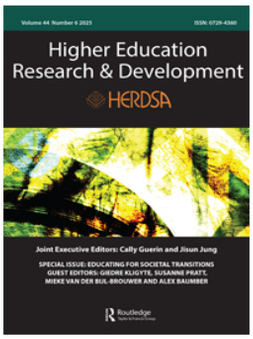

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Interdisciplinary collaboration for sustainability among students with different disciplinary backgrounds: a scoping review

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ABSTRACT

This paper offers a scoping review of the educational approaches adopted to cultivate interdisciplinary processes in higher education courses and modules concerned with sustainability among students with disciplinary backgrounds. Twenty-two empirical peer-reviewed studies published from 2018–2023 were included and synthesised in the study. The findings revealed a range of pedagogical models and categories of learning activities, learning outcomes and curricula approaches, supporting student-centred patterns. Assessment practices were less clear. The findings pave the way for emerging discussions around how to realise education for sustainable development in the future.

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Sustainability; sustainable development; learning design; educational design; interdisciplinarity; cross-disciplinarity; curriculum; alignment

Introduction

This paper starts from the fundamental premise that higher education should cultivate students' knowledge, skills, values and agency to work with issues related to sustainability (UNESCO, 2024) – i.e., sustainable living where 'everyone has access to decent work, quality health care and education', 'natural resource use avoids pollution and permanent losses to the environment' and 'public policy choices ensure that no one is left behind due to disadvantages or discrimination' as stated in the manifest for UN sustainable development goals (SDG) (United Nation, 2024). For this reason, the Education for Sustainable Development (ESD) for 2030 framework (UNESCO, 2024) is considered valuable for driving the development of courses within higher education concerned with sustainability and assuming its pivotal role as a primary contributor to sustainable development (Blake et al., 2013; Gual, 2019; Žalėnienė & Pereira, 2021). Among others, ESD stresses transforming learning environments towards 'collaboration, solidarity and inclusion for people of all genders and backgrounds' (priority action area 2 in UNESCO, 2020, p. 28), capacity building of educators to guide learners through transformation (priority action

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area 3) and empowerment and mobilisation of youth by recognising them as key contributors and actors in realising the SDGs (priority action area 4).

Addressing society's complex sustainability issues requires transformative learning environments, combining and integrating various disciplines, perspectives, and approaches. Consequently, mastering interdisciplinarity is gaining recognition and is crucial for realising sustainability (Grierson & Munro, 2018; Kishita et al., 2018). At the same time, sustainability and interdisciplinarity are considered complementary approaches, sharing similar learning outcomes such as integrating and synthesising knowledge and transversal skills such as communication and teamwork (Kishita et al., 2018; Mossman, 2018; SDSN, 2020).

Following this thinking, a pressing question is how to successfully integrate interdisciplinary processes in higher education courses and modules concerned with sustainability. Literature reviews have highlighted various challenges and a lack of knowledge regarding how we best educate for sustainability. Figueiró and Raufflet (2015) called for stronger integration of sustainability in core disciplines. Algurén (2021) demands learning activities with transformational potential, noting that participatory formats often involve interdisciplinary discussions but typically miss self-awareness and behavioural change. Mokski et al. (2023) indicate that ESD initiatives often fail across disciplinary boundaries, identifying stand-alone courses and integration into existing curricula as key approaches. They suggest a model combining both methods with interdisciplinary research. Mokski et al. emphasise reaching out to students from all disciplines, particularly those lacking exposure to sustainability in their curriculum, which ESD has yet to achieve. Horn et al. (2023) found limited studies on collaboration among students from diverse disciplines and non-academic partners. Their investigation revealed that students mainly engaged in execution, lacking involvement in preparing research questions and co-dissemination. The study also showed that interdisciplinary collaboration often depended on students' disciplinary representation rather than on training or focus on interdisciplinary integration.

Significant pedagogical investments are required to support students' interdisciplinary collaboration. Students generally lack the competencies to effectively work in cross-disciplinary teams (Ledford, 2015; MacLeod, 2018), and the lack of knowledge about how to learn best to think and collaborate across disciplinary boundaries is constraining (Fiore et al., 2019; Webber, 2013). In the end, collaborating across disciplines is challenging, and better insight into the development of pedagogy for interdisciplinary collaboration skills is needed (Falcus et al., 2019; Lindvig & Ulriksen, 2019; Markauskaite et al., 2020).

