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Action Competence in Sustainable Development (ACiSD): A systematic review of the contributing factors and learning strategies

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Abstract

Education for Sustainable Development (ESD) is recognised for its ability to provide individuals with competencies, knowledge, skills, and values necessary to address contemporary global challenges. Although Action Competence in Sustainable Development (ACiSD) is gaining popularity, there are limited systematic reviews on the contributing factors, motivation, and learning strategies associated with developing ACiSD. This review aims to enhance knowledge on the contributing factors and learning strategies that foster ACiSD. A systematic search conducted using the Web of Science and Scopus databases yielded 58 papers. The identified factors include action-oriented and participatory pedagogies, holistic teaching and learning materials, teacher training and development, and school organisations. These factors align with the whole school approach (WSA), which seeks to include sustainability at the whole school level, including pedagogy and learning, curricula, community connections, capacity building and leadership and coordination. However, WSAs have had limited impact on sustainability actions due to implementation challenges, which can be addressed through collaboration with stakeholders, and democratic decision-making. This study contributes to existing knowledge on the relevance of action-oriented courses in enhancing students' motivation and learning strategies. Further studies are needed to evaluate how WSAs foster action competence at the immediate and long-term levels.

Keywords: Action Competence; Education for Sustainable Development; Environmental Education; Whole School Approach; Action-oriented Pedagogy; ESD; ACiSD

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1. Introduction

Conserving natural resources while ensuring the well-being of the growing population is one of the significant challenges confronting the world today (Hammes et al., 2022). Thus, many societies are striving to achieve a balance between advancing development and promoting sustainable development (Rosen, 2018). Education plays a significant role in transforming societies towards a sustainable future by equipping people with the relevant competencies to act as agents to address sustainable development challenges (Demssie et al., 2020). Additionally, education has the capacity to change people's values, attitudes and actions (Carrapatoso, 2021), through interdisciplinary and holistic teaching approaches (Agueda Gras-Velazquez and Verdiana Fronza, 2022; Laurie et al., 2016). Education has the ability to transform people's actions and thinking, thus empowering people to make pro-sustainability choices to improve the environment and society (Leicht et al., 2018).

Education for Sustainable Development (ESD) is acknowledged as a significant driver for the achievement of the Sustainable Development Goals (SDGs) (UNESCO, 2017). SDG 4 seeks to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all", and Target 4.7 aims "to ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development" (United Nations, 2016 pp.18 and 21). ESD seeks to promote cognitive, socio-emotional, and behavioural dimensions of learning to empower students to make informed decisions (Chen and Liu, 2020; UNESCO, 2019). Moreover, ESD has been integrated into school curricula, educational policies, and teacher training education through global initiatives such as the UN Decade on Education for Sustainable Development (UNDESD) and the Global Action Programme on ESD (Leicht et al., 2018). Furthermore, ESD has made significant impact through the whole school or whole institution approaches (WSA/WIAs), which involves all components of institutions or school systems and stakeholders in the society (Gericke, 2022). Although they both represent approaches to integrate sustainability into the educational system, and adapting teaching, learning, and curricula to promote sustainable development, the concept WIA is more relevant for institutions including higher education institutes (HEIs) (Mathar, 2015; Ferreira, 2006; Mathie, 2024). Integrating whole school approaches into formal education is gaining popularity because of the growing recognition of the need to extend education beyond the classroom to the whole school system to ensure that students engage with sustainability concepts daily (UNESCO, 2017). Furthermore, the holistic and participatory context of the WSA connects schools to their surrounding community to enable students and communities co-develop meaning and solutions to sustainability challenges (Mathie, 2024). These collaborative activities are essential for promoting sustainability action and transforming schools by utilising the WSA as a thinking tool to initiate dialogues among stakeholders (Mathie, 2024; Mathie and Wals, 2022; Gericke, 2022). Moreover, integrating sustainability concepts into the daily activities of students can play a significant role in developing students sustainability competencies (Qablan, 2018).

Competencies are knowledge, skills, and motivational capacities people require to act in different contexts (UNESCO, 2017). Defining key competencies required for sustainability provides a reference for transparent assessment of the effectiveness of teaching and learning processes and a common framework for distinguishing and recognising schools, professions, academics among others (Wiek et al., 2011). Key sustainability competencies have been identified in existing studies (de Haan, 2006; Wiek et al., 2011). They

include systems thinking (ability to understand complex relationships between systems), anticipatory (understand the influence of one's actions), normative (ability to understand, reflect, and negotiate), strategic competence (ability to develop solutions), collaboration, critical thinking, self-awareness, and problem solving (Qablan, 2018; UNESCO, 2017). Sustainability competencies enable students to contribute to societal transformation through empowering them with knowledge and values to act on complex sustainability related challenges (Barth and Fischer, 2012; Vesterinen and Ratinen, 2024). Students' ability to act (action competence) is one of the key sustainability competencies and learning outcomes gaining popularity (Jensen and Schnack, 2006; Rieckmann and Gardiner, 2017; Sass et al., 2021).

The concept Action Competence in Sustainable Development (ACiSD) is increasingly recognised as a significant framework for addressing sustainability related challenges (Eames et al., 2010; Jensen and Schnack, 2006; Sass et al., 2020), an educational ideal and key competence to develop active individuals (Chawla and Cushing, 2007; Ellis and Weekes, 2008; Sass et al., 2020). ACiSD consists of personal and interpersonal competencies including willingness to act, holistic knowledge, confidence in one's capacity, and openness to the opinions of others (Sass et al., 2020). Sustainability courses and initiatives such as the eco-school programme which integrates action-oriented activities is essential for fostering sustainability competencies and values (Qablan, 2018). Furthermore, powerful ESD learning environments that integrates action-oriented, pluralistic, and holistic learning dimensions have been identified as essential for empowering students to act on sustainability related challenges (Sinakou et al., 2019). These learning dimensions seek to provide a holistic understanding of the environmental, social, and economic dimensions of sustainable development and their interconnections, as well as promoting participatory and pluralistic approaches and real-world sustainability actions. Action-oriented pedagogies motivate students to solve sustainability challenges through providing real-world learning experiences, and promoting student-led approaches and interventions (Steinemann, 2003; Wijnia et al., 2011). These student-centred approaches engage students as active participants in the learning process and emphasises a transition from teacher-centred transmission of knowledge to process-based learning through proactive learning strategies such as critical thinking (Thomas, 2009; Howell, 2021; Sinakou et al., 2019; Sun and Wang, 2019). They also involve a shift from limited and discipline-based strategies to interdisciplinary and multiple learning strategies, including cognitive and affective learning, which enable students to analyse and think about real world problems (Howell, 2021; Sterling and Thomas, 2006). In addition to pedagogical approaches, assessment of environmentally conscious young people revealed that emotional need for change, values and contrasting opinions, trust in adults, belongingness, action permeation through role models and confidence in one's capacity were significant factors in the development of action competence (Almers, 2013). Although the study was conducted outside the formal school system, it highlights the diverse internal and external factors fostering the development of action competence as indicated in other studies (Torsdottir et al., 2024a; Torsdottir et al., 2024b; Sinakou et al., 2019). Additionally, other factors including participation and authenticity have been highlighted as important principles for developing students action competence (Jensen and Schnack, 2006).

Existing studies on action competence have focused on the assessment of ESD and EE learning outcomes, general assessment of students' actions, and evaluation of specific course elements such as student participation, teacher training, and their role in fostering action competence (Torsdottir et al., 2024a; Isac et al., 2022; Oinonen et al., 2023; Sass et al., 2024; Torsdottir et al., 2024b). Using reliable and theory-driven instruments such as the Self-perceived Action Competence in Sustainable Development Questionnaire (SPACS-Q) (Olsson et al., 2020), Action Competence in Sustainable Development Questionnaire (ACiSD-Q) (Sass et al.,

2021), and Professional Action Competence for Education for Sustainable Development (PACesd-Q) (Sass et al., 2022) and other assessment methods to assess sustainability competencies. Despite these efforts, no systematic review has been conducted on the factors that foster the development of action competence at the formal school level. Existing systematic reviews on action competence have assessed the impact of adopting action competence through ESD and environmental education (EE) approaches based on results from empirical studies (Chen and Liu, 2020). Others have assessed the literature on action competence and EE among pre-service science teachers and the development of professional action competence among teachers (Husamah, 2022; Lohmann et al., 2021). Although there is a growing body of literature on action competence and ESD and EE, no study has summarised and synthesised the factors that contribute to fostering students' action competence from ESD and EE courses and interventions. Furthermore, the learning process of ESD and EE courses, particularly the motivation and learning strategies related to ACiSD, has received limited attention. This study aims to fill this gap by addressing two research questions; (i) what factors contribute to the development of ACiSD, (ii) what motivation and learning strategies are related to the development of ACiSD? The proceeding section delves into the concept action competence and ACiSD, its origin and components, then follows with a detailed methodology and discussion of results.

