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**Sustainability literacy in non-STEM  
higher education programmes: results  
from a multilingual systematic scoping  
review**

**Report**

**June 2024**

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# Executive summary

**Background:** Higher education institutions play a crucial role in fostering sustainability literacy and nurturing pro-environmental behaviour and mindsets.

**Objective:** This report aims to consolidate existing literature on sustainability literacy in non-STEM higher education programmes within the European Higher Education Area (EHEA), focusing on publications since 2010.

**Method:** A multilingual systematic scoping review was conducted across several databases, including Scopus, Academic Search Premier, Education Research Complete, APA PsychInfo. Studies were also sought in country- and language-specific databases. Out of 6161 screened records, 92 articles met the inclusion criteria, which were reviewed concerning the scope and focus of existing research, the competencies and knowledge to be acquired, and the design and implementation of teaching and learning processes aimed at promoting sustainability literacy.

**Results:** There has been significant growth in research interest since 2017, with 75 studies published compared to 17 in the preceding seven years. The majority of studies were conducted in Spain and the United Kingdom, followed by Germany, Turkey, and Austria, covering a total of twenty-five countries within the EHEA region. The 92 reviewed studies involved 11,790 participants and assessed 9,992 university programmes and courses. Quantitative methods, especially content analysis of degree descriptors, were prevalent, followed by surveys and intervention/pilot studies. Qualitative methods, including descriptive case studies and interviews, made up 40% of the research, while 13% employed mixed methods. Most studies came from Economics, Business, and Administrative Studies (26%), followed by Education (23%) and interdisciplinary approaches (22%). Particular attention was given in the literature to the acquisition of sustainability knowledge and competencies (27%), curriculum assessment (23%), and barriers to sustainability integration (10%). Regarding the desired knowledge and competencies, the SDGs, awareness of global and local sustainability issues, critical thinking and system thinking emerged as the most prominent learning objectives. Various pedagogical methods were also identified in the reviewed literature to foster sustainability literacy, including case-based, project-based, and experiential learning, problem-based learning, collaborative learning, reflection groups, pedagogical dialogue, flipped classrooms, game-based learning, and service learning. Assessment methods also varied (e.g., pre-post intervention designs, one-off course questionnaires, rubrics and educator observations) with some authors proposing novel assessment tools.

**Discussion and conclusions:** This report highlights the need for further research in underrepresented EHEA regions and academic disciplines. We also call for new, robust methodologies to evaluate the effectiveness of various pedagogical approaches across all non-STEM disciplines.

## Resumen

**Contexto:** Las universidades desempeñan un papel crucial en la alfabetización en sostenibilidad y en la promoción de comportamientos y actitudes proambientales.

**Objetivo:** Este informe tiene como objetivo sintetizar la literatura sobre la alfabetización en sostenibilidad en programas de educación superior no STEM dentro del Espacio Europeo de Educación Superior (EEES) desde 2010-2023.

**Método:** Se realizó una revisión sistemática multilingüe utilizando las siguientes bases de datos: Scopus, Academic Search Premier, Education Research Complete y APA PsychInfo. También se buscaron estudios en bases de datos específicas de países e idiomas europeos. De las 6161 publicaciones revisadas, 92 artículos cumplieron con los criterios de inclusión, los cuales se sintetizan con respecto al alcance y enfoque de la investigación existente, las competencias y el conocimiento a adquirir, y el diseño y la implementación de procesos de enseñanza y aprendizaje.

**Resultados:** Ha habido un crecimiento significativo en el interés investigativo con 75 estudios publicados desde 2017 en comparación con 17 en los siete años anteriores. La mayoría de los estudios se realizaron en España y el Reino Unido, seguidos de Alemania, Turquía y Austria. Los 92 estudios revisados, que cubren un total de veinticinco países dentro de EEES, involucraron a 11,790 participantes y evaluaron 9,992 programas y cursos universitarios. Los métodos cuantitativos, especialmente el análisis curricular de la incorporación de conceptos/perspectiva de sostenibilidad en las titulaciones de enseñanza superior, fueron predominantes, seguidos de encuestas y estudios empíricos e intervenciones piloto. Los métodos cualitativos, incluyendo estudios de casos descriptivos y entrevistas, constituyeron el 40% de los estudios revisados, mientras que el 13% empleó métodos mixtos. La mayor parte de la investigación entre las materias no STEM se realizó en Economía, Negocios y Estudios Administrativos (26%), seguidos por Educación (23%) y enfoques interdisciplinarios (22%). La literatura se centró principalmente en la adquisición de conocimientos y competencias en sostenibilidad (27%), la evaluación del currículo (23%) y las barreras para la integración de la sostenibilidad en diferentes materias universitarias (10%). En cuanto a los conocimientos y competencias deseados, los Objetivos de Desarrollo Sostenible (ODS), problemas de sostenibilidad globales y locales, el pensamiento crítico y el pensamiento sistémico emergieron como principales objetivos de aprendizaje. También se identificaron varios métodos pedagógicos en la literatura revisada para fomentar la alfabetización en sostenibilidad, incluyendo aprendizaje basado en casos, proyectos y experiencias, aprendizaje basado en problemas, aprendizaje colaborativo, grupos de reflexión, diálogo pedagógico, aulas invertidas, aprendizaje basado en juegos y aprendizaje-servicio. Los métodos de evaluación también variaron (por ejemplo, aplicación de pre y post test, cuestionarios de curso, rúbricas y observaciones de educadores) con algunos autores proponiendo nuevas herramientas de evaluación.

**Discusión y conclusiones:** Se necesita realizar más investigaciones en regiones y disciplinas académicas subrepresentadas. Investigaciones futuras deberían centrarse también en el desarrollo de nuevos métodos de evaluación educativa en sostenibilidad a través de todas las materias no STEM.

## Zusammenfassung

**Hintergrund:** Hochschuleinrichtungen spielen eine entscheidende Rolle bei der Förderung der Nachhaltigkeitskompetenz und der Förderung umweltfreundlicher Verhaltensweisen und Denkweisen.

**Ziel:** Dieser Bericht zielt darauf ab, die bestehende Literatur zur Nachhaltigkeitskompetenz in nicht-STEM-Hochschulprogrammen im Europäischen Hochschulraum (EHR) zu konsolidieren und dabei den Schwerpunkt auf Veröffentlichungen seit 2010 zu legen.

**Methode:** Es wurde eine mehrsprachige systematische Scoping-Überprüfung in mehreren Datenbanken durchgeführt, darunter Scopus, Academic Search Premier, Education Research Complete und APA PsychInfo. Studien wurden auch in länder- und sprachspezifischen Datenbanken gesucht. Von den 6161 gescreenten Suchergebnissen erfüllten 92 Artikel die Einschlusskriterien und wurden hinsichtlich des Umfangs und Schwerpunkts der bestehenden Forschung, der zu erwerbenden Kompetenzen und Kenntnisse sowie des Designs und der Umsetzung von Lehr- und Lernprozessen zur Förderung der Nachhaltigkeitskompetenz überprüft.

**Ergebnisse:** Seit 2017 ist das Forschungsinteresse erheblich gewachsen, mit 75 veröffentlichten Studien im Vergleich zu 17 in den vorangegangenen sieben Jahren. Die meisten Studien wurden in Spanien und dem Vereinigten Königreich durchgeführt, gefolgt von Deutschland, der Türkei und Österreich, wobei insgesamt 25 Länder innerhalb des EHR abgedeckt wurden. Die 92 überprüften Studien umfassten 11.790 Teilnehmer und bewerteten 9.992 Hochschulprogramme und -kurse. Quantitative Methoden, insbesondere Inhaltsanalysen von Studiengangsbeschreibungen, waren vorherrschend, gefolgt von Umfragen und empirischen Interventions-/Pilotstudien. Qualitative Methoden, einschließlich beschreibender Fallstudien und Interviews, machten 40 % der Forschung aus, während 13 % gemischte Methoden verwendeten. Die meisten Studien stammten aus den Bereichen Wirtschaft, Betriebswirtschaft und Verwaltung (26 %), gefolgt von Pädagogik (23 %) und interdisziplinären Ansätzen (22 %). Besonderes Augenmerk wurde auf den Erwerb von Nachhaltigkeitswissen und -kompetenzen (27 %), die Lehrplanbewertung (23 %) und Hindernisse bei der Nachhaltigkeitsintegration (10 %) gelegt. In Bezug auf die gewünschten Kenntnisse und Kompetenzen erwiesen sich die SDGs, das Bewusstsein für globale und lokale Nachhaltigkeitsthemen, kritisches Denken und Systemdenken als die wichtigsten Lernziele. In der überprüften Literatur wurden auch verschiedene pädagogische Methoden zur Förderung der Nachhaltigkeitskompetenz identifiziert, darunter fallbasiertes, projektbasiertes und erfahrungsbasiertes Lernen, problembasiertes Lernen, kollaboratives Lernen, Reflexionsgruppen, pädagogischer Dialog, Flipped Classrooms, spielbasiertes Lernen und Service Learning. Auch die Bewertungsmethoden variierten (z. B. Prä-Postinterventionsdesign, einmalige Kursfragebögen, Rubriken und Beobachtungen von Pädagogen), wobei einige Autoren neuartige Bewertungsinstrumente vorschlugen.

**Diskussion und Schlussfolgerungen:** Dieser Bericht unterstreicht den Bedarf an weiterer Forschung in unterrepräsentierten EHR-Regionen und akademischen Disziplinen. Wir fordern außerdem neue, robuste Methoden zur Bewertung der Wirksamkeit verschiedener pädagogischer Ansätze in allen Nicht-MINT-Fächern.

## Résumé

**Contexte** : Les établissements d'enseignement supérieur jouent un rôle crucial dans la promotion de la culture de la durabilité et l'encouragement des comportements et mentalités pro-environnementaux.

**Objectif** : Ce rapport vise à consolider la littérature existante sur la culture de la durabilité dans les programmes d'enseignement supérieur non-STEM au sein de l'Espace Européen de l'Enseignement Supérieur (EEES) depuis 2010.

**Méthode** : Une revue systématique multilingue a été menée à travers plusieurs bases de données, dont Scopus, Academic Search Premier, Education Research Complete, et APA PsychInfo. Des études ont également été recherchées dans des bases de données spécifiques par pays et par langue. Parmi les 6161 publications examinées, 92 articles ont satisfait aux critères d'inclusion, lesquels ont été analysés en fonction de l'étendue et de l'orientation des recherches existantes, des compétences et connaissances à acquérir, et de la conception et la mise en œuvre des processus d'enseignement et d'apprentissage visant à promouvoir la culture de la durabilité.

**Résultats** : Il y a eu une croissance significative de l'intérêt pour la recherche depuis 2017, avec 75 études publiées comparativement à 17 au cours des sept années précédentes. La majorité des études ont été réalisées en Espagne et au Royaume-Uni, suivies par l'Allemagne, la Turquie et l'Autriche, couvrant un total de vingt-cinq pays au sein de l'EEES. Les 92 études examinées impliquaient 11 790 participants et évaluaient 9 992 programmes et cours universitaires. Les méthodes quantitatives, en particulier l'analyse du contenu des descriptions de diplômes, étaient prédominantes, suivies par les enquêtes et les études pilotes/interventions. Les méthodes qualitatives, y compris les études de cas descriptives et les entretiens, représentaient 40 % des recherches, tandis que 13 % employaient des méthodes mixtes. La plupart des études provenaient des domaines de l'Économie, des Affaires et des Études Administratives (26 %), suivies par l'Éducation (23 %) et les approches interdisciplinaires (22 %). L'attention particulière était portée sur l'acquisition des connaissances et des compétences en durabilité (27 %), l'évaluation des programmes (23 %), et les obstacles à l'intégration de la durabilité dans différentes matières universitaires (10 %).

Concernant les connaissances et compétences souhaitées, les Objectifs de Développement Durable (ODD), la sensibilisation aux problèmes de durabilité globaux et locaux, la pensée critique et la pensée systémique ont émergé comme principaux objectifs d'apprentissage. Diverses méthodes pédagogiques ont également été identifiées dans la littérature pour promouvoir la culture de la durabilité, y compris l'apprentissage basé sur des cas, des projets et des expériences, l'apprentissage par problèmes, l'apprentissage collaboratif, les groupes de réflexion, le dialogue pédagogique, les classes inversées, l'apprentissage par le jeu et l'apprentissage par le service. Les méthodes d'évaluation variaient également (par exemple, les conceptions pré-post intervention, les questionnaires de cours ponctuels, les rubriques et les observations des éducateurs), certains auteurs proposant de nouveaux outils d'évaluation.

**Discussion et conclusions** : Ce rapport souligne la nécessité de poursuivre les recherches dans les régions et disciplines académiques sous-représentées de l'EEES. Il est également nécessaire de développer de nouvelles méthodologies robustes pour évaluer l'efficacité des différentes approches pédagogiques dans toutes les disciplines non-STEM.