Thus, the question remains of how interdisciplinary collaboration can be practised in ESD in higher education for disciplinary students. Through a scoping review, we aim to provide an accurate overview of current practices reported in the research literature to move forward in developing opportunities for transformative learning concerned with sustainability. While such courses and modules may (or may not) frame themselves as closely linked to sustainability development goals, they are involved in this agenda. In creating interdisciplinary learning opportunities, they offer valuable experiences of cultivating learning environments focused on developing collaboration between students of different backgrounds. Hence, the cases included can work to inform future research and sustainability initiatives in practice.

The following research question guides the scoping review: *In higher education courses and modules concerned with sustainability, how is interdisciplinary collaboration among*

students with different disciplinary backgrounds designed? The results lead to a discussion of themes around the question of how future initiatives in higher education may be designed to better realise the SDGs.

Method

The articles included in this study were identified within a large corpus of material (N = 80) identified in a scoping review of interdisciplinary learning initiatives in disciplinary higher education. Within the corpus of studies, 22 studies described sustainability and the SDGs as the objects of student collaboration. Aligning with the special issue, this paper focuses on this sub-group of studies. The following section briefly describes the searching, screening, and data extraction process adopted in the initial study, followed by an analysis of the studies concerned with sustainability.

Search and screening process

The initial study aimed to identify empirical research on interdisciplinary learning activities within specific academic programmes. Empirical studies were defined as research that provides data about students' experiences. A search and screening process was developed to locate relevant studies. Four databases were searched: Scopus, ProQuest (incorporating additional databases, such as ERIC), Web of Science, and PsycInfo. Table 1 displays the search string used for the study. The concept of interdisciplinarity emerged during the development of the search string. In education, interdisciplinary learning is considered a form of integrative learning where students synthesise knowledge across disciplinary boundaries (DeZure, 2010). It is complex and often contested, encompassing overlapping terms such as multidisciplinarity, interdisciplinarity, transdisciplinarity, and cross-disciplinarity (Pombo, 2023). These terms usually denote different forms and levels of integration; multidisciplinarity involves side-by-side knowledge from different fields, interdisciplinarity blends diverse perspectives, and transdisciplinarity transcends the disciplinary perspectives (Klein, 2017). Despite these widely accepted distinctions, the interpretation of the terms can vary, leading to ambiguity in their application (Pombo, 2023). This variability means different studies may use the same concept differently or different terms to describe the same idea. To overcome this concern, multiple terms associated with interdisciplinarity were included in the search string. The approach has been adopted in other reviews concerned with interdisciplinarity (Lindvig & Ulriksen, 2019; Oudenampsen et al., 2024).

Searching the databases Scopus, Proquest, Web of Science, and PsycInfo resulted in 6301 references, and after eliminating duplicates, 3515 remained. Subsequently, studies complying with the inclusion criteria were included (Table 2). We initially screened

Table 1. Search string.

Category	Terms
Focus	Interdisciplin* OR Multidisciplin* OR Disciplinarity OR 'Cross* discipline*' or transdisciplin*
Working format	Collaborat* OR team* OR group*
Participants	Student* OR learner* OR undergraduate* OR postgraduate* OR scholar*
Context	'Higher Education' OR HE OR 'Postsecondary Education' OR university* OR postgrad* OR tertiary OR undergrad* OR master* PR 'Post secondary Education' OR 'post grad*' OR 'under grad*'

Table 2. Inclusion and exclusion criteria.

		Inclusion	Exclusion
Pre-defined criteria for the original sample	Topic	Peer-reviewed journal articles containing empirical research on interdisciplinary learning activities	Conference papers, books, and sources not explicitly focusing on interdisciplinary learning activities (e.g., interdisciplinary research) Non-empirical research
	Context	Higher education Learning activities with students associated with different disciplinary education programmes	Not higher education Interdisciplinary educational programmes Interprofessional education (IPE)
	Date	2018–2023	Before 2018
	Location	International literature	Sources not written in English
Post-hoc criteria for selected sample	Focus area	Articles describing learning activities with sustainability as objects for student collaboration	Articles not focusing on sustainability

the title and abstract together to provide a shared understanding of the inclusion and exclusion criteria. Then, we individually screened the remaining articles, continuously comparing and negotiating their findings until only a few studies were considered relevant. Initially, we screened 512 studies based on their titles and abstracts, which led to 129 studies for full-text review. After completing a full-text review, we found 80 articles eligible for data extraction. We created a coding scheme to extract and analyse data from these studies, encompassing background characteristics, research methodology, interdisciplinary work, framework, course, and teaching descriptions. Through