1.1. The concept of action competence

Considering the societal influence on the environment and the complexities associated with such challenges, educational approaches are required to understand not only the effects but the causes and actions to address such challenges (Jensen, 2007). Action competence was introduced as a concept in environmental and health education since the 1980s as part of the MUVIN programme to develop students' ability to address environmental issues and new problems that may arise in the future (Breiting et al., 2009; Ideland, 2016; Mogensen and Schnack, 2010). The concept was introduced in the peer review literature in 1997 by Jensen and Schnack as an important construct for pedagogies related to environmental education (EE) (Breiting & Mogensen, 2006; Jensen and Schnack, 2006). Their initial work shed light on the differences between behaviour and action, as well as the facilitating role played by teachers and the importance of critical thinking in environmental education (Fontes, 2002; Gottlieb et al., 2013; Mogensen, 1997). Some of the earlier works by Jensen, (1993) defines action competence as the ability to act and not emphasising only on behavioural change and engagement in activities (Fontes, 2004). Another earlier definition provided by Hansen (1995) refers to action competence as pupils ability to make deliberate choices directed at a specific goal and giving reasons for their actions (Fontes, 2004). Therefore, action competence requires defining a critical starting point and integrating actions into the educational process as a whole (Jensen, 2007). Action competence is also defined as "the capacity to act, now and in the future, and to be responsible for one's actions" (Jensen and Schnack, 2006 p. 483). In a recent publication, Sass et al. (2020 p. 1) describe action competence as "a generic concept related to solving controversial problems in various domains". Thus, action competence focuses on empowering people with the capacity to act and address challenges including environmental and sustainability challenges. It also includes equipping people to act otherwise or to make a difference in social settings, thus increasing action competence is "to increase the space for human freedom" (Fontes, 2004 p. 155). Action competence seeks to promote democratic and pluralistic perspectives and it is identified as a more coherent and logical approach for EE which addresses environmental challenges (Breiting and Mogensen, 1999).

Furthermore, the concept action competence refers to an educational ideal which means that it is impossible to reach a place of accomplishment (Mogensen and Schnack, 2010). As an educational ideal, action competence shares similarities with sustainable development which is an ideal, and also emphasises democratic perspectives rather than prescription of specific behaviours (Mogensen and Schnack, 2010). The action competence approach unlike the failed behaviour modification perspective to EE seeks to develop "a critical reflective and participatory approach by which a developing adult can cope with future environmental problems" (Breiting and Mogensen, 1999 p. 350; Jensen, 2007). Another key feature is that action is targeted at solving an environmental problem either directly or indirectly by influencing others and either individually or collectively. The notion of targeting actions at specific problems differentiates actions from activities (Jensen, 2007; Jensen and Schnack, 2006). However, integrating participatory approaches and allowing students to influence activities can translate such activities into actions (Jensen, 2007). Another key feature of the concept is its emphasis on knowledge, sense of accomplishment, commitment, and drive (Jensen, 2007). Action competence is composed of the cognitive dimension (knowledge about the issue and how it can be solved), the normative value-based component, a social component which is about awareness of the potentials of a community and the personality component which relates to confidence, responsibility and willingness to act (Breiting et al., 2009). The sub-components of action competence include knowledge of action possibilities, willingness to act, and confidence in one's skills and ability to influence change (Sass et al., 2020; Breiting and Mogensen, 1999; Jensen, 2007; Jensen and Schnack, 2006). These components are based on the notion that coherent knowledge is required for people to understand the problems, where they originated from and how they can be solved (Jensen, 2007). Additionally, long term sustainability actions require students conviction and willingness to actively engage to translate knowledge into sustainability actions (Breiting et al., 2009). This means that action competence emphasises not only equipping students with knowledge but also fostering qualities that enables students to make informed decisions.

Over time, the concept action competence has been utilised in diverse domains of education including environmental education, health education, and education for sustainable development (ESD) (Sass et al., 2020; Husamah, 2022). ESD seeks to empower individuals with a sense of agency, knowledge, and willingness to make informed decisions to address sustainability-related challenges either directly or indirectly and individually or collectively (Breiting and Mogensen, 1999; Jensen and Schnack, 2006; Sass et al., 2020; Wilhelm et al., 2019). Agency is the ability to intentionally influence events in one's life through communication, forethought, self-regulation, reflection, and self-consciousness (Bandura, 2006). Individuals are capable of planning and acting through intentional individual actions (individual agency), acting through others (proxy agency), and acting with others (collective agency) (Bandura, 2006). As an agent, active engagement in sustainability actions requires the ability to collaboratively work with others while reflecting and developing new strategies (Koskela and Paloniemi, 2023). Thus, self-efficacy (an individual's belief in their ability and the anticipated outcome of their actions) which is the foundation of personal agency will serve as a motivation for engagement (Bandura, 2000; Bandura et al., 2001). Consequently, people with high self-efficacy beliefs are more likely to be motivated to act and persevere in demanding situations (Bandura, 1998, 2006).

Moreover, scholars have not only viewed action competence as a competence of a group of individuals and a desired learning outcome to develop active citizens, but it has also been viewed as an educational approach (Ellis and Weekes, 2008; Sass et al., 2020). As a general concept related to addressing issues, Action Competence in Sustainable Development (ACiSD) has been introduced as the "individual or collective

competence of people focused on solving sustainable development issues", and can be fostered through ESD courses (Sass et al., 2020 p. 11).

2. Methodology

2.1. Data collection

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) procedures was utilised for the systematic review. The process involves four steps: 1) identification of literature sources, 2) screening, 3) eligibility check, and 4) inclusion (Moher et al., 2010). We used Web of Science (WoS) core collection database and Scopus databases, both databases cover an extensive range of peer-reviewed articles to identify the literature sources. The selected databases, Web of Science (WoS) and Scopus databases are one of the most comprehensive bibliographic databases for bibliographic analysis (Zhu and Liu, 2020). Our literature focused on journals published from the year 2000 to 2023 to provide up-to-date information on the topic. The literature search was conducted between March and April 2024 and an additional search was conducted in October 2024. Based on initial searches the criterion for selection and keywords were developed (Table 1). The selected keywords cover the constructs of ACiSD, education for sustainable development, motivation, and learning strategies such as critical thinking, problem-solving, self-regulation, and associated words, acronyms, and synonyms. The search was limited to ESD and EE courses and interventions within the formal school system and journal articles in English (see Table 2 for the inclusion and exclusion criteria). Selected papers were exported using Research Information Systems (RIS) to the Covidence software for screening. Duplicates from search results were removed and the articles selected are presented in the PRISMA flow chart (Figure 1).

2.2. Screening and data selection

The total number of articles selected from the two databases was 2,537 (Scopus – 1152, Web of Science – 1,385). The selected articles were cross-checked, 622 duplicates were removed with the help of the Covidence software and 1 non-English article was removed. The titles and abstract of the remaining 2,069 articles were reviewed to determine the relevance of the articles to the study. From the process, 1,273 articles were identified as not relevant for the study and removed resulting in 796 articles for further assessment and screening. For the next step of the screening process, 775 full text papers were screened for eligibility after the removal of 21 papers without full texts. During the screening process, two papers; one on learning outcomes from teachers' continuous professional development programme and another on ESD at the preschool level were identified from the reference list in a snowballing process and added to the selected studies. In total, 58 papers met the inclusion and exclusion criteria and were selected. The selection procedure conducted using the PRISMA guidelines are illustrated in Figure 1.

2.3. Quality assessment and data extraction

Quality assessment of selected papers was conducted using the Mixed Method Appraisal Tool version 2018 (MMAT), which is relevant for the assessment of the quality of empirical studies (Hong et al., 2018). Assessment criteria include evaluating the clarity of research question, and specific questions based on the

methodology (mixed method, quantitative, qualitative, randomized control trials and quantitative non-randomised) adopted for the study as well as the relevance of the study findings and outcomes from the collected data. The assessment process entails providing yes, no and cannot tell responses to questions and commenting on the methodologies and findings instead of scoring. We reached an agreement on nearly all the papers. Overall, the methodology and findings of the studies were sound, they provided clear research questions to assess the learning outcomes and course content of ESD/EE courses and interventions aimed at fostering action competence.

The relevant information from the selected literature was extracted to an Excel sheet. Data extracted included information on the educational level, ESD and EE courses and interventions, pedagogies and teaching methods, learning processes, methodologies, and research findings. After the extraction process, elements that contribute to the development of ACiSD were identified and grouped into themes based on their recurrence. The themes were combined to better understand how various ESD and EE courses and learning materials promote the development of ACiSD. Similar content from multiple studies was grouped into themes and synthesised to better understand the motivation and learning strategies identified in the literature related to ESD, EE, and action competence.