## Abstract

**Contesto:** Gli istituti di istruzione superiore svolgono un ruolo cruciale nel promuovere l'educazione alla sostenibilità e nel diffondere comportamenti pro-ambientali.

**Obiettivo:** Questo studio ha l'obiettivo di identificare e sintetizzare la letteratura esistente sull'educazione alla sostenibilità nei programmi di istruzione superiore non STEM all'interno dello Spazio Europeo dell'Istruzione Superiore (EHEA), focalizzandosi sulle pubblicazioni sviluppate a partire dal 2010.

**Metodo:** In questo studio è stata condotta una revisione sistematica multilingue su diverse banche dati, tra cui Scopus, Academic Search Premier, Education Research Complete e APA PsychInfo. Inoltre, sono stati esaminati studi in banche dati specifiche nei diversi paesi e nelle diverse lingue. Tra i 6.161 documenti esaminati, 92 articoli hanno soddisfatto i criteri di inclusione e sono stati esaminati in merito all'ambito e al focus delle ricerche esistenti, alle competenze e alle conoscenze da acquisire, e alla progettazione e implementazione dei processi di insegnamento e apprendimento volti a promuovere l'educazione alla sostenibilità.

**Risultati:** L'interesse per la ricerca in questo ambito è aumentato significativamente dal 2017, con 75 studi pubblicati rispetto a 17 nei sette anni precedenti. La maggior parte degli studi sono stati condotti in Spagna e nel Regno Unito, seguiti da Germania, Turchia e Austria, per un totale di venticinque paesi della regione EHEA. I 92 studi esaminati hanno coinvolto 11.790 partecipanti ed analizzato 9.992 programmi e corsi universitari. Le metodologie quantitative, in particolare l'analisi del contenuto dei diplomi, sono emerse come predominanti, seguite da sondaggi e studi empirici di intervento/pilota. Le metodologie qualitative, che comprendono i case studies descrittivi e le interviste, costituivano il 40% delle ricerche esaminate, mentre il 13% utilizzava metodi misti. La maggior parte degli studi proveniva da corsi economici, aziendali e amministrativi (26%), seguiti da istruzione (23%) e approcci interdisciplinari (22%). Particolare attenzione è stata riposta nell'acquisizione di conoscenze e competenze in materia di sostenibilità (27%), valutazione del curriculum (23%) e ostacoli all'integrazione della sostenibilità (10%). Per quanto riguarda le conoscenze e le competenze desiderate, gli obiettivi di sviluppo sostenibile, la consapevolezza delle questioni di sostenibilità globale e locale, il pensiero critico e sistemico sono emersi come gli obiettivi di apprendimento più importanti. Nella letteratura esaminata sono stati inoltre identificati vari metodi pedagogici per promuovere l'educazione alla sostenibilità, tra cui l'apprendimento basato su case studies, su progetti ed esperienza empirica, come anche l'apprendimento basato sui problemi, l'apprendimento collaborativo, i gruppi di riflessione, il dialogo pedagogico, la didattica capovolta, l'apprendimento basato sul gioco, ed il service learning. Anche i metodi di valutazione variavano (ad esempio, progetti pre-post intervento, questionari sui corsi, rubriche e osservazioni degli educatori) con alcuni autori che proponevano nuovi strumenti di valutazione.

**Discussione e conclusioni:** Questo rapporto evidenzia la necessità di ulteriori ricerche nelle regioni dell'EHEA e nelle discipline accademiche sottorappresentate. Inoltre si evince la necessità di metodologie nuove e robuste per valutare l'efficacia dei vari approcci pedagogici in tutte le discipline non STEM.

## Abstract

**Arka Plan:** Yükseköğretim kurumları sürdürülebilirlik okuryazarlığının ve çevre yanlısı davranış ve zihniyetlerin geliştirilmesinde önemli bir rol oynamaktadır.

**Amaç:** Bu rapor, Avrupa Yükseköğretim Alanı (EHEA) içindeki STEM dışı yükseköğretim programlarında sürdürülebilirlik okuryazarlığı üzerine mevcut literatürü sağlamlaştırmayı, 2010'dan bu yana yayınlanan çalışmalara odaklanarak amaçlamaktadır.

**Yöntem:** Scopus, Academic Search Premier, Education Research Complete, APA PsychInfo gibi çeşitli veritabanlarında çok dilli sistematik bir kapsam belirleme incelemesi yapılmıştır. Ülkeye ve dile özgü veritabanlarında da çalışmalar aranmıştır. İncelenen 6161 kayıttan, dahil edilme kriterlerini karşılayan 92 makale, mevcut araştırmaların kapsamı ve odak noktası, edinilecek yetkinlikler ve bilgiler ile sürdürülebilirlik okuryazarlığını teşvik etmeye yönelik öğretim ve öğrenme süreçlerinin tasarımı ve uygulanması açısından incelenmiştir.

**Sonuçlar:** 2017'den bu yana araştırma ilgisinde önemli bir artış olmuştur; önceki yedi yıla kıyasla 75 çalışma yayımlanmıştır. Çalışmaların çoğunluğu İspanya ve Birleşik Krallık'ta yapılmıştır, ardından Almanya, Türkiye ve Avusturya gelmektedir; toplamda EHEA bölgesindeki yirmi beş ülkeyi kapsamaktadır. İncelenen 92 çalışma, 11.790 katılımcıyı içermekte ve 9.992 üniversite programı ve dersini değerlendirmektedir. Özellikle diploma tanımlayıcılarının içerik analizi olmak üzere nicel yöntemler baskındı, bunu anketler ve ampirik müdahale/pilot çalışmalar takip etti. Tanımlayıcı vaka çalışmaları ve görüşmeler gibi nitel yöntemler, araştırmaların %40'ını oluştururken, %13'ü karma yöntemler kullanmıştır. Çalışmaların çoğu Ekonomi, İşletme ve İdari Bilimler (%26) alanında iken bunu Eğitim (%23) ve disiplinler arası yaklaşımlar (%22) izlemektedir. Sürdürülebilirlik bilgisi ve yeterliliklerinin edinilmesine (%27), müfredat değerlendirmesine (%23) ve sürdürülebilirlik entegrasyonunun önündeki engellere (%10) özel önem verilmiştir. İstenilen bilgi ve yetkinliklere ilişkin Sürdürülebilir Kalkınma Hedefleri, küresel ve yerel sürdürülebilirlik konularında farkındalık, eleştirel düşünme ve sistem düşüncesi önde gelen öğrenme hedefleri olarak ortaya çıkmaktadır. İncelenen literatürde sürdürülebilirlik okuryazarlığını teşvik etmek için vaka bazlı, proje bazlı ve deneysel öğrenme, problem bazlı öğrenme, işbirlikçi öğrenme, yansıma grupları, pedagojik diyalog, ters çevrilmiş sınıflar, oyun bazlı öğrenme ve hizmet öğrenimi dahil olmak üzere çeşitli pedagojik yöntemler de belirlenmiştir. Değerlendirme yöntemleri de değişiklik gösterirken (örneğin, müdahale öncesi ve sonrası tasarımlar, tek seferlik kurs anketleri, değerlendirme listeleri ve eğitimci gözlemleri) bazı yazarlar yeni değerlendirme araçları önermişlerdir.

**Tartışma ve sonuçlar:** Bu rapor, yeterince temsil edilmeyen EHEA bölgeleri ve akademik disiplinlerde sürdürülebilirlik üzerine daha fazla araştırma yapılması ihtiyacını vurgulamaktadır. Ayrıca bu rapor ile, STEM dışı tüm disiplinlerdeki çeşitli pedagojik yaklaşımların etkinliğini değerlendirmek için yeni ve sağlam metodolojilere çağrıda bulunuyoruz.

## Abstrakt

**Kontekst:** Instytucje szkolnictwa wyższego odgrywają kluczową rolę w rozwijaniu wiedzy na temat zrównoważonego rozwoju oraz kształtowaniu zachowań i postaw prośrodowiskowych.

**Cel:** Niniejszy raport ma na celu konsolidację istniejącej literatury na temat wiedzy o zrównoważonym rozwoju w programach szkolnictwa wyższego niezwiązanych z naukami ścisłymi (non-STEM) w ramach Europejskiego Obszaru Szkolnictwa Wyższego (EHEA), koncentrując się na publikacjach od 2010 roku.

**Metoda:** Przeprowadzono wielojęzyczny systematyczny przegląd scopingowy w różnych bazach danych, w tym Scopus, Academic Search Premier, Education Research Complete, APA PsychInfo. Przeprowadzono również wyszukiwanie w bazach danych specyficznych dla danego kraju i języka. Spośród 6161 przeszukanych wyników, 92 artykuły spełniały kryteria włączenia i zostały przeanalizowane pod kątem zakresu i tematyki istniejących badań, kompetencji i wiedzy do zdobycia oraz projektowania i wdrażania procesów nauczania i uczenia się mających na celu promowanie wiedzy o zrównoważonym rozwoju.

**Wyniki:** Od 2017 roku nastąpił znaczący wzrost zainteresowania badaniami; opublikowano 75 badań w porównaniu do 17 w poprzednich siedmiu latach. Większość badań przeprowadzono w Hiszpanii i Wielkiej Brytanii, następnie w Niemczech, Turcji i Austrii, obejmując łącznie dwadzieścia pięć krajów w regionie EHEA. Analizowane 92 badania obejmowały 11 790 uczestników i oceniały 9 992 programy i kursy uniwersyteckie. W większości analizowanych badań zastosowano metody ilościowe, przede wszystkim analizę treści opisów stopni, ale także ankiety i badania interwencyjne/pilotowe. Metody jakościowe, w tym opisowe studia przypadków i wywiady, stanowiły 40% badań, podczas gdy 13% stosowało metody mieszane. Większość analizowanych badań reprezentowała nauki ekonomiczne, biznesowe i administracyjne (26%), a także nauki pedagogiczne (23%) i podejścia interdyscyplinarne (22%). Szczególną uwagę poświęcono zdobywaniu wiedzy i kompetencji w zakresie zrównoważonego rozwoju (27%), ocenie programu nauczania (23%) oraz barierom w integracji zrównoważonego rozwoju (10%). Jeśli chodzi o pożądaną wiedzę i kompetencje, najważniejszymi celami nauczania okazały się cele zrównoważonego rozwoju, świadomość globalnych i lokalnych kwestii zrównoważonego rozwoju, krytyczne myślenie i myślenie systemowe. W analizowanej literaturze wskazano także różne metody pedagogiczne mające na celu wspieranie umiejętności związanych ze zrównoważonym rozwojem, w tym uczenie się oparte na przypadkach, projektach i przez doświadczenie, uczenie się oparte na rozwiązywaniu problemów, uczenie się we współpracy, grupy refleksji, dialog pedagogiczny, odwrócone lekcje, uczenie się oparte na grach, i naukę usług. Metody oceny również były zróżnicowane (np. projekty interwencji przed i po, kwestionariusze jednorazowe podczas kursu, rubryki i obserwacje nauczycieli), a niektórzy autorzy proponowali nowatorskie narzędzia oceny.

**Dyskusja i wnioski:** W niniejszym raporcie podkreślono potrzebę dalszych badań w niedostatecznie reprezentowanych regionach EOSW i dyscyplinach akademickich. Wzywamy również do opracowania nowych, solidnych metodologii oceny skuteczności różnych podejść pedagogicznych we wszystkich dyscyplinach innych niż STEM.

# Introduction

Sustainability literacy, as defined by the United Nations, includes the knowledge, competencies, and mindsets that help compel an individual to become deeply committed to building a sustainable future and allow him or her to make informed and effective decisions to this end (United Nations, 2020). Higher education institutions are often seen as a place for disseminating this knowledge, as well as more broadly, for nurturing a strong pro-environmental mindset and behaviour (Buckler & Creech, 2014; UNESCO, 1997). While progress in Science, Technology, Engineering, and Mathematics (STEM) education programmes is considered a key priority for successfully meeting the majority of sustainable development goals (SDGs), it is increasingly recognised that students from all disciplinary backgrounds and interests can benefit from a comprehensive education for sustainable development (ESD) to bring about societal transformation. However, the integration of ESD into formal higher education (HE) systems varies widely and poses significant challenges. A detailed history of the initiatives taken in HE contexts to foster sustainable development is available in Lozano et al. (2013, 2015).