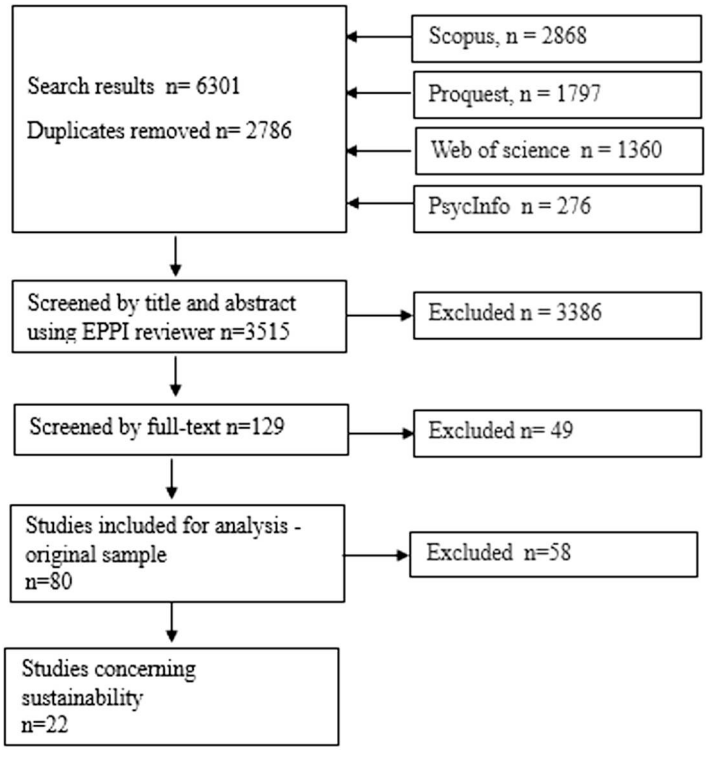

Figure 1. PRISMA flow.

this analysis, we identified 22 sustainability articles that form the study corpus for this review. See Figure 1 for PRISMA flow.

For screening and coding, we used EPPI reviewer software vs 6. developed by the EPPI-centre at the University College, London (EPPI-centre, 2024). Due to the many studies, we used text-mining technology integrated into EPPI, a prioritised screening feature based on machine learning. In an iterative process, the machine learns from the researchers which articles should be included or excluded. Based on the researchers' previous decisions about studies complying (or not) with the inclusion criteria, the machine continuously calculates relevance and sorts the data, ensuring that the most pertinent articles are present first. Therefore, this technology enables screening more studies in a shorter time (O'Mara-Eves et al., 2015). For additional reviews utilising machine learning with EPPI, see Bond et al. (2020) and Lillejord et al. (2018).

EPPI initially prioritised studies on Interprofessional Education (IPE) from health disciplines. We identified IPE as a highly specialised interdisciplinary learning opportunity