Table 1. Keywords search string

Database	**Keywords String**
Scopus	TITLE-ABS-KEY ("action competence in sustainable development" OR "self-perceived action competence" OR "action-orient*" OR "PACesd" OR "ACiSD-Q" OR "SPACS-Q") AND ("sustainability education" OR "education for sustainable development" OR "environmental education for sustainability" OR "education for sustainability" OR "environmental education" OR "EE" OR "ESD") (n = 73)
	TITLE-ABS-KEY ("action competenc*" OR "professional action competence in education for sustainable development" OR "action competence in sustainable development" OR "self-perceived action competence" OR "action-orient*" OR "PACesd" OR "ACiSD-Q" OR "SPACS-Q" OR “knowledge of action possibilities" OR "knowledge" OR "self-efficacy" OR "willingness to act" OR "outcome expectancy" OR "capacity expectation" OR “pedagogical content knowledge” OR “content knowledge” OR “PCK” OR “CK”) AND ("sustainability education" OR "education for sustainable development" OR "environmental education for sustainability" OR "education for sustainability" OR "environmental education" OR "EE" OR "ESD") AND ("cognitive" OR "problem-solving" OR "critical thinking" OR "peer learning" OR "learning strateg*" OR "learning process" OR "process" OR "metacognit*" OR “self-regulat*”) (n = 633)

Table 1. *Cont.*

Database	Keywords String
	("action competenc*" OR "professional action competence in education for sustainable development" OR "action competence in sustainable development" OR "self-perceived action competence" OR "action-orient*" OR "PACesd" OR "ACiSD-Q" OR "SPACS-Q" OR "knowledge of action possibilities" OR "knowledge" OR "self-efficacy" OR "willingness to act" OR "outcome expectancy" OR "capacity expectation" OR "pedagogical content knowledge" OR "content knowledge" OR "PCK" OR "CK") AND ("sustainability education" OR "education for sustainable development" OR "environmental education for sustainability" OR "education for sustainability" OR "environmental education" OR "EE" OR "ESD") AND ("willingness" OR "willingness to act" OR "positive attitude" OR "intrinsic motivation" OR "extrinsic motivation" OR "commitment" OR "motivat*" OR "motivation" OR "interest" OR "goal orientation") (n = 519)
Web of Science	("action competence in sustainable development" OR "self-perceived action competence" OR "action-orient*" OR "PACesd" OR "ACiSD-Q" OR "SPACS-Q") AND ("sustainability education" OR "education for sustainable development" OR "environmental education for sustainability" OR "education for sustainability" OR "environmental education" OR "EE" OR "ESD") (n = 81)
	TITLE-ABS-KEY ("action competenc*" OR "professional action competence in education for sustainable development" OR "action competence in sustainable development" OR "self-perceived action competence" OR "action-orient*" OR "PACesd" OR "ACiSD-Q" OR "SPACS-Q" OR "knowledge of action possibilities" OR "knowledge" OR "self-efficacy" OR "willingness to act" OR "outcome expectancy" OR "capacity expectation" OR "pedagogical content knowledge" OR "content knowledge" OR "PCK" OR "CK") AND ("sustainability education" OR "education for sustainable development" OR "environmental education for sustainability" OR "education for sustainability" OR "environmental education" OR "EE" OR "ESD") AND ("cognitive" OR "problem-solving" OR "critical thinking" OR "peer learning" OR "learning strateg*" OR "learning process" OR "process" OR "metacognit*" OR "self-regulat*") (n = 841)
	TITLE-ABS-KEY ("action competenc*" OR "professional action competence in education for sustainable development" OR "action competence in sustainable development" OR "self-perceived action competence" OR "action-orient*" OR "PACesd" OR "ACiSD-Q" OR "SPACS-Q" OR "knowledge of action possibilities" OR "knowledge" OR "self-efficacy" OR "willingness to act" OR "outcome expectancy" OR "capacity expectation" OR "pedagogical content knowledge" OR "content knowledge" OR "PCK" OR "CK") AND ("sustainability education" OR "education for sustainable development" OR "environmental education for sustainability" OR "education for sustainability" OR "environmental education" OR "EE" OR "ESD") AND ("willingness" OR "willingness to act" OR "positive attitude" OR "intrinsic motivation" OR "extrinsic motivation" OR "commitment" OR "motivat*" OR "motivation" OR "interest" OR "goal orientation") (n = 544)

Table 2. Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Database	Scopus, Web of Science	Other databases
Period	2000 - 2023	Earlier studies
Language	English	Other languages
Data Source	Empirical studies	Conceptual, theoretical, or review papers
Intervention	Action competence as a learning outcome of ESD and EE courses and interventions	Other learning outcomes of ESD and EE courses and interventions

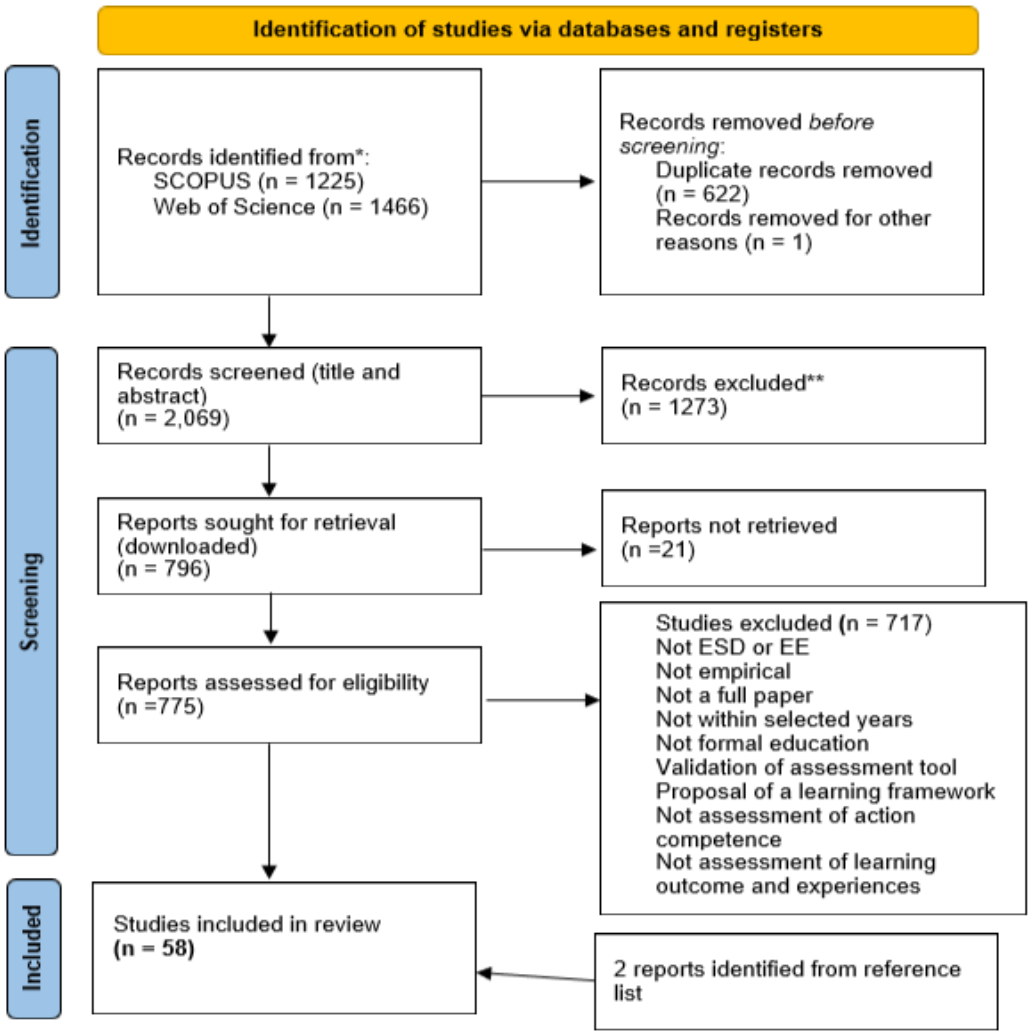


Figure 1. Document identification and selection process

3. Results

3.1. Characteristics of selected studies

Figure 2 illustrates results for trend of publications. Generally, the trend of publication reveals periods of increase and fall. The highest number of publications was in 2022, a notable increase from previous years but a reduction in the subsequent year. The regional distribution of selected papers is presented in Figure 3. The results reveal that the majority of the publications originated from the European region (43%), followed by Asia (15.52%), multi-country interventions and America (10.34%). Other regions covered included Oceania (New Zealand and Australia) representing (8.62%) and Africa (6.9%). The least represented regions were the Caribbean and the Middle East. For the educational level, ESD and EE courses were found at all educational levels, from preschool to higher education institutions and university levels (Figure 4). Most studies were based on courses and interventions at the secondary and high school level (12 studies), followed by the university level (11 studies), primary and elementary schools (8 studies) and pre-service education (7 studies). Some studies included interventions consisting of diverse educational levels including middle school and high school as well as whole school approaches and interventions involving students and teachers. The least represented educational level was the junior high school and preschool level. Although the selected studies focused on formal ESD and EE programs, some studies highlight interventions between schools and communities and agencies, youth extracurricular activities, proposals for formal education based on assessment of two informal youth organisations and school club activities (Dittmer et al., 2018; Ian et al., 2019; Kalla et al., 2022; Lee, 2017; Monroe et al., 2016). The research design of selected studies is presented in Figure 5. The results reveal a dominance of research pertaining to qualitative methods (25 studies) including interviews, reflection notes, classroom observations and analysis of textbooks and curricula, followed by quantitative methods (14 studies) including surveys and experimental interventions, and mixed method approaches (12 studies) comprising of surveys and interviews, focus group discussions, refection notes, and observation.