The purpose of this report is to consolidate the existing body of literature on sustainability literacy, with particular focus on HE programmes outside the STEM fields. These include disciplines such as humanities, social sciences, political science, economics and finance, and law. Sustainability in STEM education has already been covered by several systematic reviews, including reviews focused on higher education contexts (Acosta Castellanos et al., 2021; Thürer et al., 2018). At the same time, the literature on how to undertake education for sustainable development and foster sustainability literacy more widely in and through non-STEM disciplines is fragmented and under-reported. In this review we focus on post-2010 publications from the European Higher Education Area (EHEA). The 2010 publication cutoff date is meant to ensure that we cover the most relevant and up-to-date studies which adhere to current research standards. Likewise, the review is principally intended for institutions, academics, and other higher education stakeholders in the United Kingdom and other European countries where the review team is employed and conducts their research (e.g., Germany, Luxembourg, Italy, and Turkey). Hence the emphasis on the EHEA region. Furthermore, narrowing the focus to the EHEA, which has its own set of policies, goals, and guidelines for higher education, also allows for generating insights and recommendations that are contextually relevant.

The questions guiding the review have been formulated using the SPICE framework<sup>1</sup> with input from sustainability champions working at a UK-based university:

RQ1: What is the extent and focus of existing research about integrating sustainability and sustainable development into non-STEM programme curricula?

RQ2: What are the competencies and knowledge to be acquired?

RQ3: How are teaching and learning processes designed and implemented to foster sustainability literacy?

## Method

We conducted a multilingual systematic scoping review. Systematic scoping reviews serve to chart the main sources and types of evidence pertaining to a specific subject area and they typically encompass an extensive search and study identification strategy (Arksey & O'Malley, 2005). Unlike systematic reviews, however, which tackle focussed questions drawing from a relatively narrow selection of quality-assessed studies, systematic scoping reviews address broad questions, considering a wide array of studies using diverse methods and approaches. A novel aspect of this review is also its multilingual search and study identification strategy, which is meant to counteract the geographical bias typically associated with research originating from English-speaking countries and higher education contexts. This bias often results from an (over)reliance on English-only search terms even where no language restrictions are applied. To guide the search and reporting, we employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Page et al., 2021).

### Search strategy

The searches and screening were conducted in English, Spanish, French, German, Italian, Turkish, Norwegian, Swedish, and Polish. We searched several electronic databases and collections from 1 January 2010 to 30 June 2023, including Scopus, Academic Search Premier, Education Research Complete, APA PsychInfo, CINAHL, Teacher Reference Center, Humanities International Complete, Psychology and Behavioral Sciences Collection. Studies were also sought in country- and language-specific databases such as Dialnet, ÍndICES, REDalyc, SUDOC, MOSA, Cairn.info, Persee.fr, and BASE to mention but a few. We also conducted searches on Google Scholar using translated versions of the search terms provided in Table 1.

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<sup>1</sup> **S**etting – universities and other higher education institutions; **P**erspective – higher education students and staff; **I**nterest/Intervention – curricular activities aimed at the development/assessment of sustainability literacy in non-STEM education fields; **C**omparator – none; **E**valuation – success of the pedagogical activity (approach) in terms of mindset, competency and knowledge acquisition or engagement.

Table 1. Search strategy used in Scopus

| Search within      | Search terms  |
|--------------------|---|
| ABS-TITLE-KEYWORDS | Sustainability OR “sustainable development” OR “education for sustainable development” OR ESD OR “climate education” OR “climate change education” OR “sustainable development goals” OR “SDG” OR “sustainability integration” OR “sustainability literacy” |
| <b>AND</b>         |   |
| ABS-TITLE-KEYWORDS | university OR “higher education” OR HE OR graduate OR undergraduate OR postgraduate OR bachelor OR master OR PhD OR doctoral  |
| <b>AND</b>         |   |
| ABS-TITLE-KEYWORDS | education OR law OR “legal studies” OR “social science” OR “social studies” OR economics OR finance OR business OR language OR linguistics OR communication OR literature OR history* OR philosoph* OR “creative arts” OR arts OR design                    |
| <b>AND NOT</b>     |   |
| ABS-TITLE-KEYWORDS | Engineer* OR technolog* OR agriculture OR medicine OR sciences OR architecture  |
| LIMITS:            | <ul style="list-style-type: none"> <li>○ Years: 2010 onwards</li> <li>○ Document type: articles</li> <li>○ Country/territory: EHEA countries and undefined</li> <li>○ Source type: journal</li> <li>○ Languages: any</li> </ul>                             |

The search terms and syntax - which combine core concepts related to sustainability literacy, higher education, and non-STEM fields – were developed in English and subsequently refined through a series of preliminary searches. Table 1 provides an overview of the search strategy used in Scopus; the search terms in the other languages are available upon request. The list of academic subjects was compiled based on the definition of STEM and non-STEM fields adopted by the UK Parliament’s Science and Technology Committee (2012). Where possible, search results were limited to the publication start year (2010 onwards) and document and source type (journal articles) and filtered by research location (EHEA countries and undefined). In databases lacking advanced search options, a combination of simplified search terms was used with the results ranked by relevance. No language restrictions were applied at any point to maintain the inclusive character of the review. After removing duplicates (n = 321), 6161 records were retained for screening and eligibility assessment.

#### Eligibility criteria and study selection

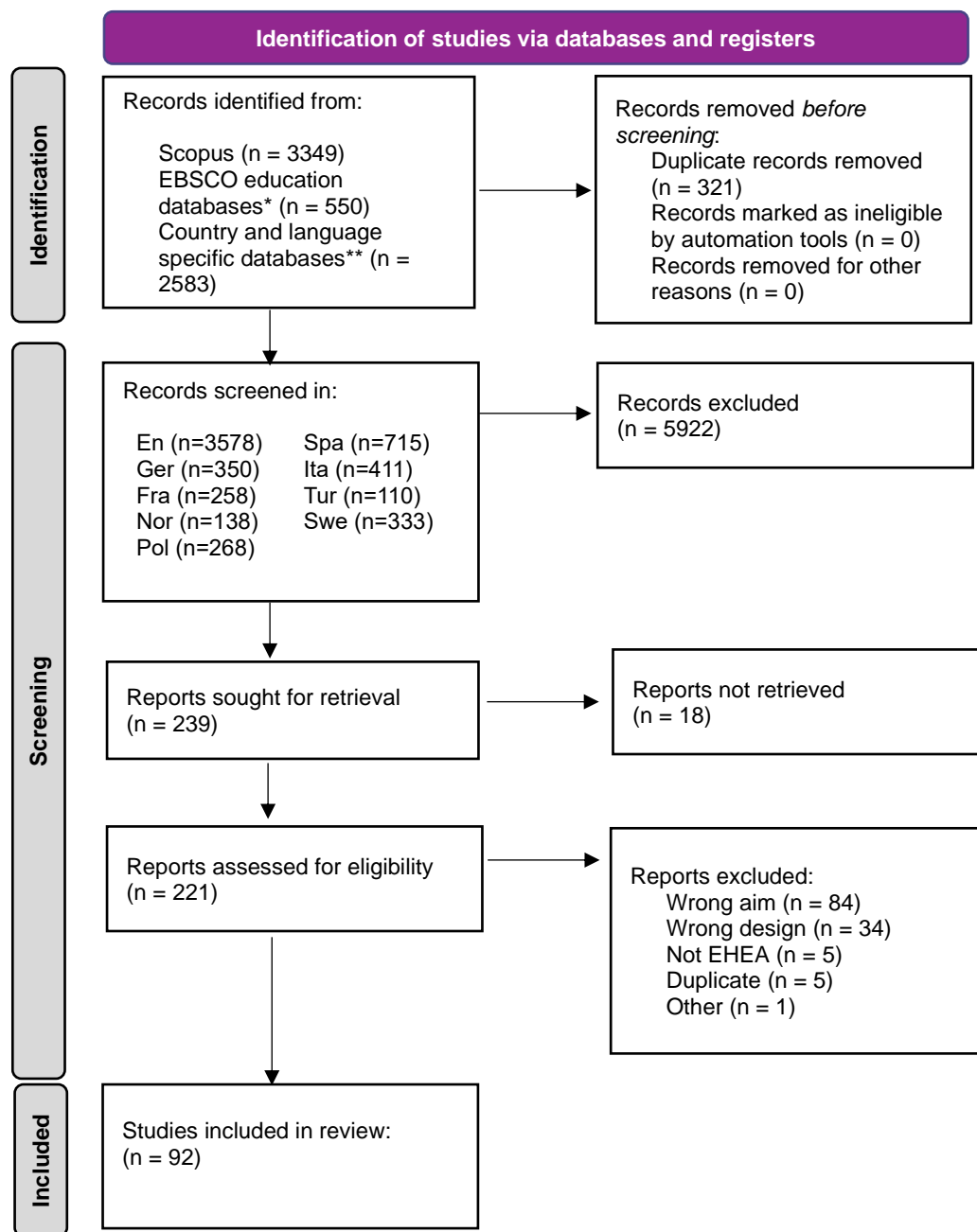
Study selection was undertaken in two phases. For the first level of screening, the team assessed the titles and abstracts against the eligibility criteria summarised in Table 2. A first screen of English records (n = 3578) was carried out in duplicate using Rayyan QCRI (Ouzzani et al., 2016), a web-based reference manager platform for collaborative literature reviews. There was a high level of agreement (> 95%) between the assessors. Disagreements and any records for which eligibility could not be determined based on the abstract were moved onto the next stage of the review process. For records published in languages other than English (n = 2583), conducting duplicate screening was not feasible. Nevertheless, whenever possible, the lead author reviewed a random selection of papers to ensure accuracy.

Table 2. Eligibility criteria

|                   | Include  | Exclude  |
|-------------------|--|--|
| SETTING           | University-level programmes (Bachelor, Master, doctorate)  | Further education, foundation programmes, primary education, secondary education, lifelong learning  |
|                   | Social Studies, Law, Economics<br>Business and Administrative Studies, Mass Communication and Documentation, Linguistics, Classics and Related Subjects, Languages, Literature and related subjects, Historical and Philosophical Studies, Creative Arts and Design, Education       | STEM subjects<br><br>Studies focussed on country- and university-level initiatives without extractable data on sustainability integration into non-STEM subjects   |
|                   | Studies conducted within the European Higher Education Area:<br><a href="https://ehea.info/page-full_members">https://ehea.info/page-full_members</a>  | Studies contacted outside of the European Higher Education Area  |
| INTEREST          | Bachelor, Master or doctoral -level course activities aimed at the development and/or assessment of sustainability knowledge and literacy (including awareness raising/mindset)  | <ul style="list-style-type: none"> <li>• Extra-curricular activities run in higher education contexts</li> <li>• Course activities without a sustainability component</li> </ul>   |
| EVALUATION /FOCUS | <ul style="list-style-type: none"> <li>• Knowledge acquisition</li> <li>• Development of sustainability competencies and/or mindset</li> <li>• Pedagogy – teaching &amp; learning processes, including methodological proposals</li> <li>• Assessment processes and tools</li> </ul> | <ul style="list-style-type: none"> <li>• Studies about the general role of sustainability in higher education</li> <li>• Sustainable campuses</li> <li>• Studies assessing higher education staff's knowledge or attitudes towards sustainability issues</li> <li>• Studies assessing the public's attitudes and/or universities impact on sustainability in the wider community (incl. where university students are recruited as a sample for gauging public opinion)</li> </ul> |
| RESEARCH DESIGN   | Empirical research (qualitative, quantitative or mixed method; including case studies and action research)   | <ul style="list-style-type: none"> <li>• Articles that do not report empirical research, such as: <ul style="list-style-type: none"> <li>- Theoretical-, conceptual or argument papers about the role/importance of sustainability</li> <li>- Calls to action</li> <li>- Editorials</li> <li>- Literature reviews</li> <li>- Commentaries</li> </ul> </li> </ul>   |
| PUBLICATION       | Peer reviewed journal articles   | Books, doctoral theses, grey literature  |
|                   | Peer reviewed book chapters in edited collections  | Book chapters that have not undergone peer review  |
| TIMEFRAME         | 2010 onwards   | Publications prior to 2010   |

In the subsequent phase, full text articles (n = 239) were assessed for eligibility. Where full text was not available, we reached out to the corresponding authors. If a response was not received after a one-month waiting period, the study was excluded (n = 18). Figure 1 presents a summary of the study selection process, including the reasons for exclusion after full-text assessment.

Figure 1. Prisma diagram: Identification and selection of studies



\* Academic Search Premier, Education Research Complete, APA PsychInfo, CINAHL, Teacher Reference Center, Humanities International Complete, Psychology and Behavioral Sciences Collection

\*\* Dialnet, ÍnDICES, REalyc, SUDOC, MOSA, Cairn.info, Persee.fr, BASE, eDoc Server, ORIA, DIVA, Swepub, RCIN, CeON REspository, and InfoNa. Searches with translated keywords have also been run on Scopus, Google Scholar, EBSCO, and university libraries across the EHEA region.