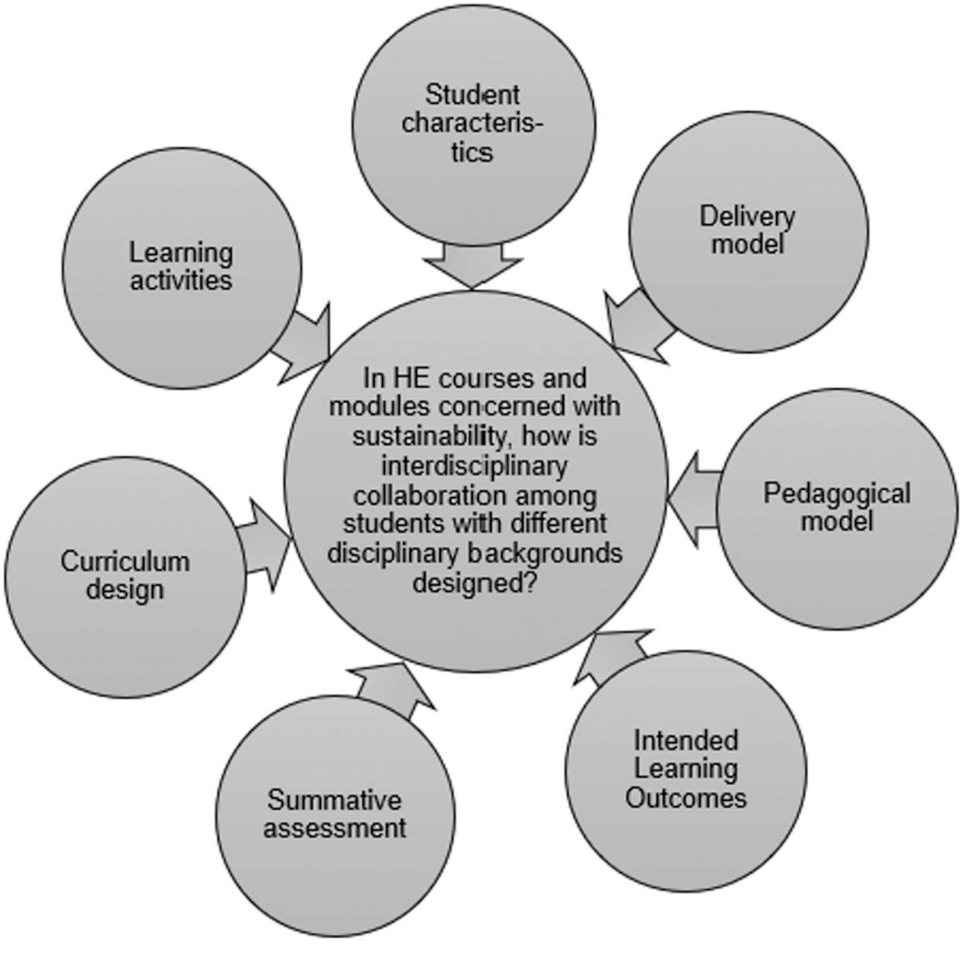

Figure 2. Conceptual categories for illuminating interdisciplinary collaboration among students with different disciplinary backgrounds.

and field less relevant to the research question (Mohammed et al., 2021). To ensure a broader range of disciplines and learning situations and avoid a missorted emphasis, we excluded these studies.

Data extraction and analysis process

Figure 2 depicts the conceptual categories that underpin the analysis of the 22 selected studies. In our examination of collaboration among students from various disciplines across these studies, we drew inspiration from the field of learning design. A learning design is a description of the learning opportunities of a learning course, often including intended learning objectives, content, activities, and roles. The description represents pedagogical choices for teaching and learning in a context using a shareable framework (Dalziel et al., 2016; Nørgård et al., 2019). We employed selective coding for components like student population, disciplines, and delivery model. For other components, we extracted data, allowing us to identify and formulate overarching themes.

Results

Study characteristics

Publication year

Figure 3 displays the distribution of publications over five years. The distribution of the 22 publications included in this study indicates a rising field of research. We observe a similar increase in publications for the overall corpus.

Geographical distribution

Table 3 illustrates the geographical distribution of the 22 included studies across continents compared to the overall sample. The majority of these studies originated from Europe. Compared to the overall corpus, European studies represent a larger percentage of the included studies concerning sustainability (+11%). Furthermore, studies from Asia

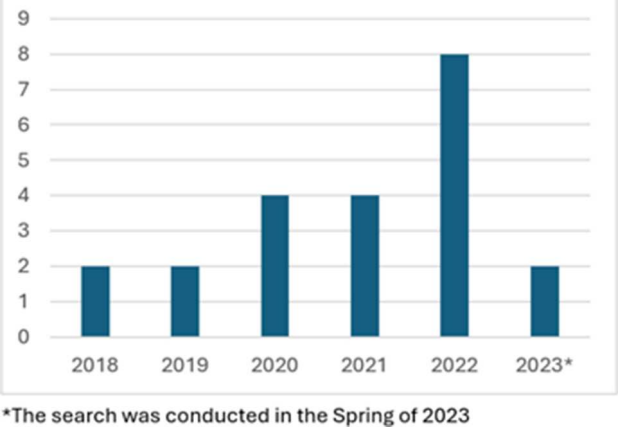

Figure 3. Publication year.

Table 3. Study characteristics.

		Sustainability studies (number of studies) *Percental difference from the original sample* n = 22 *N = 80*
Location	Europe	54% (12) + *11%*
	Asia	23% (5) + *4%*
	North America	17% (3) *−13%*
	Africa	9% (2) + *5%*
	Oceania	5% (1) *−3%*
	South America	5% (1) + *1%*

accounted for a larger percentage (+4%), while studies from North America represented a smaller percentage (−13%) of the sustainability studies relative to the overall corpus.