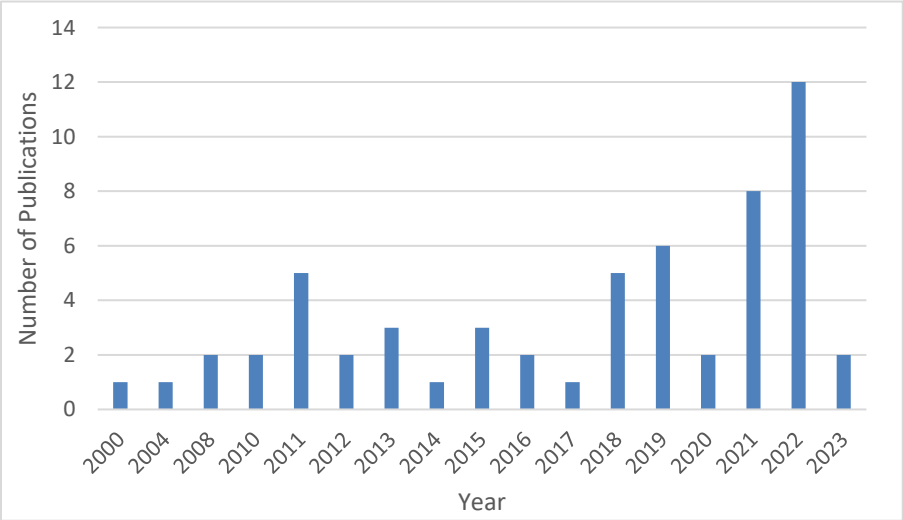


Figure 2. Trend of publications

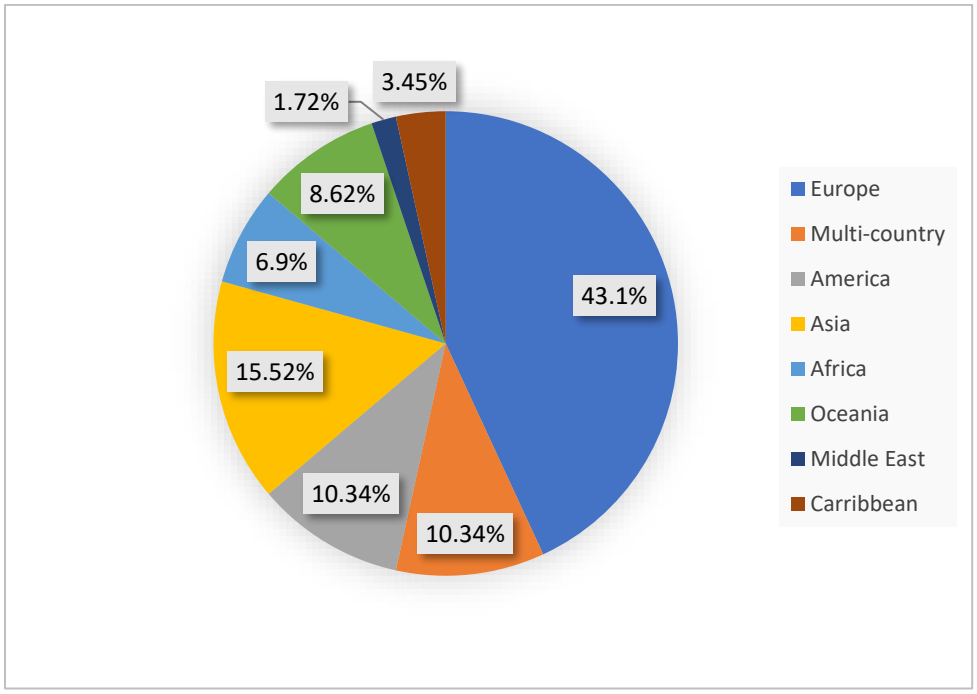


Figure 3. Regional distribution of publications

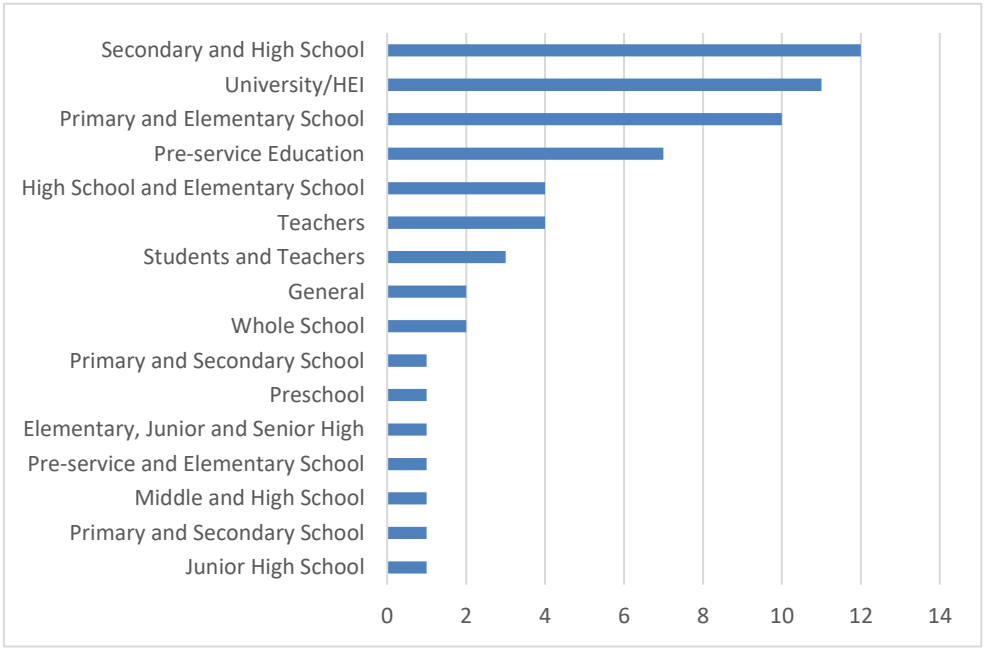


Figure 4. Educational level

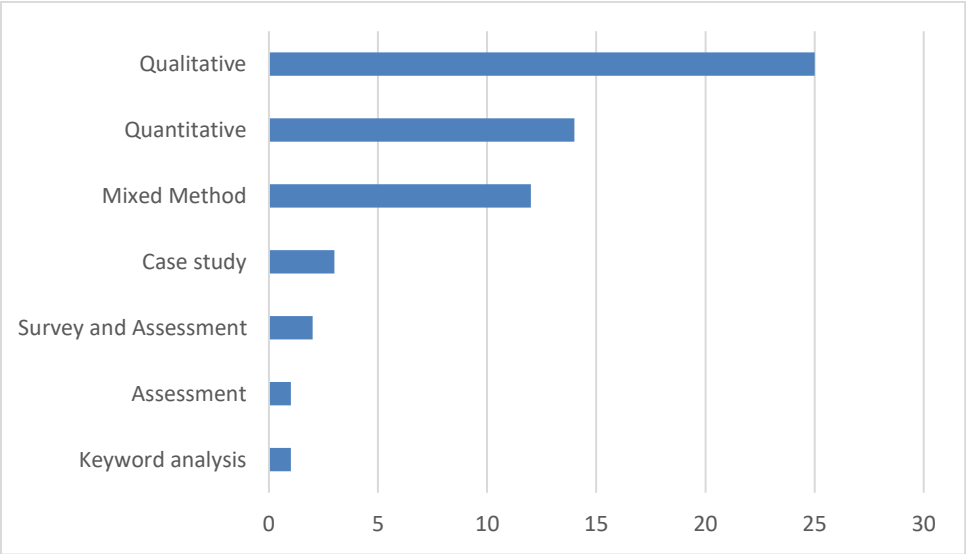


Figure 5. Research design

3.2. Contributing factors to the development of ACiSD

Based on the analysis of courses and results from the learning outcomes, four main factors were identified to foster ACiSD. They are action-oriented and participatory pedagogies, teaching and learning materials, teacher education and training, and school organisations. The proceeding sections provide a detailed summary and synthesis of the identified factors. Table 3 provides a summary of the identified contributing factors.

3.2.1. Action-oriented and participatory pedagogies

The literature indicates that ESD and EE courses integrating traditional and experiential learning and action-oriented methods are effective approaches fostering action competence. Traditional classroom activities including brainstorming, lectures and presentations provide students with foundational knowledge, while experiential learning methods including drama, field visits and film-making enable students to apply knowledge in real world settings through direct and indirect actions (Dimopoulos et al., 2008; Koutalidi et al., 2016; Moyer-Horner et al., 2010; Piasentin and Roberts, 2018; Zhan et al., 2019; Bramwell-lalor et al., 2020; Eppinga et al., 2019; Harness and Drossman, 2014). ESD and EE courses promoted direct actions including developing practical solutions such as water conservation plans and checklists, waste auditing and tracking, development of sustainability plans, volunteering and community environmental campaigns (Ian et al., 2019; Moyer-Horner et al., 2010; Zhan et al., 2019; Mcnaughton, 2004; Stoll et al., 2022). These hands-on learning activities increased students understanding of sustainability challenges and how they can contribute to solving these challenges. Indirect actions involved students in tasks related to advocacy and policy such as writing letters to the Ministry of Environment to advocate for people affected by biodiversity conservation measures and submission of proposals to the local government (Dimopoulos et al., 2008; Birdsall, 2010). Some course activities combined both direct and indirect actions (Birdsall, 2010), while others extended learning beyond the classroom through home-based activities. This approach enabled students to involve their families in hands-on sustainability learning, as seen in the “Do One Thing” (DOT) strategy and the urban farming project, where students and their families proposed actionable sustainability solutions and engaged in urban farming

and water conservation activities at home and school (Dutta and Chandrasekharan, 2018; Muller and Wood, 2021; Zhan et al., 2019). Furthermore, ESD and EE courses integrating outdoor activities enabled students to connect and explore nature. For example, field visits to mangrove sites, urban farms and lakes increased students moral judgement, willingness to collaborate with others and enabled them to overcome fear associated with environmental actions (Birdsall, 2010; Eppinga et al., 2019; Moyer-Horner et al., 2010; Palmberg and Kuru 2010; Sieg and Dreesmann, 2021). The relevance of combining hands-on learning activities in fostering competence was demonstrated in studies conducted by Freund (2019), which found that students felt disempowered to contribute to orangutan and forest conservation due to lack of hands-on conservation activities such as tree planting, and clean up exercises. In addition to hands-on learning activities, guiding students and encouraging them to reflect on their sustainability habits and actions is relevant not only for fostering action competence but also ensuring that hands-on learning methods are effective (Guerra et al., 2022; Sammalisto et al., 2016). Besides, one-time sustainability interventions might not support the development of action competence in the long term, thus incorporating sustainability education into the whole curriculum is essential (Tsevreni, 2011).