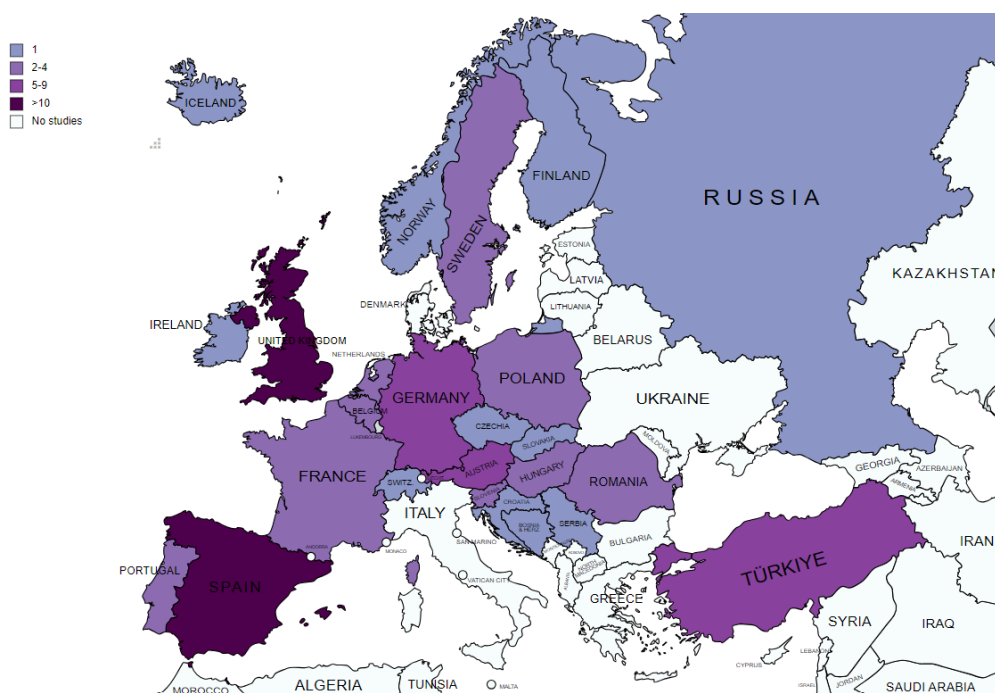
The included studies (n = 92) were split among the review team for data extraction according to the contributors' expertise and the language of publication. The data extraction sheet was developed, pilot tested on twenty-five randomly selected articles and then refined. The following data were extracted for each publication: country of study, language of publication, non-STEM field, study design and methods, participant details, pedagogical approach, and focus of the study. The extracted information was first analysed using descriptive statistics with data represented in visual graphs to depict prevailing trends. Next a narrative synthesis was undertaken to synthesise the findings across studies, identifying common themes, patterns, and discrepancies.

## Results

### Descriptive results: extent and focus of existing research

Our database searches yielded 6161 records after removal of duplicates, of which 92 articles met the inclusion criteria. The majority of studies discussed in these articles were carried out in Spain and the United Kingdom, followed by Germany, Turkey and Austria. Studies from a total of twenty-five countries have been identified, providing comprehensive geographical coverage across various regions within the EHEA area. Figure 2 shows the **geographical distribution** of studies in more detail. Twenty-four articles were published in languages other than English.

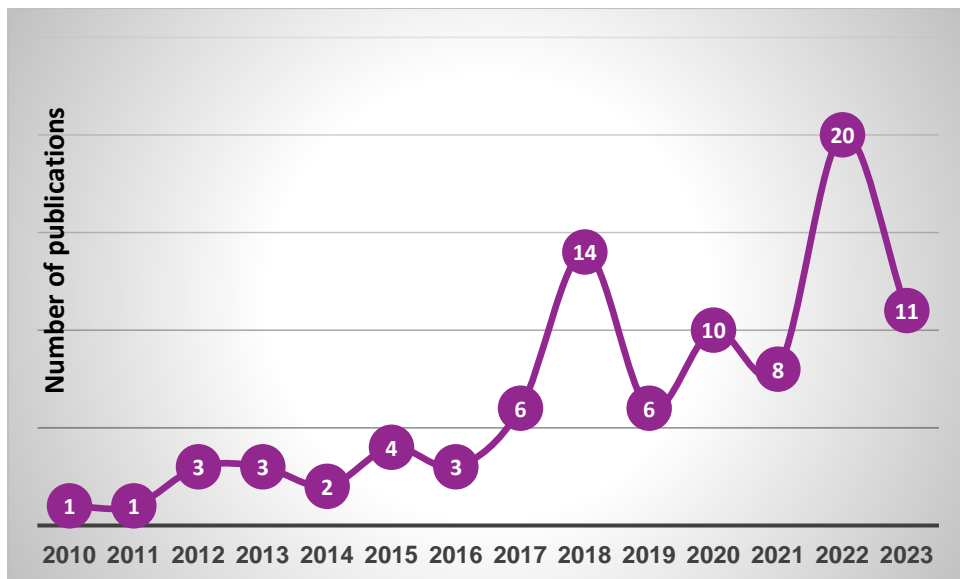
Figure 2<sup>2</sup>. Geographical distribution of studies by EHEA countries



<sup>2</sup> Created with [www.mapchart.net](http://www.mapchart.net)

The **number of studies published per year** (see Figure 3) suggests a substantive growth of research interest in sustainability and sustainable development in non-STEM programme curricula over the past years: a total of 75 studies have been published since 2017, in contrast to the seventeen articles released during the preceding seven-year cycle from 2010 to 2016. The rate of new publications moderately decreased during the Covid-19 pandemic, likely reflecting the disruption in academic and research activities experienced in the field.

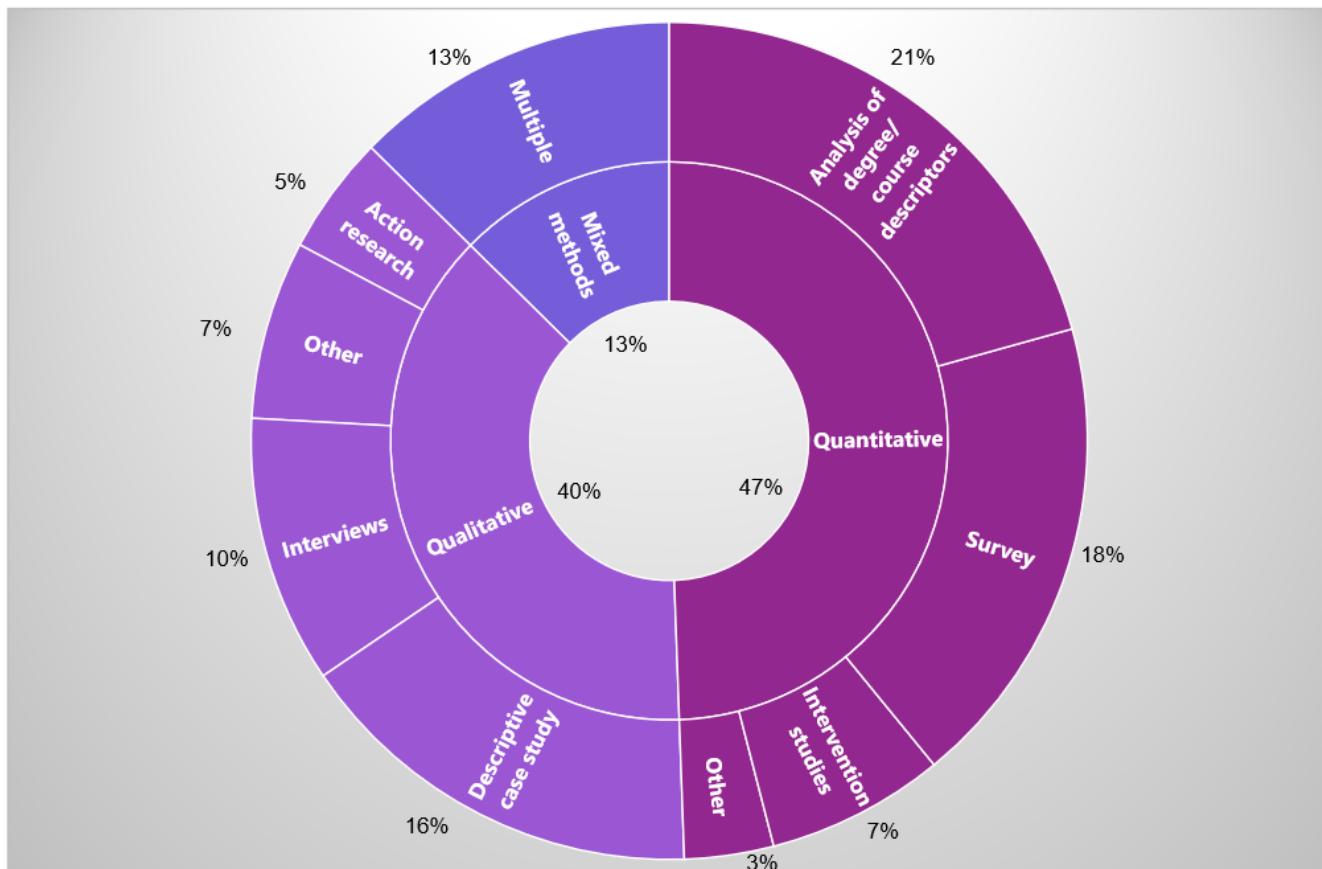
Figure 3. Number of research papers published per year, 2010-2023



From a methodological perspective (Figure 4), the reviewed studies employed primarily quantitative methods (47%), among them content analysis of degree and course descriptors to evaluate the incorporation (or absence) of sustainability in the curriculum of the selected non-STEM study programmes. Survey studies were also common along with intervention studies designed to evaluate the acquisition of sustainability knowledge/competencies or shifts in sustainability mindset. These latter studies typically employed a simple one-group pre- and post-test evaluation design, which, though offering insights into changes throughout a course or study programme, might have had important limitations in establishing causal relationships or determining the effectiveness of different pedagogical approaches. 40% of the reviewed studies employed qualitative methods, primarily relying on descriptive case studies, action research, and semi-structured interviews conducted with HE students, academic staff, programme leads, and heads of departments about student progress, barriers and challenges to sustainability integration in non-STEM programmes, and the implementation and efficacy of various pilot initiatives. Finally, 13% of studies employed mixed methods, often combining the analysis of degree and course descriptors with qualitative interviews, or utilising multiple assessment tools simultaneously, such as quantitative sustainability competency assessment instruments and open-ended questions and/or learning journals (sometimes within pre- and post-test designs). The reviewed studies included a total of 11,790 participants (mostly undergraduate and postgraduate students), excluding articles in which the exact participant numbers were not stated or clear. Additionally, curricular assessments, which did not involve human

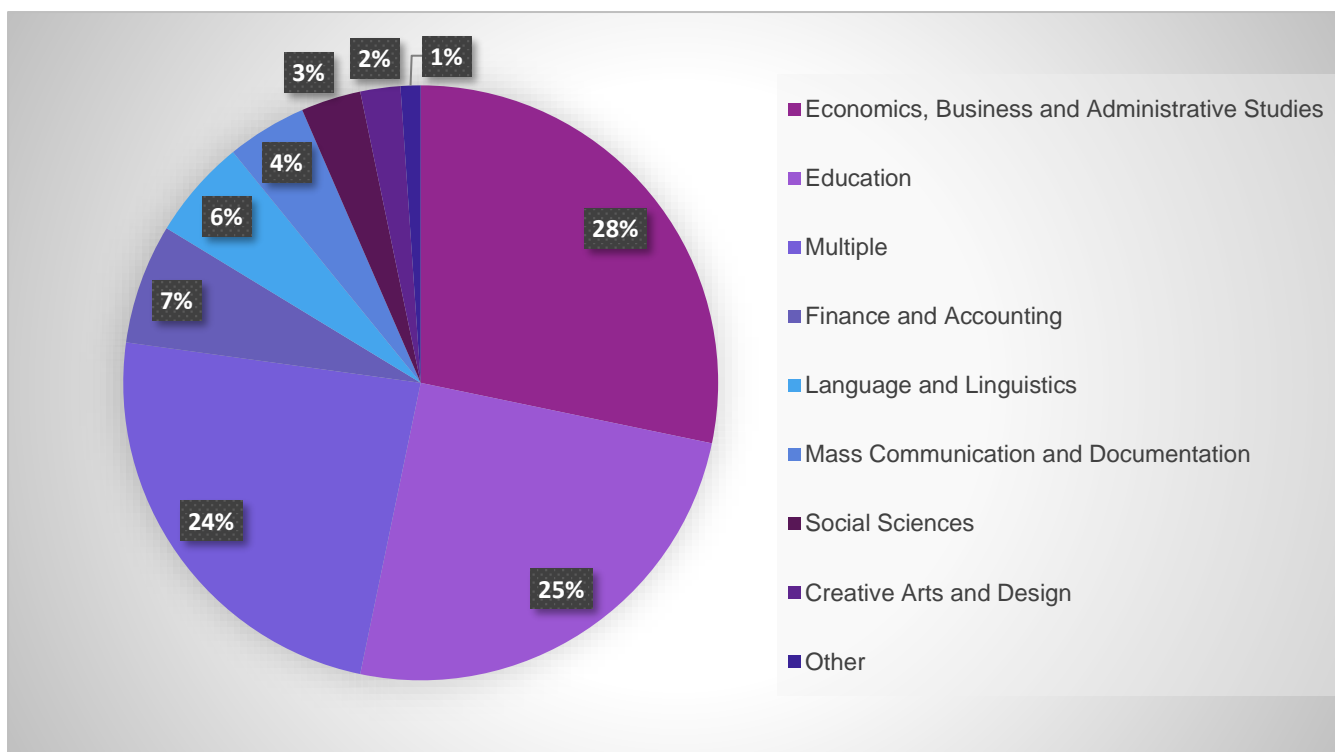
participants, encompassed a total of 9,992 university programmes and courses. This excludes articles that only indicated the number of participating universities without providing details on the quantity of degree programmes/courses scrutinised.