RQ: How is interdisciplinary collaboration among students with disciplinary backgrounds designed?

The following sections highlight educational approaches to interdisciplinary collaboration adopted in higher education as described in the included studies.

Student characteristics: population and disciplines

The 22 included studies primarily focused on graduate students, followed by undergraduates, while the overall corpus' student population mainly comprised undergraduates, followed by graduates (Table 4).

The student disciplines invited to collaborate in each study were mapped according to the categorisation offered by the UNESCO Institute for Statistics (2012) into Science, Technology, Engineering, and Mathematics (STEM), Social Science and Humanities (SSH), Health, and Teacher Education. As seen in Table 4, 41% (−3%) of the included studies only involved students from STEM programmes. The tendency is also evident in the overall corpus. 27% (+16%) of the included studies did not specify the students'

Table 4. Student characteristics.

		Sustainability studies (number of studies) *Percental difference from the original sample* n = 22 *N = 80*
Student population	Undergraduates	41% (9) - *29%*
	Graduates	73% (16) + *14%*
	Doctoral	14% (3) + *9%*
	Not specified	14% (3) + *9%*
Combination of disciplines	STEM	41% (9) *−3%*
	SSH	5% (1) *0%*
	SSH-STEM	9% (2) *−6%*
	STEM-Health	- (0) *−6%*
	STEM-Teacher	- (0) *−1%*
	SSH-Health	- (0) *−6%*
	SSH-Teacher	5% (1) + *4%*
	STEM-SSH-Health	5% (1) *−1%*
	STEM-SSH-Teacher	5% (1) + *4%*
	STEM-SSH-Health-Teacher	5% (1) + *1%*
	Not specified	27% (6) + *16%*

disciplinary background but reported that the students came from a broad spectrum of disciplines. Thus, interdisciplinary collaboration concerned with sustainability is mainly designed for graduate students within the STEM disciplines.

Delivery model

The coding of included studies reveals that interdisciplinary courses concerned with sustainability adopted various delivery formats, including onsite, online, and hybrid formats. Of these, 12 were conducted onsite, seven were hybrid, and three were fully online. In a few studies, online or hybrid formats were a response to the COVID-19 pandemic. Twelve studies involved institutional partnerships: seven at the national level and five at the international level.

Most studies described interdisciplinary collaboration in semester-long courses of eight to 14 weeks (e.g., Li et al. (2018), Moosavi and Bush (2021), and Oh (2019)) with only a few concerning interventions of shorter duration, such as 1–3 week summer courses (Hermann et al., 2022; Lekies & Moore, 2020), or a feedback session (Ostuzzi & Hoveskog, 2020). As highlighted, interdisciplinary collaboration benefits from semester-long courses delivered on campus; however, online options may be used to overcome geographical borders and cope with emergency situations.

Pedagogical model

Most authors characterised the interdisciplinary collaboration as part of a pedagogical model. The models applied included project-based learning (Braßler & Schultze, 2021; Braßler & Sprenger, 2021; Gladysz et al., 2020; Li et al., 2018), studio learning (Moosavi & Bush, 2021; Oh, 2019; Oonk et al., 2022), community service learning (Horn et al., 2022a; Horn et al., 2022b; Tijsma et al., 2023), problem-based learning (Hermann et al., 2022; Liu et al., 2022), and challenge-based learning (Huijben et al., 2022; Kasch et al., 2023).

Intended learning outcomes

Only ten of 22 studies explicitly described the intended learning outcomes of the learning activities. Most outcomes focused on cognitive skills and competencies, such as knowledge acquisition on the SDGs and urbanisation (Kasch et al., 2023; Li et al., 2018), processes and approaches such as problem-solving (Roy et al., 2020; Tijsma et al., 2023), knowledge integration (Tijsma et al., 2023), or interdisciplinary research (Horn et al., 2022a; Horn et al., 2022b). More of the outcomes related to the social interactions among the students or between students or external partners, for instance, communication skills (Hermann et al., 2022; Roy et al., 2020; Tijsma et al., 2023) and forming collaborative partnerships across disciplines (Roy et al., 2020).

Summative assessment

Further, we examined the assessment practice adopted for evaluating students' achievement of the intended learning outcomes. Out of 22 studies reviewed, only five described using summative assessment, and, among these, only one reported the assessment results. The summative assessment used across studies combined individual and group assessments, mainly in a written format. Examples of summative formats were group assessments based on product/project (Braßler & Schultze, 2021; Gladysz et al., 2020),

individual written exams or assignments (Lekies & Moore, 2020; Tamura et al., 2018), and a combination of presentations, progress reports and reports (Oh, 2019).