Nonetheless, the diverse pedagogical strategies engaged students in diverse learning environments which increased their understanding of sustainability. Examples include creative activities like filmmaking and active pedagogies involving role plays, film-making and drama, which provided students with greater understanding of sustainability actions compared to the control group in the EE class and enhanced communication, collaboration and self-expression abilities (Birdsall, 2010; Harness and Drossman, 2014; Mcnaughton, 2004). To add to these, web-based and online platforms have emerged as important learning platforms to acquire sustainability knowledge through integrating documentary clips, videos and animations into classroom learning activities (Bramwell-lalor et al., 2020; Lee, 2017). These platforms facilitated exchange of ideas and sharing of sustainability projects, and artefacts among students from diverse countries (Bramwell-lalor et al., 2020; Muller and Wood, 2021). Similarly, extra-curriculum and school club activities provided distinct platforms for student engagement, through enhancing existing knowledge and practical sustainability activities. These activities deepened students' sustainability knowledge and promoted student-led initiatives including the development of sustainability plans, management of school blogs, and the design of cooking stoves to address sustainability challenges (Dittmer et al., 2018; Ian et al., 2019; Lee, 2017). Furthermore, formal sustainability courses have led to the formation of student-initiated clubs such as the Making Aruba a Greener Environment Club, (M.A.G.E.C.). The formation of the club highlights the relevance of student-centred and practical sustainability courses in increasing sustainability actions beyond schools to the wider community (Eppinga et al., 2019).

In addition to course activities, a comprehensive understanding of environmental science, socio-economic systems and pathways for transformation, as outlined by (Jensen, 2010), can serve as a prerequisite for sustainability action (Birdsall, 2010). Studies by Tsevreni (2011) suggested that increased sustainability knowledge can enhance students awareness of their exclusion from sustainable urban planning. Moreover, incorporating holistic sustainability knowledge with outdoor field activities is emphasised as a crucial approach to deepen students' understanding of real-world issues. This approach enables students to envision a sustainable future where environmental resources are managed effectively (Birdsall, 2010). Additionally, integrating systematic, action-related and practical understanding of sustainability empowers students to make informed sustainability decisions and fosters their ability to recognise trade-offs (Liefländer et al., 2015).

Collaboration with stakeholders, including state agencies, NGOs, and community members played an essential role in translating sustainability knowledge into real world actions aimed at managing wildfires and deforestation (Dittmer et al., 2018; Monroe et al., 2016). The courses at HEIs and universities engaged students and teachers to collaboratively propose solutions to sustainability challenges through assessment of multiple sustainability cases, systems thinking, transformational learning approaches, and service-oriented activities that involved working with teachers, experts and local NGOs to develop capstone projects (Dittmer et al., 2018; Amashi et al., 2021; Bryant et al., 2023; Kinoshita et al., 2019; Nelson et al., 2022; Piasentin and Roberts, 2018). The aim was to develop students as sustainability leaders and stewards who can collaborate with other stakeholders. Student agency and willingness to act which emerged from transformative and project-based learning was exhibited in diverse contexts including co-construction and collaboration with peers, lecturers, across programmes of study, faculty, university and community (Bryant et al., 2023; Guerra et al., 2022). However, there were differences in students' awareness and personal sustainability actions (Guerra et al., 2022).

Furthermore, student participation in decision-making was identified as a key factor in developing action competency. Cincera and Krajhanzl (2013) discovered a strong link between students' perceived participation and action competence, as well as student membership and satisfaction with Eco school programs. Similarly, Silo (2013) found students increased responsibility and motivation through student-led initiatives that emerged from dialogues and participatory decision-making processes. Participatory and pluralistic learning empowers students to make decisions on alternative actions to address sustainability related challenges (Hedefalk et al., 2014; Olsson et al., 2022). Conversely, limited participation and normative teaching principles, which is learning based on predetermined values, and actions tend to narrow students' ability to think critically and contribute to addressing sustainability related challenges (Cincera and Krajhanzl, 2013; Hedefalk et al., 2014; Silo, 2013; Olsson et al., 2022). Although results from the review revealed positive outcomes from sustainability courses, some studies highlighted significant differences in knowledge, motivation, self-efficacy, and commitment among female and male students, and students with existing knowledge and good academic performance. Specifically, girls and students with high grades reported greater awareness and motivation (Koutalidi et al., 2016; Sammalisto et al., 2016).

3.2.2. Teaching and learning materials

The review included empirical assessments of teaching and learning materials that fosters action competence. The study findings emphasise the relevance of integrating sustainable development into existing curricula and school subjects such as science, biology, and geography and including knowledge on the dimensions of sustainable development, promoting student autonomy and leadership, as well as critical thinking, and action-oriented tasks (Biström and Lundström, 2021; Jóhannesson et al., 2011; Kowasch, 2017; Mongar, 2022). The free-choice project-based learning curriculum identified that real-world, student-centred learning, as well as democratic, and reflective learning processes as essential elements for developing action competence at the formal education level (Kalla et al., 2022). Nonetheless, results from the systematic review revealed inadequate integration of ESD and elements related to action competence in existing school teaching and learning materials. While elements of action competence including democracy, critical thinking, and communication skills were available in school subjects such as arts and crafts, science and environmental education, and life skills curricula, there was no specific focus on ESD (Jóhannesson et al., 2011). Additionally, the course contents

were focused on the causes and consequences of sustainability issues, rather than promoting sustainability vision and alternative solutions (Dalelo, 2012; Eliyawati et al., 2022).

Moreover, teaching and learning materials overemphasised the environmental aspects of sustainable development, neglecting the economic and social dimensions (Biström and Lundström, 2021; Mongar, 2022). For example, evaluation of a sustainable land use curricula revealed that teachers emphasised environmentally friendly actions such as recycling and waste management actions over non-environmentally friendly actions including information sharing, collaboration with local organizations, participation in planning meetings and consumer transportation actions (Kumler, 2011). Overemphasising the environmental aspects of sustainable development reduces students' understanding of sustainability, especially the complexities associated with the concept. Reducing the complexity of sustainability hinders students' ability to engage in critical thinking (Biström and Lundström, 2021; Mongar, 2022; Raselimo et al., 2013).

Furthermore, the review revealed that school curricula and textbooks provided limited content and guidance on action-oriented teaching methods, including hands-on and learner-centred approaches and actions related to climate change mitigation and adaptation (Dalelo, 2012; Kowasch, 2017; Kumler, 2011; Raselimo et al., 2013). The absence of these pedagogical elements has been found to limit students' participation in sustainability actions and negatively affect the effectiveness of ESD and EE courses and interventions.

3.2.3. Teacher education and training

Both pre-service and in-service teachers play a significant role in fostering action competence. Existing literature on teachers and action competence are mainly focused on sustainability interventions and courses developed not only to equip educators at all educational levels to teach sustainability-related courses but to act as sustainability change agents. Thus, teacher training is vital for effective implementation of ESD courses and the enhancement of students sustainability competencies (Murphy et al., 2020). These training programmes seek to enhance teachers understanding of sustainability content knowledge (CK) and pedagogical content knowledge (PCK) through diverse teaching methods, such as lectures, hands-on practical learning, self-directed and collaborative action research activities. Moreover, targeted training programmes equip teachers with PCK and practical strategies to implement sustainability courses and curricula. For example, studies by Isac et al. (2022) found that collaborative engagement with in-service teachers resulted in strong PCK, increased confidence and willingness to implement ESD; regardless of gender, educational level, or previous experiences. Furthermore, collaborative action research facilitated through co-designing and planning with experts and researchers ensured participation and the development of teachers' abilities to be sustainability agents (López-Alcarria et al., 2021). Additionally, integrating hands-on and practical learning activities into teacher training programmes as part of a continuous professional development (CPD) was found to be beneficial for both students and teachers. These activities not only helped teachers develop strategies to implement real-world sustainability projects, but they also increased teachers value for environmentally friendly behaviour and actions (Bramwell-lalor et al., 2020; Murphy et al., 2020). Furthermore, reports from students whose teachers took part in a CPD programme revealed an increase implementation of real-world learning activities, as well as improved students understanding due to inclusion of holistic sustainability concepts (Olsson et al., 2022; Murphy et al., 2021). However, the lack of adequate teacher training and support programmes hinders teachers' ability to adopt innovative sustainability teaching practices, even when they

recognise the relevance of such approaches. Mongar et al. (2023) identified a misalignment between teachers' value for sustainability actions and their actual implementation of action-oriented practices in the classroom. The study emphasised the need to create support programmes and expert groups to support teachers to incorporate action-oriented pedagogies in their teaching practices.