Figure 4. Distribution of research methods



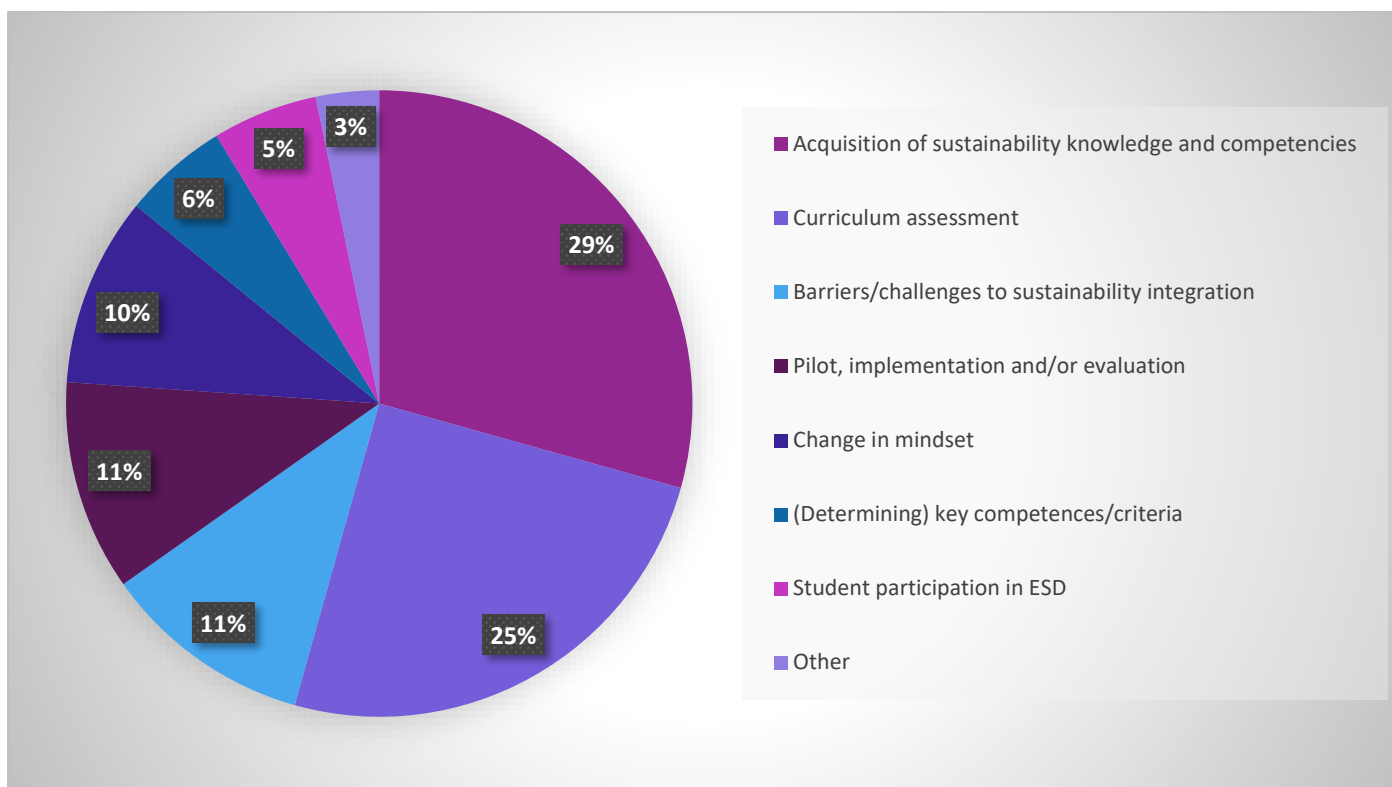
Various HE fields have also contributed to the current literature (see Figure 5). Economics, Business, and Administrative Studies held the largest share of reviewed studies (26%), followed by Education (23%). 22% of the corpus corresponded to multiple disciplines, which is understandable given the interconnected nature of sustainability. We have also identified several gaps in research; for instance, Finance and Accounting contributed only 6%, suggesting a need for deeper exploration. Similarly, Language and Linguistics, Mass Communication and Documentation, and Social Sciences collectively represented only 12% of the reviewed studies, which suggests a relatively modest emphasis on societal perspectives and communication strategies about and for sustainability. Creative Arts and Design, contributing 2%, constitute a niche area where more research could enrich interdisciplinary perspectives on sustainability.

Figure 5. Non-STEM fields (as percentage % of all identified studies)



The current body of research also explored several vital dimensions, with particular attention given to the acquisition of sustainability knowledge and competencies, which emerged as the predominant focus, encompassing 27% of the studies. Curriculum assessment came second, accounting for 23% of the literature. Furthermore, 10% of the reviewed studies addressed challenges and barriers to sustainability integration, above all in the United Kingdom and Spain. This reflects a concerted effort in these countries to identify and mitigate the obstacles faced by educators and institutions in incorporating education for sustainability into curricula. Pilot initiatives, implementation and evaluation research comprised 10% of the literature, suggesting a modest focus on testing, refining and real-world application of different approaches to sustainability education. Additionally, changes in students' mindset were explored in 9% of the reviewed studies, including intervention studies focussed on shaping attitudes and beliefs about sustainability. 5% of the literature focused on determining key competences in sustainability literacy. Finally, active student participation in ESD was another notable area, representing 5% of the studies.

Figure 6. Focus of identified studies (as percentage % of all identified studies)



#### Knowledge and competencies

In the literature detailing acquisition and practical examples of pilot schemes/pedagogical interventions to boost sustainability literacy various **knowledge areas** and competencies emerged as prominent. Teaching the *SDGs*, including their objectives, targets, and indicators (Albareda-Tiana, Vidal-Raméntol, & Fernández-Morilla, 2018; Juan et al., 2022; Sánchez-Carracedo et al., 2021; Tomasella et al., 2023; Udvari & Vizi, 2023; Vasconcelos et al., 2022), alongside *awareness of macro-sustainability trends* (e.g., Angiel & Pokojski, 2019; Watson et al., 2022) were a common topic of interest, i.e. students were often introduced as part of course curricula to broader sustainability issues shaping the global landscape, such as climate change, biodiversity loss, resource depletion, and technological advancements and were encouraged to explore the link between these and their study specialisation. Additionally, *knowledge of local sustainability issues* (e.g., Ruyffelaert, 2022), including environmental degradation and social inequities, were often part of learning objectives to enable students to recognise the specific challenges within their communities/regions.

Regarding **competencies**, the literature underscored the importance of several competencies taught usually in conjunction as part of the reviewed pilots and programmes. These included *systems thinking* in grasping the interconnectedness of social, environmental, and economic systems (Alm et al., 2022; Tomasella et al., 2023), *critical thinking* (Perkiss et al., 2020) and *problem-solving skills* (Ortiz & Huber-Heim, 2017) (including evaluating evidence, identifying root causes, and considering diverse perspectives) for analysing sustainability challenges and proposing innovative solutions. *Ethical awareness*

(Albiez et al., 2018; Martínez Lirola, 2018; Stough et al., 2021) was further considered as a desirable learning objective given the moral dimensions of sustainability decisions. *Interdisciplinary knowledge* was also considered necessary by educators aiming to incorporate sustainability in their course programming. *Global awareness and citizenship* (Alm et al., 2022; Udvari & Vizi, 2023) were further competencies considered desirable for understanding global sustainability challenges and promoting cooperation in addressing them. *Communication skills* were also recognised in some cases as crucial (Karmasin & Voci, 2021; López, 2022), particularly for conveying complex sustainability-related concepts and for engaging stakeholders. Finally, cultivating an *action-oriented mindset* focused on taking concrete steps towards sustainability goals (e.g., Beecroft, 2018) was very much present as a learning objective, particularly in game- and project-based learning initiatives reflecting a commitment to empowerment, agency, and continuous learning and improvement. Of these, systems thinking and integrated problem-solving are competencies specific to sustainability education as per UNESCO's (2017) definition, while the remainder are competencies generally important to any HE work. Systems thinking, which is the ability to recognise and understand relationships and complex systems embedded within different domains and scales, enables students to see the bigger picture and interdependencies between different elements of their and other fields. Integrated problem-solving, the ability to apply various problem-solving frameworks to complex sustainability problems, equips learners with the skills necessary for developing viable, inclusive, and equitable solutions for sustainable development (UNESCO, 2017).

**Assessment** of sustainability literacy varied substantially across the reviewed literature. Most often assessed aspects included knowledge of the SDGs, understanding of SD issues, changes in mindset, and changes in sustainability-related behaviour. Some studies utilised pre-post intervention designs (e.g., Andersson et al., 2013; Emblen-Perry, 2022; Fuertes-Camacho et al., 2019; Tassone et al., 2017; Vasconcelos et al., 2022; Vega & Álvarez, 2012; Watson et al., 2022) but were limited by their use of only one group, which may introduce bias and limit the ability to draw causal conclusions. It is important to bear in mind that causality cannot be easily inferred with any assessment design, since changes in mindset or behaviour represent long-term efforts mediated by numerous causes. Educators in some case studies also provided their observations on learning (Gabaudan, 2022; MacVaugh & Norton, 2012; Martínez Lirola, 2018; Ruyffelaert, 2022), particularly in instances where new cross-disciplinary courses or content were introduced by them and/or used new assessment rubrics (Albareda-Tiana et al., 2019; Albareda-Tiana, Vidal-Raméntol, & Fernández-Morilla, 2018; Fernández Morilla et al., 2015). Other studies sought to assess students' familiarity with sustainable development and available resources, as well as their perceptions of learning, improvements in sustainability awareness, critical thinking, and other competencies, utilising one-off course questionnaires (Alfirević et al., 2022; Alm et al., 2022; Angiel & Pokojski, 2019; Badea et al., 2020; Baena-Morales, García-Taibo, et al., 2023; Bezeljak et al., 2020; Buil-Fabregá et al., 2019; Hubscher-Davidson & Panichelli-Batalla, 2016; Juan et al., 2022; Martínez Lirola, 2018; Piroscă et al., 2020; Tomasella et al., 2023; Wynder et al., 2013). Furthermore, a handful of studies proposed novel assessment instruments to enhance the evaluation of sustainability literacy (e.g., Azcárate Goded et al., 2016; Baena-Morales, Urrea-Solano, et al., 2023; Stough et al., 2018).

In terms of developing teaching and learning processes to enhance sustainability literacy, three **fundamental approaches** were identified. These approaches encompassed *adapting current course materials* with additional content and perspectives (Gracia Villar et al., 2023; Watson et al., 2022), providing *standalone lectures and workshops* throughout the term (Andersson et al., 2013; Hazelton & Haigh, 2010; Küçüksayraç & Ariburun Kirca, 2020; Ødegaard et al., 2021; Tiana & Villarreal, 2016), or establishing entirely *new cross-disciplinary curricula* specifically focused on sustainability (Albareda-Tiana et al., 2019; Albiez et al., 2018; Beecroft, 2018; Micklethwaite, 2022). The **pedagogical methods** discussed in the literature included:

- *Case and project-based learning*: this approach involved presenting students with real-world sustainability scenarios (challenges) and guiding them through the process of analysing, problem-solving, and proposing solutions (Albareda-Tiana, Vidal-Raméntol, Pujol-Valls, et al., 2018; Alm et al., 2022; Emblen-Perry, 2022; Fernández Morilla et al., 2015; Fuertes-Camacho et al., 2019; Führ et al., 2018; López, 2022; Pellaud et al., 2013; Singer-Brodowski, 2017; Tomasella et al., 2023; Tran & Herzig, 2023; Vasconcelos et al., 2022);
- *Experiential learning* which engaged students in direct experiences via role-playing, simulation and field trips to explore sustainability issues firsthand (Anastasiadis et al., 2021; Perkiss et al., 2020; Spörk et al., 2023);
- *Problem-based learning* in which complex, open-ended problems were used as a vehicle to promote learning about sustainability concepts and challenges, critical thinking, and collaboration (Albareda-Tiana et al., 2019; Gusc & Heijes, 2018; MacVaugh & Norton, 2012; Ortiz & Huber-Heim, 2017; Rögele et al., 2022);
- *Collaborative learning* with students working together in groups to explore sustainability topics, discuss ideas, and solve problems collectively to foster among others communication skills, teamwork, and the exchange of diverse perspectives (Grau et al., 2022; Martínez Lirola, 2018; Vega & Álvarez, 2012);
- *Reflection groups* which provided structured opportunities for students to reflect on their learning experiences, insights, and personal values related to sustainability (Libertson, 2023).
- *Pedagogical (Bohmian) dialogue* which emphasised open and exploratory discussions (Hämäläinen, 2022);
- *Flipped classroom approaches* (inverted teaching), which involved shifting the delivery of instructional content outside of the classroom and utilising class time for student-led presentations, interactive activities and application-based exercises facilitated by HE educators (Buil-Fabregá et al., 2019; Gabaudan, 2022; Udvari & Vizi, 2023);
- *Game-based learning*, that is, the use of games and simulations to engage students in sustainability education (Emblen-Perry, 2018); and finally,

- *Service learning* which combined academic learning with a voluntary community service at a civil society partner, to connect students with their social environment and allow them to apply classroom knowledge to real-world sustainability projects and thus contribute to positive environmental and social impact (Alfirević et al., 2022).