Curriculum design

Our analysis of the curriculum revealed three categories of sustainability curriculum: (1) Sustainability as improving disciplinary collaboration, (2) sustainability as integrated products that tackle problems and (3) sustainability as empowerment (see Table 5). Category 2, designing a curriculum as a series of themes for students to become familiar with to tackle societal problems, was most prevalent.

Additionally, two categories of authorship were identified: student authorship and teacher authorship. Student authorship implies that students are positioned as mediators of disciplinary knowledge and decision-makers of relevant expertise. Examples of student authorship include student teams taking responsibility for integrating knowledge from various participating disciplines (Braßler & Sprenger, 2021), students making decisions and performing tasks to refine the scope of their projects (Li et al., 2018), and students being encouraged to co-create curriculum and seek expertise outside their groups (Huijben et al., 2022). A sub-category focuses on students being responsible for identifying and integrating knowledge from external stakeholders. One example is when students meet with professionals and practitioners to enhance their understanding of a specific topic and better grasp community needs (Lekies & Moore, 2020). Another example is

Table 5. Curriculum categories.

Category	Description	Examples
Sustainability as improving disciplinary collaboration (N = 10)	Based on the premise that working with sustainability requires knowledge, skills, and competencies of different disciplines, knowledge of interdisciplinary collaboration and processes is positioned as pivotal.	• Learning materials about interdisciplinarity (Horn et al., 2022b). • Journal club in which students from different disciplines share disciplinary work (Horn et al., 2022a). • Course content focusing on interdisciplinary collaboration (Kasch et al., 2023). • Facilitation of collaboration between stakeholders (van den Berg & Verster, 2022).
Sustainability as integrated products that tackle problems (N = 17)	Curricula are presented as a series of environmental, social and economic sustainability-related themes. These emerged as a fixed catalogue of topics for students to become familiar with.	• The curriculum addressed lifestyle, sustainability, thermodynamics and sustainable consumption (Braßler & Sprenger, 2021). • Knowledge areas included sea level rise, drainage issues and landfill areas (Moosavi & Bush, 2021). • Business Model Innovation (BMI) for sustainability focused on integrating economic, social, and environmental factors (Ostuzzi & Hoveskog, 2020).
Sustainability as empowerment (N = 5)	The curriculum is approached as a 'pedagogical vehicle' (Barnett, 2009) and a 'negotiated artefact' (Annala et al., 2016, *p.* 178) for student influence on knowledge identification and creation. Students' interests and development define the curriculum.	• Students participated in integrating disciplines and establishing a new academic field (Tamura et al., 2018). • Students adopted a proactive role and selectively acquired and created knowledge (Li et al., 2018). • Students were positioned as agentive participants and learning as knowledge creation (Vartiainen et al., 2022).

students participating in community service, such as working directly with impacted populations, to gain knowledge that enables them to develop projects addressing specific needs (Li et al., 2018).

In teacher authorship, teachers identify relevant and valid knowledge for the students to encounter during a course and learning intervention. Mostly teacher-authored curricula appeared to be co-developed by teachers from different disciplines or sustainability topics, either by including lectures from different fields to make curriculum choices on what topics to highlight (Braßler & Schultze, 2021) or by an interdisciplinary teaching team developing the course and the curriculum (Kasch et al., 2023; Roy et al., 2020).

Learning activities

Finally, studies were reviewed to identify the learning activities cultivating interdisciplinary collaboration. We identified five student activities reported by more than half of the included studies (Table 6): 1. collaborating in teams, 2. reflecting, 3. presenting, 4. engaging with the context, and 5. giving and receiving feedback.

The main activity in sustainability studies was collaboration; students worked in groups on shared tasks. Following collaborative learning models, most studies involved group projects on sustainability issues, ranging from simple to complex. A few studies combined individual and group tasks.

Reflection activities were a formalised part of the learning interventions in more than half of the studies. These activities included oral reflection sessions, written reflection (individual or group), and journaling. The reflection objects varied and involved examples of different perspectives or disciplinary positions, the outcome of discussions, collaboration and group dynamics, and the learning experience and outcomes.

Presenting was the third most common activity among the included studies. More than half of the studies reported that students should present their work in various auditions (including co-students, teachers, external partners, or the public) and multiple formats (for instance, oral presentations, exhibitions/events, or poster sessions/pin-ups).