In addition to in-service teacher training programmes, teacher education institutions aim to enhance pre-service teachers' capacity to implement ESD and EE courses by integrating sustainability courses into existing educational curricula. These courses aim to develop both PCK and CK through diverse pedagogies and teaching methods. The incorporation of ESD into teacher education was found to significantly improve teachers' understanding of sustainability issues and willingness to engage in environmentally friendly actions such as reduction of meat consumption (Banos-González et al., 2021; Ferguson et al., 2022). Furthermore, Brandt et al. (2019), highlighted the relevance of integrating theoretical and practical pedagogies and enhancing students' personal connection to course content in strengthening pre-service teachers CK. Moreover, hands-on and practical learning approaches not only enhanced pre-service teachers' knowledge but also improved their confidence, self-efficacy and motivation to teach ESD (Gal, 2023; Brandt et al., 2019, 2022; Ferguson et al., 2022; Lindemann-Matthies et al., 2011; Merritt et al., 2019; Nielsen et al., 2012). Besides, these pedagogical approaches provided pre-service teachers with a holistic understanding of sustainability, thus enhancing their sense of responsibility and competence to teach sustainability-related topics including hands-on and outdoor learning activities (Lindemann-Matthies et al. 2011; Brandt et al., 2019; Merritt et al., 2019; Nielsen et al., 2012; López-Alcarria et al., 2021).

Additionally, pre-service teachers' sustainability knowledge and capacity for implementation were strengthened through diverse pedagogical approaches. One significant transformation from such an initiative was the shift in pre-service teachers perspective from viewing sustainability education as a narrow concept related to recycling towards recognising the broader dimensions of sustainability and the relevance of teaching young students about sustainability (Gal, 2023). Furthermore, integrating diverse learning approaches enhanced interaction between student teachers and implementors of sustainability courses including tutors and in-service teachers. These learning experiences offered them a practical understanding of hands-on learning activities such as gardening, and waste auditing (Brandt et al., 2019; Gal, 2023; Nielsen et al., 2012; Brandt et al., 2022). However, the inability of pre-service teachers' to design integrated teaching plans was identified as a limitation to fostering action competence (Gooch et al., 2008). To address this challenge, Gooch et al. (2008) and Gal (2023) recommend that teacher education programmes guide pre-service teachers to develop model plans, utilise required reference materials and interact with their communities to improve their practical understanding of sustainability.

3.2.4. School organisations

School organisations play a pivotal role in fostering action competence. Verhelst et al. (2022) found that sustainability leadership, including promoting long-term, inclusive and democratic decisions and interventions influences students action competence, particularly knowledge and willingness to act. Furthermore, visionary leadership and resource availability were identified as essential factors for establishing partnerships between educational institutions, communities, and state institutions and agencies (Monroe et al., 2016). These collaborations are relevant for developing sustainability interventions that promote students' sustainability actions and they ensure the effectiveness of such interventions.

Table 3. Summary of the contributing factors to the development of ACiSD

Factor	Elements identified in courses and initiatives	Reference
Action-oriented and participatory pedagogies	Traditional classroom and hands-on learning to enable practical application of knowledge	Birdsall, 2010; Dimopoulos et al., 2008; Koutalidi et al., 2016; Lin et al., 2022; Moyer-Horner et al., 2010; Piasentin and Roberts, 2018; Stoll et al., 2022; Zhan et al., 2019
	Diverse learning platforms including informal school clubs and online platforms for continuous engagement	Bramwell-lalor et al., 2020; Dittmer et al., 2018; Eppinga et al., 2019; Ian et al., 2019; Lee, 2017; Muller and Wood, 2021
	Holistic knowledge of the dimensions of sustainable development and the interconnections between them	Birdsall, 2010; Olsson et al., 2022; Tsevreni, 2011
	Dialogues and participatory decision-making processes and autonomy through student-led initiatives	Cincera and Krajhanzl, 2013; Silo, 2013; Hedefalk et al., 2014
	Collaborative and community engagement in sustainability courses and interventions	Dittmer et al., 2018; Monroe et al., 2016; Guerra et al., 2022; Ian et al., 2019; Kinoshita et al., 2019; Nelson et al., 2022
Teaching and learning Materials	Incorporating ESD and EE into existing curricula and holistic teaching and learning materials	Biström and Lundström, 2021; Kowasch, 2017; Mongar, 2022; Raselimo and Wilmot, 2013
Teacher education and training	Teachers' competencies and professional development from collaborative learning activities	Isac et al., 2022; López-Alcarria et al., 2021; Brandt et al., 2019; Ferguson et al., 2022; Nielsen et al., 2012
	Teacher support programmes to increase action-oriented knowledge and development of teaching materials	Gooch et al., 2008; Mongar et al., 2023
	Practical and hands-on learning to promote theoretical and practical knowledge of sustainability	Merritt et al., 2019; Nielsen et al., 2012; Brandt et al., 2019
	Interactions with teachers and implementors of hands-on sustainability courses and interventions	Brandt et al., 2019; Gal, 2023; Nielsen et al., 2012; Brandt et al., 2022
School organisations	Sustainability leadership, democratic decision-making, and availability of resources	Monroe et al., 2016; Verhelst et al., 2022

3.3. Motivation and learning strategies

3.3.1. Motivation

The review indicates students' improved confidence, self-efficacy, and value for sustainability-related topics after participating in sustainability courses, based on data gathered from pre- and post-surveys, interviews, student interactions, and student and teachers' willingness to participate in individual sustainability actions (Table 4). Results from the review indicates that students' confidence and interest significantly improved as a result of place-based learning experiences, through interacting with sustainability leaders and engaging in real world actions addressing issues such as biodiversity conservation, deforestation, and waste management (Sieg and Dreesmann, 2021; Dittmer et al., 2018; Lin et al., 2022; Moyer-Horner et al., 2010; Silo, 2013; Stoll et al., 2022; Dimopoulos et al., 2008; Freund, 2019; Lindemann-Matthies et al., 2011; Zhan et al., 2019). These diverse pedagogical approaches were beneficial for students and empowered both in-service and pre-service teachers to implement sustainability courses in the classroom. These methods fostered students agency and increased their locus of control and intentions for continuous sustainability actions (Harness and Drossman, 2014; Merritt et al., 2019; Nielsen et al., 2012; Stoll et al., 2022; Lindemann-Matthies et al., 2011; Birdsall, 2010; Eames et al., 2018). Despite facing challenges while engaging in real-world learning activities, students found motivation, autonomy, and a sense of purpose in real world sustainability actions (Dutta and Chandrasekharan, 2018).

The review further indicates that sustainability learning experiences significantly influenced the value both students and teachers placed on nature and sustainability-related challenges, thus enhancing their willingness to contribute to change. For example, teachers realised the value for trees in a project-based learning initiative involving practical classroom implementation and hands-on learning activities (Bramwell-lalor et al., 2020). These pedagogical elements not only increased pre-service teachers desire to teach and learn about sustainability (Bramwell-lalor et al., 2020; Brandt et al., 2022; Gal, 2023; Merritt et al., 2019; Nielsen et al., 2012), but also emphasised the role of intrinsic motivation and personal interest which serve as an influencing factors in students decision to engage in sustainability courses (Ian et al., 2019; Murphy et al., 2020; Nelson et al., 2022).

Students' self-efficacy and confidence for sustainability actions were reflected in their willingness to initiate personal sustainability initiatives, such as creating blogs focused on sustainability topics, communicating about environmental problems, actively participating in local sustainability actions, and volunteering (Tsevreni, 2011; Bryant et al., 2023; Dittmer et al., 2018; Moyer-Horner et al., 2010; Sieg and Dreesmann, 2021; Zhan et al., 2019; Piasentin and Roberts, 2018). Students overcame initial fears of conserving bumblebees through outdoor learning activities, which fostered essential skills for developing self-efficacy including positive emotions and enhanced group and self-reflection (Birdsall, 2010; Gal, 2023; Sieg and Dreesmann, 2021). Although students can experience negative emotions while studying in real-world settings, training teachers to address the negative emotions that may arise from real-world sustainability learning and linking sustainability education to students' community context can provide emotional grounding (Muller and Wood, 2021). Additionally, students' developed a sense of accomplishment from the opportunity to develop student-led solutions to waste management in their school (Silo, 2013).

Motivation also played an instrumental role in enabling students to complete their sustainability-related tasks, for example, students commitment to collecting marine litter to develop sculptures for an ESD art course

(Stoll et al., 2022). Although results from the review have established the relevance of combining classroom learning and hands-on activities in enhancing students understanding and motivation to act, some studies reported that these positive transformations were significant for female students and better performing students (Koutalidi et al., 2016). Studies by Eames et al. (2018) and Olsson et al. (2022) found that even after sustainability courses, students had limited confidence for public sustainability actions. Olsson and colleagues (2022) attributed students' low confidence to limited opportunities for student participation in decision-making. However, Tsevreni (2011) suggested that the confidence building is a gradual process evolving from self-denial to willingness to engage in proactive actions.