The above methods have been described in the literature as means to actively engage students in their education. According to the study authors each offered unique benefits in terms of promoting sustainability knowledge and competencies, above all critical thinking and application of classroom knowledge to real-world problem-solving. It is worth noting that these approaches were not seen by educators as mutually exclusive as the reviewed studies often combined multiple methods to create comprehensive ESD experiences for students (Alm et al., 2022; Azcárate Goded et al., 2016; Ortiz & Huber-Heim, 2017; Tiana & Villarreal, 2016; Tran & Herzig, 2023). Furthermore, current research within the EHEA have also underscored the need for professional development initiatives to equip staff with the knowledge and skills necessary to effectively integrate sustainability principles and contents into their teaching. Additionally, curriculum assessment and evaluation mechanisms have been widely implemented to gauge the extent of sustainability-focused teaching and identify areas for improvement (Albareda-Tiana, Vidal-Raméntol, & Fernández-Morilla, 2018; Artuner Özder, 2018; Azcárate Goded et al., 2016; Aznar et al., 2018; Bekmeier-Feuerhahn et al., 2018; Ergün et al., 2022; Gómez-Jarabo et al., 2019; Karmasin & Voci, 2021; Lorek et al., 2023; Micklethwaite, 2022; Minguet et al., 2011; Obrecht et al., 2022; Okanović et al., 2021; Pálsdóttir & Jóhannsdóttir, 2021; Papadimitriou, 2022; Sánchez-Carracedo et al., 2021; Sprenger & Nienaber, 2018; Stough et al., 2018, 2021; Torres et al., 2017; Wrase et al., 2023; Yüksel, 2020).

## Discussion

This multilingual systematic scoping review shed light on the extent and focus of existing research regarding sustainability literacy in non-STEM higher education programmes in the EHEA region. Out of 6161 screened records, 92 articles met the inclusion criteria, indicating a notable interest in this area of study. There has been a sharp increase in publications since 2017, which also signals a growing scholarly and research focus on integrating sustainability themes and competencies into non-STEM curricula. It is important to note, however, that there was a moderate drop in publication rates during the Covid-19 pandemic. This drop is likely attributable to general disruptions in academic activities during 2020-2022 (Grek & Landri, 2021). The focus on post-2010 publications might have also led us to miss early initiatives aimed at addressing the SDGs in non-STEM subjects, even though the low number of research papers published per year up to 2016 (see Figure 3) seems to support our cut-off date. When examining the geographical distribution of the reviewed studies, certain countries such as Spain, the United Kingdom, Germany, Turkey, and Austria, emerged as focal points for research. The results - summarised in Figure 2 - also suggest that there may be regions within the EHEA where sustainability literacy in non-STEM programmes is unexplored/understudied. This prompts us to ask: are there any underlying factors driving



research concentration on the topic, such as availability of funding, institutional priorities, or the overall emphasis on sustainability in HE? A deeper exploration of this question will be necessary in the future to fully understand the dynamics behind research production (or the lack of it) in the EHEA.

The results of the review also bring to light gaps and areas that warrant additional exploration with respect to specific HE fields. The dominant position of Economics, Business, and Administrative Studies, along with Education in the reviewed literature (please refer to Figure 5), suggest a good progress in integrating sustainability knowledge and competencies into some core non-STEM disciplines. Nevertheless, the relatively limited presence of Finance and Accounting in the literature, as well as Language and Linguistics, Law, Mass Communication and Documentation, and Social Sciences, suggests potential gaps in disciplines whose graduates are also likely to enter careers crucial for driving sustainable change. Moreover, the modest contribution from Creative Arts and Design to the current research literature also highlights a niche area. While all these aforementioned fields may not have been traditionally priorities in sustainability education, their inclusion can promote awareness, open up ethical questions and discussion about the cultural dimensions of sustainability, and lead to creative solutions through interdisciplinary dialogue (Hunter et al., 2018; Jónsdóttir, 2017). A note of caution is due here: the weak presence of these disciplines may have also resulted from the inclusion criteria applied in this review, which surveyed peer-reviewed publications that are not necessarily the main dissemination channel for scholars in some of these fields.

Further to the first review question (extent and focus of existing research), current studies predominantly concentrated on research into the acquisition of sustainability knowledge and competencies and curriculum assessment. This emphasis, however, might overshadow other critical areas such as innovative pedagogical approaches or systemic barriers/ challenges in integrating sustainability in non-STEM curricula (exceptions: Bradley, 2019; Cebrián, 2020; Guerenabarrena-Cortazar et al., 2021; Hindley, 2022; Minguet et al., 2011). Pilots and implementation/evaluation studies were also reported (e.g., Beecroft, 2018; Cincera et al., 2018; Führ et al., 2018; Grau et al., 2022; Gusc & Heijes, 2018; Gusc & van Veen-Dirks, 2017; Hazelton & Haigh, 2010; P. Azcárate P et al., 2012; Pellaud et al., 2013), yet their relatively small share in the current literature suggests a need for further investigation, especially into the effectiveness and scalability of different sustainability literacy initiatives across institutions, fields, and education systems. This finding has to be interpreted with caution, however, as pilot studies are not always reported in the type of literature we surveyed, potentially contributing to their underrepresentation. Finally, fostering mindset change (Alfirević et al., 2022; Andersson et al., 2013; Badea et al., 2020; Buil-Fabregá et al., 2019; MacVaugh & Norton, 2012; Ruyffelaert, 2022; Udvari & Vizi, 2023; Vega & Álvarez, 2012; Wynder et al., 2013), determining key competencies (Aznar Minguet et al., 2014; Gracia Villar et al., 2023; Jeziorski et al., 2015; Libertson, 2023; Matesanz et al., 2023) and student participation in ESD generally (Emblen-Perry, 2018; Gabaudan, 2022; Martínez Lirola, 2018; Płonka et al., 2022; Valderrama-Hernández et al., 2020) (Martínez Lirola, 2018) are recognised in the current literature but warrant further exploration for effective sustainability education in non-STEM fields.

The research into sustainability literacy in non-STEM HE programmes was also characterised by methodological diversity: almost half of the studies reviewed employed quantitative methods, followed by qualitative studies (40%) and mixed methods research (13%). Curriculum assessment using quantitative content analysis of degree/course descriptors was one of the most common study types detected. This approach provided a systematic way to evaluate the presence or absence of sustainability concepts within curricula either at single HE institutions (e.g., Gómez-Jarabo et al., 2019; Stough et al., 2018) or in comparative frameworks (e.g. Papadimitriou, 2022; Sprenger & Nienaber, 2018). These studies offered some valuable insights into the extent of sustainability-focused teaching, however, there were also inherent limitations to this approach since it often captured only surface-level indications of sustainability integration into under/postgraduate programmes, without providing evidence on actual implementation and/or the effectiveness of different educational initiatives. Similarly, survey studies and intervention studies - often utilising one-group pre- and post-test designs (e.g., Andersson et al., 2013; Emblen-Perry, 2022; Fuertes-Camacho et al., 2019; Tassone et al., 2017; Vasconcelos et al., 2022; Vega & Álvarez, 2012; Watson et al., 2022) - offered interesting insights into changes in sustainability knowledge and competencies. Yet, most studies fell short of determining the effectiveness or impact of specific pedagogical approaches on student outcomes and reported instead (solely) self-reported data regarding shifts in sustainability mindset or behaviour. Qualitative and mixed methods, including case studies (Albiez et al., 2018; Gracia Villar et al., 2023; Grau et al., 2022; Gusc & Heijes, 2018; Micklethwaite, 2022; Pellaud et al., 2013), educator observations and interviews (Cincera et al., 2018; Singer-Brodowski, 2017), complemented the quantitative approaches, providing nuanced understandings of barriers, challenges, implementation strategies and/or acceptability of the proposed interventions. By engaging students, academic staff, programme leads and other HE stakeholders, these studies captured some of the complexities surrounding sustainability integration into non-STEM programmes, but their findings require careful interpretation within specific contexts. Differences in student/staff backgrounds, educational settings and teaching and learning approaches likely influenced the outcomes, making it essential to consider these factors when interpreting findings. More robust evaluation designs, including longitudinal studies, controlled intervention studies, and more mixed methods approaches (see Gopalan et al., 2020; Ponce & Pagán-Maldonado, 2015) are desirable in future research to explore and evidence the pedagogical effectiveness of specific sustainability literacy proposals for non-STEM disciplines and their impact on student learning outcomes and societal change.

Regarding the second review question (knowledge and competencies to be acquired), the teaching of SDGs, including their objectives, targets, and indicators, awareness of global and local sustainability issues, critical thinking and system thinking emerged as the most prominent learning objectives. These competencies and knowledge, which are generally considered crucial for addressing the multifaceted challenges of sustainability effectively (Wiek et al., 2011), were often introduced to the students either in the form of standalone lectures and workshops, or via pilot studies working with new cross-disciplinary curricula. There is substantial published work on the implementation of different pedagogical proposals, but only a few studies which have attempted to evaluate student learning with respect to real-word problem-

solving or discipline specific sustainability expertise. The currently deployed assessment tools also seem to lack consistency, which makes it challenging to compare outcomes across programmes and institutions to promote best practice. Furthermore, most current assessment methods have a narrow focus which may fail in capturing the interdisciplinary and systemic nature of sustainability. By prioritising specific knowledge areas or competencies, existing proposals may have also overlooked the interconnectedness and real-world applicability of sustainability issues, limiting non-STEM students' understanding and learning. Moreover, a more general problem that goes beyond non-STEM fields and affects HE more broadly, is that assessment methods at times lack authenticity and fail to reflect real-world sustainability issues adequately (Cross & Congreve, 2021). The feasibility and practicalities of using what may seem like “authentic” assessment should, however, be considered carefully, as this type of assessment would likely require substantial planning and resources, including strong partnerships with external organisations, which may be easier to achieve in some fields than in others.

In terms of teaching and learning processes (third review question), a diverse range of pedagogical approaches has been documented in the literature. These included case and project-based learning, experiential learning, problem-based learning, collaborative learning, reflection groups, pedagogical dialogue, flipped classroom, game-based learning, and service learning. Various studies (e.g., Emblen-Perry, 2022; Ortiz & Huber-Heim, 2017) saw these methods - all grounded in active learning and immersive experiences - as the best way to engage students in sustainability conversations and to foster awareness, analysis, and problem-solving. Some authors like Alfirević et al. (2022) have also argued for a strong community engagement in ESD via service learning to ensure truly hands-on experiences, although this approach may suit some disciplines better than others. In addition to the strengths mentioned above, our review has also highlighted important gaps and limitations in the current literature. For example, an important part of existing work leans - perhaps excessively - towards dissecting teaching and learning processes without any evaluation of the outcomes achieved (e.g., Fernández Morilla et al., 2015; Führ et al., 2018; Micklethwaite, 2022). Thus, as previously suggested, future ESD initiatives and research should also include an assessment or evaluation component to ensure that students not only actively engage with sustainability subjects within their disciplines, but also achieve the desired learning outcomes in knowledge, attitudes and/or sustainability competencies. Furthermore, even though several studies combined multiple pedagogical methods (e.g., Alm et al., 2022; Azcárate Goded et al., 2016; Ortiz & Huber-Heim, 2017; Tiana & Villarreal, 2016; Tran & Herzig, 2023), empirical evidence on the effectiveness of these integrated approaches compared to individual or more traditional teaching-learning methods is lacking. This is an important area for future research. Furthermore, although our review excluded professional development initiatives for HE staff and assessments of their sustainability knowledge and/or attitudes, the research literature on barriers to sustainability education in non-STEM programmes which was considered (e.g., Bradley, 2019; Cebrián, 2020; Guerenabarrena-Cortazar et al., 2021; Hindley, 2022; Minguet et al., 2011) underscored the need for additional research and training programmes in this area. Future work should therefore also better support educators in acquiring the necessary knowledge, skills, and practical experience to successfully integrate sustainability topics and competencies into their teaching.