Engaging with the context was the fourth most common activity in the learning interventions reported by the included studies. The students participated in, for instance, site visits (Hermann et al., 2022; Moosavi & Bush, 2021), fieldwork (Lekies & Moore, 2020), and different types of engagement with external partners. External partners included industry, local community, non-governmental organisations, and local government. The external partners primarily served as experts bringing practice-oriented perspectives, for instance, in open discussions or panel debates (Huijben et al., 2022; Lekies & Moore, 2020; Moosavi & Bush, 2021), or participating in stakeholder/community interviews

Table 6. Top five learning activities in studies concerning sustainability.

Sustainability studies (n = 22)	STEM studies[a] (n = 9)	Others[b] (n = 13)
Collaborating	Collaborating	Collaborating
Reflecting	Designing	Reflecting
Presenting	Engaging with the context	Discussing*
Engaging with the context	Presenting	Gaining knowledge*
Giving and receiving feedback	Giving and receiving feedback	Giving and receiving feedback **
		Presenting**

[a]Including studies only involving STEM students, [b]excluding studies only involving STEM students
*,** same amount of studies

(Roy et al., 2020; Tijsma et al., 2023). In some cases, students worked with problems or problem domains adapted or presented by companies and industries (Gladysz et al., 2020; Vartiainen et al., 2022).

Last, giving and receiving feedback was a central activity in half of the included studies. Feedback varied in terms of format and addressers. In most of the studies, the feedback was formative feedback from instructors or teachers (Liu et al., 2022; Oh, 2019). More studies also involved feedback from peers (Hermann et al., 2022; Ostuzzi & Hoveskog, 2020; van den Berg & Verster, 2022) and external practitioners (Moosavi & Bush, 2021; Vartiainen et al., 2022; Verster & van den Berg, 2022).

The combination of discipline appears to influence the learning activities adopted. Zooming in on learning activities distinguishing STEM studies from others (Table 6), STEM studies tend to adopt product-oriented activities, transitioning from societal needs to concrete solutions. Conversely, the activities of the other studies strongly emphasise enhancing students' knowledge and understanding of self-reflection.

Discussion

One auspicious approach to sustainability education is represented in the attempts to cultivate interdisciplinary learning opportunities among students from different disciplinary backgrounds. Thus, the scoping review aimed to confine the educational approaches adopted in higher education initiatives concerned with sustainability. So, what insights can this scoping review provide for the future development of sustainability courses in higher education?

Regarding forming educational approaches for sustainability, the approaches identified in the included studies elicit that student-centred strategies (Klemenčič, 2019) are generally used to facilitate interdisciplinary collaboration on sustainability among students from different disciplines. We identified five student-centred learning tasks supporting student work on sustainability: Collaborating in teams, reflecting, presenting, engaging with the context, and giving and receiving feedback. Differences in the choice of learning activities suggest that disciplinary background matters, which resonates with prior research (Parpala et al., 2010; Wichmann-Hansen & Nielsen, 2023). Specifically, interdisciplinary collaboration among STEM students tends to support a product focus. In contrast, collaborative processes involving disciplines beyond STEM tend to increase the focus on developing students' knowledge and self-reflection. The direction of learning activities aligns with the explicit learning outcomes identified, ranging from developing students' cognitive knowledge to social interaction skills. We also identified limited use of explicit learning goals. The limited use resonates with the findings in another review study of interdisciplinary higher education (Oudenampsen et al., 2024). Further, a literature review by Menon and Suresh (2020) suggests that educational approaches to sustainability often involve pedagogical tools that instigate emancipatory learning focused on the learning process, not the learning outcome. Integrating several lower-stake assessment activities rather than one high-stake assessment at the end is consistent with a student-centred approach (Klemenčič, 2019).

Supporting notions of student-centred learning strategies, our analysis also reveals how underpinning ideals of student-centred learning of student empowerment (Klemenčič, 2019) extend to curriculum formation. In particular, having students make

choices about selection, sequencing, pace and evaluation (Bernstein, 2004) may be viewed as opening up to refiguring curriculum as a 'collectively attested set of understandings' (Barnett, 2009, p. 432) identified as relevant for students to encounter in a course or a learning task to form an understanding (whether theoretical or practical) of the course topic and focus. One might justifiably add that the variations identified in the understanding of curriculum resonate with prior studies of curriculum in higher education (Annala et al., 2016). All told, the findings illustrate how educational approaches to interdisciplinary collaboration in higher education centre on student learning as participation rather than acts of acquiring something (knowledge, concepts, etc.), referencing Sfard's (2009) differentiation between learning as acquisition or participation. The findings resonate with Vygotsky's idea of learning progressing from the periphery of the practice to more fully participating within the context in which the practice occurs.