Table 4. Summary of the contributing factors to the development of ACiSD

Motivation	Key points	References
Confidence and self-efficacy (belief in the capacity to act)	Confidence for sustainability actions through hands-on learning activities	Dittmer et al., 2018; Piasentin and Roberts, 2018; Sieg and Dreesmann, 2021; Isac et al., 2022; Monroe et al., 2016; Zhan et al., 2019
	Self-efficacy for personal sustainability actions and teaching sustainability-related topics in the classroom	Dittmer et al., 2018; Moyer-Horner et al., 2010; Piasentin and Roberts, 2018b; Tsevreni, 2011; Tsevreni, 2011; Bryant et al., 2023; Dittmer et al., 2018; Moyer-Horner et al., 2010; Sieg and Dreesmann, 2021; Zhan et al., 2019; Piasentin and Roberts, 2018
Value	Improved value for sustainability related topics after course activities	Bramwell-lalor et al., 2020
Intrinsic motivation	An influencing factor in students and teachers' decision to participate in ESD courses	Ian et al., 2019; Murphy et al., 2020; Nelson et al., 2022
Positive emotions	Reduced fear and anxiety from place-based and hands-on courses	Muller and Wood, 2021; Sieg and Dreesmann, 2021
	Intrinsic reward from student-led interventions	Silo, 2013

3.3.2. Learning strategies

The analysis of course descriptions and learning activities highlights the dominant use of collaboration, peer learning and cognitive strategies such as critical thinking (Table 5). Collaboration and peer learning strategies are essential strategies for sustainability courses aimed at fostering action competence. The literature identifies multiple forms of collaborations. These include internal and external collaborations among students locally and across different countries (Birdsall, 2010; Dimopoulos et al., 2008; Dutta and Chandrasekharan, 2018; Eppinga et al., 2019; Bramwell-lalor et al., 2020; Muller and Wood, 2021). External partnerships between educational institutions and local communities, government agencies, and non-governmental organizations (NGOs) (Guerra et al., 2022; Kinoshita et al., 2019; Monroe et al., 2016; Nelson et al., 2022).

Additionally, collaboration extends to interactions between students, experts, and researchers (Brandt et al., 2019; Dittmer et al., 2018; López-Alcarria et al., 2021; Merritt et al., 2019; Piasentin and Roberts, 2018), as well as between students and teachers (Bryant et al., 2023; Kinoshita et al., 2019). It also includes broader internal school engagement involving principals, care takers, and parents, thus emphasising whole school approaches to sustainability education (Lee, 2017; Murphy et al., 2021). These collaborative activities enabled students to co-develop creative solutions to real-world sustainability challenges while learning from experts and communities.

Furthermore, collaboration plays a pivotal role in fostering sustainability competences. Isac et al. (2022) found that participation in a teacher co-learning environment increased teachers' professional action competence and preparedness to implement ESD courses in the classroom. These communities of practice allowed educators with shared interests to engage in collaborative learning to develop skills and strategies to implement ESD courses at diverse educational levels (Isac et al., 2022; Kalla et al., 2022; López-Alcarria et al., 2021). Beyond collaboration among teachers, effective implementation of ESD requires broader coordination among stakeholders. Murphy et al. (2020, 2021) highlighted those collaborative interventions encompassing teachers, principals, students, and care takers as part of professional development programmes not only built educators' capacity to implement whole school sustainability plans but enhanced mutual learning. These collaborative frameworks facilitate exchange of knowledge and allows students and teachers to co-develop sustainability solutions, thus developing both individual and collective competencies (Bramwell-lalor et al., 2020; Bryant et al., 2023; Kinoshita et al., 2019). Besides, collaborations between students and teachers have resulted in significant student-led initiatives, particularly on waste management and sanitation through inclusive decision-making processes and dialogues (Silo, 2013).

Additionally, local and global interactions among students through online platforms, have promoted cross-cultural exchange and expanded students' awareness of global sustainability issues. These digital connections facilitate interactions between students from diverse backgrounds to discuss issues such as climate change and to share insights on their sustainability projects, thus providing an opportunity to cultivate comprehensive understanding of sustainability challenges (Bramwell-lalor et al., 2020; Muller and Wood, 2021). These collaborations have provided meaningful learning platforms that facilitates discussions and debates on complex sustainability as well as equipping students to overcome real world sustainability challenges, facilitating deeper understanding of sustainability issues, and building motivation for sustainability actions (Lee, 2017; Muller and Wood, 2021; Guerra et al., 2022; Dutta and Chandrasekharan, 2018; Brandt et al., 2019). The significance of group activities in preparing students for sustainability actions is highlighted by (Kumler, 2011), who found that students encountered greater obstacles when addressing sustainability challenges individually.

Cognitive learning strategies, including critical thinking are essential for fostering action competence. Critical thinking enable students to interpret and analyse the complex interaction between ecosystems and humans, thus empowering them to translate knowledge into actions (Biström and Lundström, 2021; Brandt et al., 2019; Koutalidi et al., 2016; Merritt et al., 2019; Piasentin and Roberts, 2018; Stoll et al., 2022). Critical thinking skills were further enhanced by engaging different pedagogical methods including hands-on and student-centred approaches. These methods allowed students to participate in innovative problem-solving activities as part of the real-world learning process (Gal, 2023). For instance, certain course activities demanded students to creatively transform marine litter into sculptures, to engage in imaginative activities, to

envision the future, to develop SDG plans, and to conduct environmental audits (Ian et al., 2019; Nielsen et al., 2012; Stoll et al., 2022; Tsevreni, 2011). These creative exercises enabled students to visualise an alternative future world and formulate actionable steps to achieve the envisioned world through engaging in reflection activities (Merritt et al., 2019; Tsevreni, 2011; Bramwell-lalor et al., 2020). However, students' ability to think critically can be constrained by oversimplification of the complexities associated with the concept of sustainable development (Biström and Lundström, 2021). This limitation highlights the need for holistic and comprehensive sustainability education (Olsson et al., 2022).

Table 5. Summary of the motivation and learning strategies associated with ACiSD

Learning strategy	Key findings	Reference
Collaboration	Internal collaborations- among peer students, students and teacher interactions, and interactions between teachers, students, principals and school staff	Bryant et al., 2023; Dimopoulos et al., 2008; Dutta and Chandrasekharan, 2018; Kinoshita et al., 2019; Lee, 2017; Silo, 2013; Bramwell-lalor et al., 2020; Muller and Wood, 2021; Birdsall, 2010; Dimopoulos et al., 2008; Dittmer et al., 2018; Isac, et al., 2022; Tsevreni, 2011; Zhan et al., 2019
	External collaborations; partnerships between schools and state agencies, NGOs, communities and sustainability leaders and peer collaborations among students from different countries	Dittmer et al., 2018; Guerra et al., 2022; Monroe et al., 2016; Piasentin and Roberts, 2018
	Both internal and external collaborations	Bramwell-lalor et al., 2020; Muller and Wood, 2021; Kinoshita et al., 2019; Piasentin and Roberts, 2018
Critical thinking	Analysis and interpretation of complex sustainability information	Biström and Lundström, 2021; Brandt et al., 2019; Koutalidi et al., 2016; Merritt et al., 2019; Piasentin and Roberts, 2018; Stoll et al., 2022
	Learning strategy for hands-on, creative and imaginative learning approaches	Gal, 2023; Ian et al., 2019; Nielsen et al., 2012; Stoll et al., 2022; Tsevreni, 2011
	Developed through holistic and comprehensive sustainability courses and textbooks	Biström and Lundström, 2021; Olsson et al., 2022
Self-directed and self-regulation strategies	Student leadership in sustainability courses encouraged goal-setting, teamwork, planning, and monitoring	Brandt et al., 2022b; Guerra et al., 2022; Moyer-Horner et al., 2010; Piasentin and Roberts, 2018
	Independent and student led research inspired by active pedagogical approaches	Mcnaughton, 2004

Besides, incorporating traditional classroom methods and action-oriented learning activities allowed students to employ a variety of learning strategies. Moyer-Horner et al. (2010) demonstrated students' utilization of multiple cognitive processes, such as conceptual and procedural knowledge for exams and classroom discussions, as well as metacognitive strategies for hands-on and real-world learning such as tracking personal and household waste. To add to these, diverse pedagogical approaches including collaborative learning and drama transformed students' and pre-service teachers' cognitive understanding and stimulated students to reconstruct their understanding of sustainability (Dutta and Chandrasekharan, 2018; Gal, 2023; Mcnaughton, 2004).

Furthermore, the review highlights students' engagement in self-directed and self-regulated learning activities, particularly through student-led interventions and courses. Through these initiatives, students utilised several self-regulation skills including goal-setting, teamwork, planning, and collective sustainability actions and monitoring (Guerra et al., 2022; Moyer-Horner et al., 2010). Through strategic planning strategies, pre-service teachers could develop lesson plans and communicate effectively, while goal-setting enabled university students to complete course tasks and assessments (Brandt et al., 2019; Piasentin and Roberts, 2018). Furthermore, active learning strategies involving educational drama enabled students to engage in independent research to find answers to emerging questions on waste and recycling activities (Mcnaughton, 2004). This independent research led to student-led community environmental campaigns using booklets and posters prepared by students.

4. Discussion

4.1. Characteristics of selected studies

Results from the review reveal a growing popularity of ESD and EE courses and interventions aimed at developing action competence at all educational levels. The periodic times of rise and fall in publications between 2014 to 2017 and a period of rise between 2021 and 2022 were also found by (Husamah, 2022). Chen and Liu (2020) also found limited studies on action competence in the early years of development of the topic. Nonetheless, this review found that the topic action competence is expanding and becoming relevant globally, the study found publications from all over the world (Husamah, 2022). However, the European region had the highest number of publications. The European region is regarded as the originator and the highest contributor of research on action competence and EE (Chen and Liu, 2020; Husamah, 2022). Nonetheless, the rise in the recognition for sustainability action across the various regions can be explained by the growing impact of unsustainable human behaviour on the environment and the expansion of EE to address environmental challenges (Husamah, 2022; Beny et al., 2021). It also emphasises the growing recognition of sustainability action and competence-based education, which prioritises problem-solving and social skills instead of the acquisition of knowledge (Carrapatoso, 2021; Frisk and Larson, 2011; de Haan, 2006). These learning approaches play a significant role in identifying the most effective method to promote real-world learning (Qablan, 2018).