# Conclusions

In conclusion, this review has showed the multifaceted nature of sustainability literacy research within non-STEM higher education programmes, underlining the imperative for ongoing investigation, new teaching methods, and institutional backing to nurture a cohort of students proficient in tackling global sustainability issues. While sustainability literacy has been a growing topic of interest in HE research contexts, evidenced by a rise in outputs since 2017, our review has also highlighted important gaps. Based on our results, we call for further research into EHEA regions and non-STEM fields/disciplines that have received comparatively less attention, along with the factors that shape research priorities and concentration. We conclude with some questions that may help steer future research endeavours: Are certain disciplines receiving disproportionate research attention at the expense of others? Are there systemic barriers hindering the integration of sustainability themes, challenges and competencies into specific non-STEM fields? How do different pedagogical approaches compare in terms of effectiveness for fostering sustainability literacy in and across HE fields? What new educational practices are emerging, and how can we fairly assess them and/or evidence their benefits for students and the environment? To address these questions, future research can build on the existing body of knowledge reviewed in this report along with targeted capacity-building initiatives for researcher-educators to support them in engaging in interdisciplinary collaborations and advancing sustainability literacy in their practice.

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# Appendix

## Table A1: Study characteristics

| Publication                | Country          | HE field / subject                             | Study design  | Study method(s)   | Participants                                       | Level of study                 | Pedagogical approach  | Focus                                  |
|----------------------------|------------------|--|---------------|---|--|--------------------------------|---|--|
| Tomasella et al., 2023     | United Kingdom   | Multiple                                       | Mixed methods | Survey and qualitative interviews   | n = 84 (survey); n = 8 (interviews)                | Undergraduate                  | Social enterprise projects run by UG students involved in Enactus UK                                    | Acquisition of knowledge/competencies  |
| Tran & Herzig, 2023        | Germany          | Economics, Business and Administrative Studies | Qualitative   | Learning journals, video recorded sessions and qualitative interviews           | n = 17   | Postgraduate                   | Blended case-based learning of accounting for sustainability  | Acquisition of knowledge/competencies  |
| Lorek et al., 2023         | Poland           | Economics, Business and Administrative Studies | Quantitative  | Survey  | n = 200  | Undergraduate                  | Not applicable  | Curriculum assessment                  |
| Udvari & Vizi, 2023        | Hungary          | Economics, Business and Administrative Studies | Quantitative  | Pre- and post-test  | n = 44   | Undergraduate                  | Flipped classroom   | Change in mindset                      |
| Matesanz et al., 2023      | Spain & Portugal | Multiple                                       | Qualitative   | Semi-structured interviews  | n = 6 (heads of departments)                       | Unclear                        | Not applicable  | (Determining) key competences/criteria |
| Wrase et al., 2023         | Multiple         | Economics, Business and Administrative Studies | Quantitative  | Content/keyword analysis  | n = 122 (institutions), n = 374 (study programmes) | Postgraduate                   | Not applicable  | Curriculum assessment                  |
| Libertson, 2023            | Sweden           | Economics, Business and Administrative Studies | Qualitative   | Semi-structured interviews  | n = 7 (academic staff)                             | Undergraduate and postgraduate | Reflection groups   | (Determining) key competences/criteria |
| Watson et al., 2022        | Turkey           | Mass Communication and Documentation           | Mixed methods | Pre- and post-course test using a mix of qualitative and quantitative questions | n = 150  | Undergraduate                  | Adaptation of an existing course with expanded materials and perspectives, controversies-based approach | Acquisition of knowledge/competencies  |
| Spörk et al., 2023         | Austria          | Economics, Business and Administrative Studies | Mixed methods | Pre- and post-survey & qualitative freewriting exercise                         | n = 35   | Postgraduate                   | Humour/comedy scripts as experiential learning method   | Acquisition of knowledge/competencies  |
| Alm et al., 2022           | Sweden           | Multiple                                       | Quantitative  | Survey  | n = 30   | Postgraduate                   | Case studies through real-life learning (internships)   | Acquisition of knowledge/competencies  |
| Gracia Villar et al., 2023 | Spain            | Economics, Business and                        | Qualitative   | Descriptive   | Not applicable                                     | Postgraduate                   | Adaptation of existing course contents  | (Determining) key competences/criteria |

|                          |                |  |               |   |   |                                |  |                                       |
|--------------------------|----------------|--|---------------|---|---|--------------------------------|--|---------------------------------------|
|                          |                | Administrative Studies                         |               |   |   |                                |  |                                       |
| Emblen-Perry, 2022       | United Kingdom | Economics, Business and Administrative Studies | Mixed methods | Pre- and post-module survey   | n = 116   | Unclear                        | Audit-based learning (i.e. auditing case studies)  | Acquisition of knowledge/competencies |
| Gabaudan, 2022           | Ireland        | Language and Linguistics                       | Qualitative   | Observation and survey  | Unclear   | Undergraduate                  | Flipped classroom & integrating sustainability through new programmes/cross-disciplinary curricula | Student participation in ESD          |
| Płonka et al., 2022      | Poland         | Multiple                                       | Quantitative  | Survey  | n = 105 (expert respondents), n = 844 (students, of which 406 enrolled in economic and social science programmes) | Undergraduate and postgraduate | Not applicable   | Student participation in ESD          |
| Hämäläinen, 2022         | Finland        | Language and Linguistics                       | Qualitative   | Qualitative content analysis - student reflections published via blog | n = 19  | Unclear                        | Pedagogical (Bohmian) dialogue   | Acquisition of knowledge/competencies |
| Obrecht et al., 2022     | Slovenia       | Multiple                                       | Quantitative  | Content/keyword analysis  | n = 1051 (study programmes)   | Undergraduate and postgraduate | Not applicable   | Curriculum assessment                 |
| Ruyffelaert, 2022)       | Spain          | Language and Linguistics                       | Qualitative   | Pedagogical proposal and reflection on implementation                 | Not applicable  | Undergraduate                  | Integrating sustainability through new programmes/cross-disciplinary curricula                     | Change in mindset                     |
| Hindley, 2022            | United Kingdom | Economics, Business and Administrative Studies | Qualitative   | Semi-structured interviews  | n = 9 (programme leaders)   | Undergraduate                  | Not applicable   | Barriers/challenges                   |
| Lozano et al., 2022      | Multiple       | Multiple                                       | Quantitative  | Survey  | n = 678 (HE staff)  | Undergraduate and postgraduate | Not applicable   | Other                                 |
| Vasconcelos et al., 2022 | Multiple       | Multiple                                       | Quantitative  | Pre- and post-design, quasi-experimental                              | n = 208   | Undergraduate and postgraduate | Case-based teaching  | Acquisition of knowledge/competencies |
| López, 2022)             | Spain          | Mass Communication and Documentation           | Mixed methods | Evaluation of assignments and learning outcomes                       | n = 37  | Postgraduate                   | Case-based teaching in hybrid environment  | Acquisition of knowledge/competencies |

|                                      |  |  |               |  |  |                                |  |   |
|--------------------------------------|--|--|---------------|--|--|--------------------------------|--|---|
| Micklethwaite, 2022                  | United Kingdom                             | Creative Arts and Design                       | Qualitative   | Case study   | Not applicable                                     | Postgraduate                   | Integrating sustainability through new programmes/cross-disciplinary curricula | Curriculum assessment                   |
| Juan et al., 2022                    | Spain                                      | Education                                      | Quantitative  | Survey   | n = 216  | Postgraduate                   | Not applicable   | Acquisition of knowledge/competencies   |
| Grau et al., 2022)                   | Spain                                      | Finance and Accounting                         | Qualitative   | Case study   | n = 33   | Undergraduate                  | Collaborative learning   | Pilot, implementation and/or evaluation |
| Ødegaard et al., 2021                | Norway                                     | Education                                      | Mixed methods | Interviews, video observations and course evaluation forms | n = 330  | Undergraduate and postgraduate | Lectures and interdisciplinary workshops                                       | Barriers/challenges                     |
| Papadimitriou, 2022                  | Multiple                                   | Social sciences                                | Qualitative   | Analysis of degree/subject descriptions                    | n = 94 (universities), n = 2613 (courses analysed) | Undergraduate                  | Not applicable   | Curriculum assessment                   |
| Pálsdóttir & Jóhannsdóttir, 2021     | Iceland                                    | Multiple                                       | Quantitative  | Analysis of degree/subject descriptions                    | n = 3239 (courses analysed)                        | Undergraduate and postgraduate | Not applicable   | Curriculum assessment                   |
| Guerenabarrena-Cortazar et al., 2021 | Spain                                      | Multiple                                       | Quantitative  | Survey   | n = 1094 (HE teaching staff; 51% non-STEM)         | Undergraduate and postgraduate | Not applicable   | Barriers/challenges                     |
| Anastasiadis et al., 2021            | Austria and UK                             | Economics, Business and Administrative Studies | Qualitative   | Interviews   | n = 7 (unclear how many from EHEA countries)       | Undergraduate and postgraduate | Experiential learning with an open ESG data tool                               | Barriers/challenges                     |
| Okanović et al., 2021                | Sweden & Serbia                            | Multiple                                       | Quantitative  | Analysis of degree/subject descriptions                    | n = 398  | Undergraduate and postgraduate | Not applicable   | Curriculum assessment                   |
| Sánchez-Carracedo et al., 2021       | Spain                                      | Education                                      | Quantitative  | Analysis of degree/subject descriptions                    | n = 843 (courses analysed)                         | Undergraduate                  | Not applicable   | Curriculum assessment                   |
| Stough et al., 2021                  | Belgium                                    | Economics, Business and Administrative Studies | Quantitative  | Analysis of degree/subject descriptions                    | n = 30 (courses analysed)                          | Undergraduate and postgraduate | Not applicable   | Curriculum assessment                   |
| Betáková et al., 2020                | Hungary, Slovakia, Poland & Czech Republic | Economics, Business and Administrative Studies | Quantitative  | Survey   | n = 1456   | Postgraduate                   | Not applicable   | Acquisition of knowledge/competencies   |
| Badea et al., 2020                   | Romania                                    | Economics, Business and Administrative Studies | Quantitative  | Survey   | n = 1253   | Undergraduate and postgraduate | Not applicable   | Change in mindset                       |



|  |                          |  |               |  |  |                                |  |   |
|--|--------------------------|--|---------------|--|--|--------------------------------|--|---|
| Küçüksayraç & Arıburun Kırca, 2020                         | Turkey                   | Creative Arts and Design                       | Qualitative   | Course questionnaire                                   | n = 29   | Undergraduate                  | Workshop   | Acquisition of knowledge/competencies   |
| Perkiss et al., 2020                                       | United Kingdom & Austria | Economics, Business and Administrative Studies | Qualitative   | Course questionnaire                                   | n = 549 (174 students from UK and Austria)                                     | Undergraduate and postgraduate | Experiential learning with an open ESG data tool | Acquisition of knowledge/competencies   |
| Yüksel, 2020   | Turkey                   | Finance and Accounting                         | Quantitative  | Analysis of degree/subject descriptions                | n = 129 (courses analysed)   | Undergraduate and postgraduate | Not applicable                                   | Curriculum assessment                   |
| Buil-Fabregá et al., 2019                                  | Spain                    | Economics, Business and Administrative Studies | Quantitative  | Survey   | n = 154  | Undergraduate                  | Flipped classroom                                | Change in mindset                       |
| Bradley, 2019  | United Kingdom           | Economics, Business and Administrative Studies | Mixed methods | Survey, key word analysis and interviews               | n = 96 (survey), n = 7 (interviews, teaching staff)                            | Undergraduate                  | Not applicable                                   | Barriers/challenges                     |
| Fuertes-Camacho et al., 2019                               | Spain                    | Education                                      | Quantitative  | Pre- and post-design, quasi-experimental               | n = 16   | Undergraduate                  | Project method                                   | Acquisition of knowledge/competencies   |
| Gusc & Heijes, 2018  | Netherlands              | Finance and Accounting                         | Qualitative   | Observation and document analysis                      | n = 16   | Postgraduate                   | Lemniscate learning                              | Pilot, implementation and/or evaluation |
| Cincera et al., 2018                                       | Multiple                 | Economics, Business and Administrative Studies | Qualitative   | Observation, interviews and evaluative questionnaire   | n = 17 (observation), n = 9 (interviews), n = 43 (questionnaire, all HE staff) | Postgraduate                   | Not applicable                                   | Pilot, implementation and/or evaluation |
| Stough et al., 2018  | Belgium                  | Economics, Business and Administrative Studies | Quantitative  | Analysis of degree/subject descriptions                | n = 1  | Postgraduate                   | Not applicable                                   | Curriculum assessment                   |
| Albareda-Tiana, Vidal-Raméntol, & Fernández-Morilla, 2018) | Spain                    | Multiple                                       | Mixed methods | Analysis of degree/subject descriptions and interviews | n = 14 (degree programmes analysed)<br>n = 8 (interviews)                      | Unclear                        | Not applicable                                   | Curriculum assessment                   |
| Wynder et al., 2013  | Germany                  | Finance and Accounting                         | Quantitative  | Experimental, survey with an evaluation tasks          | n = 38 (students in Germany, total = 113)                                      | Postgraduate                   | Not applicable                                   | Change in mindset                       |
| Azcárate P et al., 2012                                    | Spain                    | Multiple                                       | Qualitative   | Semi-structured interviews                             | n = 3  | Unclear                        | Multiple   | Pilot, implementation and/or evaluation |
| Minguet et al., 2011                                       | Spain                    | Multiple                                       | Quantitative  | Survey   | n = 135 (non-stem HE staff, of the total = 331)                                | Unclear                        | Not applicable                                   | Curriculum assessment                   |
| Hazelton & Haigh, 2010                                     | France                   | Finance and Accounting                         | Qualitative   | Action research  | Not applicable   | Undergraduate and postgraduate | Lecture  | Pilot, implementation and/or evaluation |