However, we should also critically consider the potential of the designs for interdisciplinary learning adopted in initiatives concerned with sustainability (Algurén, 2021). More specifically, we need to consider how learning environments foster 'collaboration, solidarity and inclusion for people of all genders and backgrounds' (UNESCO, 2020, p. 28) and focus on the empowerment and mobilisation of youth – by recognising them as key contributors and actors in realising the SDGs (priority action area 4). Student-centred approaches show promise in empowering learners through transformative experiences. However, few studies on summative assessment reveal that sustainability-focused courses are not thoroughly integrated or aligned with success criteria. Consequently, while interdisciplinary collaboration promotes student-centred and emancipatory learning, the lack of defined success criteria may undermine these goals by obstructing formal assessment.

Another concern emerging from this finding relates to the infrastructure supporting student-centred learning. Student-centred learning environments should be supported by an ecosystem constituted by institutional policy, rules and norms (Klemenčič, 2019). Without engaging with institutional infrastructure, learning designs for sustainability become less sustainable (Casanova & Price, 2018). Departing from these guiding principles, it is concerning that the ecosystems surrounding the synthesised interventions are mostly left undefined in the empirical studies. To further insights into designing for student learning in sustainability courses, research should explore the ecosystem for sustainability education.

Against the SDGs, we also find it important to emphasise that while the included studies cultivate collaboration among a wide range of programmes, most students included are graduate students from STEM disciplines at European higher education institutions, followed by Asia and North America. The narrow sample of students concurs with the findings of Mokski et al. (2023). The distribution of student populations and disciplines suggests that while diversity and equity are pervasive within ESD, practice deviates, illustrating a wide focus on students from STEM. Kalocsányiová et al. (2024) review sustainable literacy in non-STEM higher education, noting an unequal distribution among disciplines. They urge further research on whether some fields are prioritised and if systemic barriers hinder ESD initiative integration. The review highlights the need to examine participant involvement, practice variations across disciplines, and challenges in interdisciplinary sustainability efforts.

Finally, there is the need to consider the approaches to curriculum. We cannot conclude from our findings that a particular approach is associated with particular qualities or is more supportive of interdisciplinary collaboration. However, as Mintz and Tal (2014) identified, engaging with curriculum content focused on sustainability issues does not automatically lead to learning about sustainability or higher levels of sustainability awareness. As suggested by Barnett (2009), considerations of how a curriculum is constructed are required; if it is sufficiently demanding, offers contracting insights and perspectives, requires a continual presence and commitment and contains sufficient space on the part of the student for authenticity and integrity. The suggestions resonate with the proposal by Mintz and Tal (2018) for courses concerned with sustainability to consider the extent to which content includes several sustainability issues, interrelations between society, economics, and the environment processes, global and local needs, and expose learners to different ways of knowing and relating. The included studies lack such reflections.

Limitations

This study adopted a systematic scoping review approach. The review was constructed to capture empirical studies focusing on interdisciplinary learning initiatives integrated into disciplinary programmes in higher education. A selection of studies from the overall corpus of included literature was selected to explore studies on sustainability. Other reviews have adopted different approaches and criteria to capture research that explores sustainability in higher education. For example, Algurén (2021) conducted a search specifying the intervention through terms such as education for sustainable development, learning for sustainability and education and learning for sustainable development. Nevertheless, the characteristics related to the sustainability studies sample included in this study correspond with the findings from other reviews.

It is pertinent to mention that we did not conduct a quality assessment of the studies; thus, further evaluation of each study is required to explore the impact of the interventions conducted. Although efforts were made to identify assessment results, data was limited, resembling the findings in the review undertaken by Oudenampsen et al. (2024). Thus, future research could enrich our understanding of the field by conducting additional research and including indicators of effect other than the one chosen in this study.

Conclusion

This scoping review investigated what educational approaches have been utilised to equip university students to collaborate across disciplines on sustainability-related topics. These findings not only outline educational approaches supporting student-centred and potentially empowering learning but propose a challenging set of themes around how future initiatives in higher education may be designed to better realise the SDGs.

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