has a conspicuous structural research gap. However, there are scholars who have started considering design education as a potential point of entry into implementing ESD. One of the results of the analysis is that the major concepts of ESD imply an inherent possibility of interdisciplinary introduction in a number of educational settings, which are transformative learning, action-oriented learning, citizenship development, and systems thinking. These theories and methods provide the potential avenues of incorporating ESD into art education.

All in all, creating a knowledge map assists scholars in discovering structural gaps in the existing research and offers constructs to direct upcoming research. The fusion of ESD and art education will tend to evolve in a more systematic manner in terms of theory, practice, and policy in the future.

## Disclosure statement

The authors declare no conflict of interest.

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