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|---|----------------------------------|--|--------------|---|---------------------------------------|--------------------------------|--|---|
| Karmasin & Voci, 2021)                    | Multiple                         | Mass Communication and Documentation           | Quantitative | Analysis of degree/subject descriptions and interviews            | n = 1068 (degree programmes analysed) | Undergraduate and postgraduate | Not applicable   | Curriculum assessment                   |
| MacVaugh & Norton, 2012                   | United Kingdom                   | Economics, Business and Administrative Studies | Qualitative  | Action research   | Not applicable                        | Undergraduate                  | Problem based learning   | Change in mindset                       |
| Baena-Morales, García-Taibo, et al., 2023 | Spain                            | Education                                      | Quantitative | Survey  | n = 341                               | Undergraduate and postgraduate | Not applicable   | Acquisition of knowledge/competencies   |
| Baena-Morales, Urrea-Solano, et al., 2023 | Spain                            | Education                                      | Quantitative | Survey  | n = 341                               | Undergraduate and postgraduate | Not applicable   | Acquisition of knowledge/competencies   |
| Rögele et al., 2022)                      | Germany                          | Multiple                                       | Qualitative  | Interview   | n = 16 (professors)                   | Unclear                        | Research-based learning, problem-based learning and design thinking  | Acquisition of knowledge/competencies   |
| Alfirević et al., 2022                    | Croatia & Bosnia and Herzegovina | Economics, Business and Administrative Studies | Quantitative | Survey  | n = 366                               | Undergraduate                  | Service-learning (i.e. structuring of an academic course in term of a voluntary service provided to the community) | Change in mindset                       |
| Bezeljak et al., 2020                     | Austria & Slovenia               | Education                                      | Quantitative | Survey  | n = 120                               | Undergraduate                  | Not applicable   | Acquisition of knowledge/competencies   |
| Piroscă et al., 2020                      | Romania                          | Economics, Business and Administrative Studies | Quantitative | Survey  | n = 1249                              | Undergraduate                  | Not applicable   | Acquisition of knowledge/competencies   |
| Albareda-Tiana et al., 2019)              | Spain                            | Education                                      | Quantitative | Students' EF & expert evaluation of student competencies (rubric) | n = 93                                | Undergraduate                  | Problem-based learning, project-oriented learning, cross-disciplinary workshops                                    | Acquisition of knowledge/competencies   |
| Angiel & Pokojski, 2019                   | Poland                           | Education                                      | Quantitative | Survey  | n = 70                                | Undergraduate and postgraduate | Not applicable   | Acquisition of knowledge/competencies   |
| Beecroft, 2018                            | Germany                          | Multiple                                       | Qualitative  | Descriptive case studies  | n = 6 (courses analysed)              | Unclear                        | Transdisciplinary courses carried out in Real-world labs (RWLs)  | Pilot, implementation and/or evaluation |
| Albareda-Tiana, Vidal-Raméntol,           | Spain                            | Education                                      | Quantitative | Expert evaluation of students'                                    | n = 23                                | Undergraduate                  | Project-oriented learning and cross-   | Acquisition of knowledge/competencies   |

|  |                |  |               |   |   |                                |   |   |
|--|----------------|--|---------------|---|---|--------------------------------|---|---|
| Pujol-Valls, et al., 2018                    |                |  |               | competencies (rubric)   |   |                                | disciplinary workshops  |   |
| Aznar et al., 2018                           | Spain          | Education                                      | Quantitative  | Analysis of degree/subject descriptions                             | n = 21 (subjects analysed)                                  | Postgraduate                   | Not applicable  | Curriculum assessment                   |
| Sprenger & Nienaber, 2018                    | Germany        | Education                                      | Quantitative  | Analysis of degree/subject descriptions                             | n = 107 (degree programmes analysed), n = 55 (universities) | Postgraduate                   | Not applicable  | Curriculum assessment                   |
| Torres et al., 2017                          | Portugal       | Education                                      | Mixed methods | Analysis of degree/subject descriptions                             | n = 87 (course units analysed)                              | Postgraduate                   | Not applicable  | Curriculum assessment                   |
| Singer-Brodowski, 2017                       | Germany        | Education                                      | Qualitative   | Interviews and observation  | n = 18  | Unclear                        | Project-based learning  | Other                                   |
| Ortiz & Huber-Heim, 2017                     | Austria        | Economics, Business and Administrative Studies | Qualitative   | Case study  | n = 1 (course evaluated)                                    | Undergraduate                  | Experiential and problem-based learning   | Pilot, implementation and/or evaluation |
| Tassone et al., 2017                         | Netherlands    | Social sciences                                | Mixed methods | Pre- and post-course test and open-ended questions                  | n = 24  | Undergraduate and postgraduate | EYE: Educating yourself in Empowerment tool   | Acquisition of knowledge/competencies   |
| Gusc & van Veen-Dirks, 2017                  | Netherlands    | Finance and Accounting                         | Qualitative   | Descriptive case study  | n = 450   | Undergraduate                  | Active (problem-based) learning   | Pilot, implementation and/or evaluation |
| Tiana & Villarreal, 2016                     | Spain          | Education                                      | Qualitative   | Descriptive case study  | n = 51  | Unclear                        | Multiple (lecture & workshop, collaborative learning and research, creative/video work) | Acquisition of knowledge/competencies   |
| Hubscher-Davidson & Panichelli-Batalla, 2016 | United Kingdom | Language and Linguistics                       | Quantitative  | Survey  | n = 42  | Undergraduate                  | Not applicable  | Acquisition of knowledge/competencies   |
| Vladimirovna A. E., 2015                     | Russia         | Social sciences                                | Quantitative  | Unclear   | n = 600 (unclear how many participants from Sociology)      | Undergraduate                  | Not applicable  | Acquisition of knowledge/competencies   |
| Andersson et al., 2013)                      | Sweden         | Education                                      | Quantitative  | Pre- and post-intervention survey, with treatment and control group | n = 323   | Unclear                        | Lecture and workshop  | Change in mindset                       |
| Emblen-Perry, 2018                           | United Kingdom | Economics, Business and Administrative Studies | Qualitative   | Questionnaire (open-ended)  | n = not stated  | Undergraduate                  | Game-based learning   | Student participation in ESD            |

| <b>Publications in Spanish</b>         |                |                          |               |  |  |               |                        |  |
|--|----------------|--------------------------|---------------|--|--|---------------|------------------------|--|
| Vega & Álvarez, 2012                   | Spain          | Education                | Quantitative  | Pre- and post-intervention test (incl. attitudes and carbon footprint) | n = 137  | Unclear       | Collaborative learning | Change in mindset                      |
| Albareda Tiana et al., 2017            | Spain          | Multiple                 | Mixed methods | Semi-structured interviews & survey                                    | n = 254 (academic and administrative staff and students, unclear how many from non-STEM) | Unclear       | Not applicable         | Barriers/challenges                    |
| Alcalá del Olmo Fernández et al., 2020 | Spain          | Multiple                 | Qualitative   | Semi-structured interviews   | n = 36 (academic teaching staff)   | Unclear       | Not applicable         | Barriers/challenges                    |
| Cebrián, 2020                          | United Kingdom | Multiple                 | Qualitative   | Action research  | n = 5 (academic teaching staff)  | Undergraduate | Not applicable         | Barriers/challenges                    |
| Valderrama-Hernández et al., 2020      | Spain          | Multiple                 | Qualitative   | Focus groups   | n = 24 (students from non-STEM courses of the total of 29)                               | Postgraduate  | Not applicable         | Student participation in ESD           |
| Fernández Morilla et al., 2015         | Spain          | Education                | Quantitative  | Course grades (rubric) and auto-evaluation                             | not stated   | Undergraduate | Project-based learning | Acquisition of knowledge/competencies  |
| Aznar Minguet et al., 2014             | Spain          | Education                | Qualitative   | Observation  | n = 7 (HE teaching staff)  | Postgraduate  | Not applicable         | (Determining) key competences/criteria |
| Aznar Minguet et al., 2013             | Spain          | Multiple                 | Qualitative   | Interviews   | n = 16 (HE staff from non-STEM of the total of 30 participants)                          | Unclear       | Not applicable         | Barriers/challenges                    |
| Martínez Lirola, 2018)                 | Spain          | Language and Linguistics | Mixed methods | Observation and post-course survey                                     | n = 102  | Undergraduate | Collaborative learning | Student participation in ESD           |
| Gómez-Jarabo et al., 2019              | Spain          | Education                | Quantitative  | Analysis of degree/subject descriptions                                | n = 12 (courses analysed)  | Undergraduate | Not applicable         | Curriculum assessment                  |
| Azcárate Goded et al., 2016            | Spain          | Multiple                 | Quantitative  | Analysis of degree/subject descriptions (thesis!!!)                    | n = 10 (theses analysed)   | Undergraduate | Not applicable         | Curriculum assessment                  |
| Cardeñoso Domingo et al., 2015         | Spain          | Education                | Qualitative   | Descriptive case study   | Not stated   | Undergraduate | Not applicable         | Other                                  |
| <b>Publications in Turkish</b>         |                |                          |               |  |  |               |                        |  |

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|---------------------------------|-------------|--|--------------|---|--------------------------------------|--------------------------------|--|---|
| Artuner Özder, 2018             | Turkey      | Other  | Qualitative  | Analysis of degree/subject descriptions | n = 94 (department syllabi analysed) | Undergraduate                  | Not applicable                             | Curriculum assessment                   |
| Şardagi, 2022                   | Turkey      | Mass Communication and Documentation           | Quantitative | Analysis of degree/subject descriptions | n = 70 (universities)                | Undergraduate                  | Not applicable                             | Curriculum assessment                   |
| Ergün et al., 2022              | Turkey      | Economics, Business and Administrative Studies | Quantitative | Analysis of degree/subject descriptions | n = 25 (universities)                | Undergraduate and postgraduate | Not applicable                             | Curriculum assessment                   |
| <b>Publications in French</b>   |             |  |              |   |                                      |                                |  |   |
| Jeziorski et al., 2015          | France      | Multiple                                       | Qualitative  | Questionnaire (open-ended)              | n = 19 (HE staff)                    | Undergraduate and postgraduate | Not applicable                             | (Determining) key competences/criteria  |
| Pellaud et al., 2013)           | Switzerland | Education                                      | Qualitative  | Descriptive case study                  | N/A                                  | Undergraduate                  | Project-based learning                     | Pilot, implementation and/or evaluation |
| <b>Publications in German</b>   |             |  |              |   |                                      |                                |  |   |
| Albiez et al., 2018             | Germany     | Education                                      | Qualitative  | Descriptive case study                  | n = 30                               | Undergraduate                  | New programme/Cross-disciplinary curricula | Barriers/Challenges                     |
| Bekmeier-Feuerhahn et al., 2018 | Germany     | Economics, Business and Administrative Studies | Quantitative | Analysis of degree/subject descriptions | n = 31 (universities)                | Postgraduate                   | Not applicable                             | Curriculum assessment                   |
| Führ et al., 2018               | Germany     | Economics, Business and Administrative Studies | Qualitative  | Descriptive case study                  | n/a                                  | Postgraduate                   | Project-based learning                     | Pilot, implementation and/or evaluation |