Furthermore, interventions at all educational levels emphasise the growing recognition of the significant role education plays in facilitating changes in how students think, act, and transition to sustainable lifestyles (Qablan, 2018; UNESCO, 2012). The review findings on interventions targeted at high school and elementary

students and limited interventions at the preschool and early childhood education level is similar to earlier reviews by (Chen and Liu, 2020). However, unlike results from earlier reviews the study found a high number of interventions and courses at the university level. This emphasises the recognition of the changing role of universities and higher educational institutions as relevant forces and agents in the advancement of sustainable development (Abo-khalil, 2024; Tejedor et al., 2019). From the review, action competence can be evaluated using quantitative, qualitative, or mixed methods and the dominant assessment method was qualitative methodologies. Existing studies also found the dominant use of qualitative methods (Husamah, 2022; Aguilar, 2018; Chen and Liu, 2020; Sinakou et al., 2019). The high number of qualitative methods highlight the growing interest in understanding the process through which sustainability competences are developed (Chen and Liu, 2020). Besides, some studies adopted mixed study designs by combining surveys to derive quantitative data and qualitative assessment methods such as reflection notes, focus group discussion and interviews to provide deep understanding of students' learning experiences. Relying solely on quantitative data does not provide a deep understanding of research findings, thus qualitative methodologies can serve as complementary approaches to provide explanation and understanding of how variables affect each other (Sass et al., 2024). Nevertheless, Sinakou et al. (2019) indicate that insufficient development of instruments has limited the use of mixed method approaches.

4.2. Contributing factors to the development of ACiSD

The results from the review reveal that action competence is fostered by action-orientated and participatory pedagogies, holistic teaching and learning materials, teacher education and training, and school organisations. From the review, integrating traditional classroom and experiential activities foster action competence by engaging students in direct and indirect actions at home, school, and community level. Out of the 58 studies reviewed, a majority (about 46) focused on learning outcomes from sustainability courses that incorporate active and real-world learning alongside classroom sustainability learning or as an alternative to classroom learning at diverse educational levels including HEIs, pre-service education and teacher education programmes. These studies employed diverse pedagogical methods including place-based education, drama, film-making, arts and craft, project and/or problem-based learning, outdoor as well as service learning pedagogies, and web-based and digital learning tools. These pedagogies provided students with a deep understanding of sustainability practices ensuring theoretical and real-world application of knowledge. Lecture-based approaches to sustainability education on the other hand, have been identified to be limited in their ability to involve students in real-world environments, institutions and communities and thus are unable to provide deep sustainability understanding (Domask, 2007, p. 60). Real-world learning allows students to connect theoretical knowledge with hands-on actions, thus fostering students practical and strategic competencies to address sustainability challenges (Brundiers et al., 2010). Furthermore, real-world learning experiences such as service learning provide personal benefits for students and their communities through improving students' writing, commitment to activism and choice of career (Rey-Garcia and Mato-Santiso, 2020). Torsdottir et al. (2024b) found that engaging in society-focused action-oriented sustainability experiences fostered the development of students' action competence (confidence, knowledge, and willingness to act). However, engaging in real-world learning does not automatically foster the development of sustainability competencies (Brundiers et al., 2010).

Although results from ESD and EE courses from the review revealed improvements in students' knowledge and willingness to engage in sustainability actions, gaps regarding confidence for personal actions with girls and academically sound students showing greater knowledge and motivation remained. Similar to Chen and Liu (2020), the identified gaps and negative outcomes were found in studies using delayed measurement and longitudinal assessments. This highlights the need for long-term assessment of sustainability courses which might provide insights into learning outcomes that might be overlooked in immediate evaluation of learning outcomes. Moreover, Aguayo (2017) found that the failure of a community-level ESD intervention to promote sustainability actions was due to lack of continuous engagement and post-learning experiences. Follow-up sessions using social media platforms have proved to be effective means for facilitating students exchanges through sharing projects and interacting with the public (Warner et al., 2014). That notwithstanding, teachers' attitudes, philosophies, and ability to use social media platforms were found to influence teachers' continuous post-learning engagement. Felix and Johnson (2013) found that teachers engaged in frequent follow-up exercises believed that such learning experiences were important for students while teachers practicing limited follow-up exercises treated EE topics separately and less important. Additionally, pre-intervention initiatives for example, introduction videos before activities such as outdoor and field visits among other preparatory activities have been identified as relevant for effective real-world learning experiences (Powell et al., 2023). This indicates that equipping teachers to conduct follow-up exercises and preparatory activities are essential for preparing students for sustainability courses and fostering their continued engagement after the completion of sustainability courses.

Moreover, evaluation of student actions revealed disconnection between their sustainability concern and actual actions and preference for personal and individual one-time sustainability actions, such as recycling, rather than long-term and transformative actions including community building, pursing environmental careers, and political engagement (Mudaliar et al., 2022; Gallagher et al., 2020). Students preferred individual and short-term actions because of limited sustainability education, as well as course activities focused on actions related to consumption and use of resources, and inadequate networks and social support systems (Gallagher et al., 2020; Mudaliar et al., 2022). This highlights the need for schools to incorporate social and economic sustainability actions and create social networks and community partnerships to equip student for sustainability actions.

Furthermore, teachers contribute to the effectiveness of sustainability courses and interventions, by designing effective learning environments that promote a deep understanding of sustainability while empowering students to apply knowledge to solve real-world problems and ensuring that sustainability courses and actions are not one-off events (Powell et al., 2023; Wilhelm et al., 2019; Rieckmann, 2018; Kostova and Atasoy, 2008; Felix and Johnson, 2013; Warner et al., 2014). Thus, teachers require support programmes, mentoring and collaborative activities to equip them to integrate sustainability concepts in the curricula and, to continuously engage students to ensure that sustainability courses and interventions achieve the aim of influencing student actions (Felix and Johnson, 2013). Based on this, there is a growing trend of research on teacher education and action competence (Maraat et al., 2023; Nguyen, 2024), highlighting the role teachers play in fostering action competence and the need for teacher professional development through collaborative and hands-on approaches. Teachers' professional competence enhances their knowledge, values, skills, motivation and commitment to implement sustainability courses and interventions, and equips them to overcome barriers in the implementation process (Leicht et al., 2018; Lohmann et al., 2021; Parry and Metzger, 2021). In addition to teachers, school organisations influence how students interact with their community and

the environment at large, thus, these stakeholders have the capacity to equip students to engage in environmentally friendly actions (Frisk and Larson, 2011). At the school level, principals, school staff and communities contribute to the classroom practices adopted by teachers through interacting with teachers' instructional practices and local communities to influence student outcomes (Supovitz et al., 2010; Scott, 2013). They also play a significant role in promoting daily sustainability actions and participatory decision-making through providing resources and exhibiting commitment for sustainability courses and initiatives (Figueredo and Tsarenko, 2014; Schelly et al., 2012). These factors indicate that fostering action competence requires a transformation from lecture-based teaching approaches to real-world approaches, along with holistic course content and curricula, and enhanced teacher education and training and support from school organisations. Although few studies collectively addressed these elements, their integration aligns with the WSA to ESD which seeks to promote sustainability into all parts of the school system.

4.3. Whole School Approaches (WSA) and ACiSD

The determinant factors of ACiSD as identified from the review encompass many parts of the school system including pedagogies, curriculum and learning materials, teachers' development and school support and leadership. These factors can be captured within the WSA to ESD. The WSA is a holistic and participatory educational framework which aims to enhance school environments as meaningful learning spaces through redesigning education to address global challenges (Gericke, 2022; Mathie and Wals, 2022). The WSA emphasises the role of schools as "living laboratories for participation and active citizenship allowing learners to learn what they live and live what they learn" (Peter, 2021 p. 3). Although there are different variations of WSAs, they fall into five main components including "the learning content and processes, institutional culture and practices, integration of the wider community including family, continuous development of staff and pro-active leadership and coordination" (Mathie, 2024 p. 26). The framework by Mathie and Wals (2022) introduces institutional transformation as another component which is related to promoting behaviours that reflects schools' sustainability visions and goals. While the role of institutional transformation within schools was not found in this review, all the other components within the WSA emerged as essential for fostering students' action competence. A WSA emphasises the need for integrating sustainability learning across educational systems including policies, learning environments, communities and organisations (Holst et al., 2024). This approach involves school leaders promoting participatory approaches for all stakeholders to co-create sustainability visions in schools, integrating sustainability topics into curricula, adopting alternative teaching methods and real-world approaches, ensuring that institutional practices reflect a sustainable vision, promoting community partnerships and capacity building for teachers (Mathie and Wals, 2022). In addition, democratic and participatory approaches are emphasised in most WSAs, although levels of participation may differ (Mathie, 2024). In Figure 6, these components are represented with overlapping circles to portray the relevance of interconnection and the need for holistic change in educational processes, particularly ensuring a sound policy-environment for effective WSAs.(Mathie and Wals, 2022). Additionally, the overlapping circles highlight the significance of promoting changes in the whole educational system to ensure integration among the key components (Mathie, 2024).

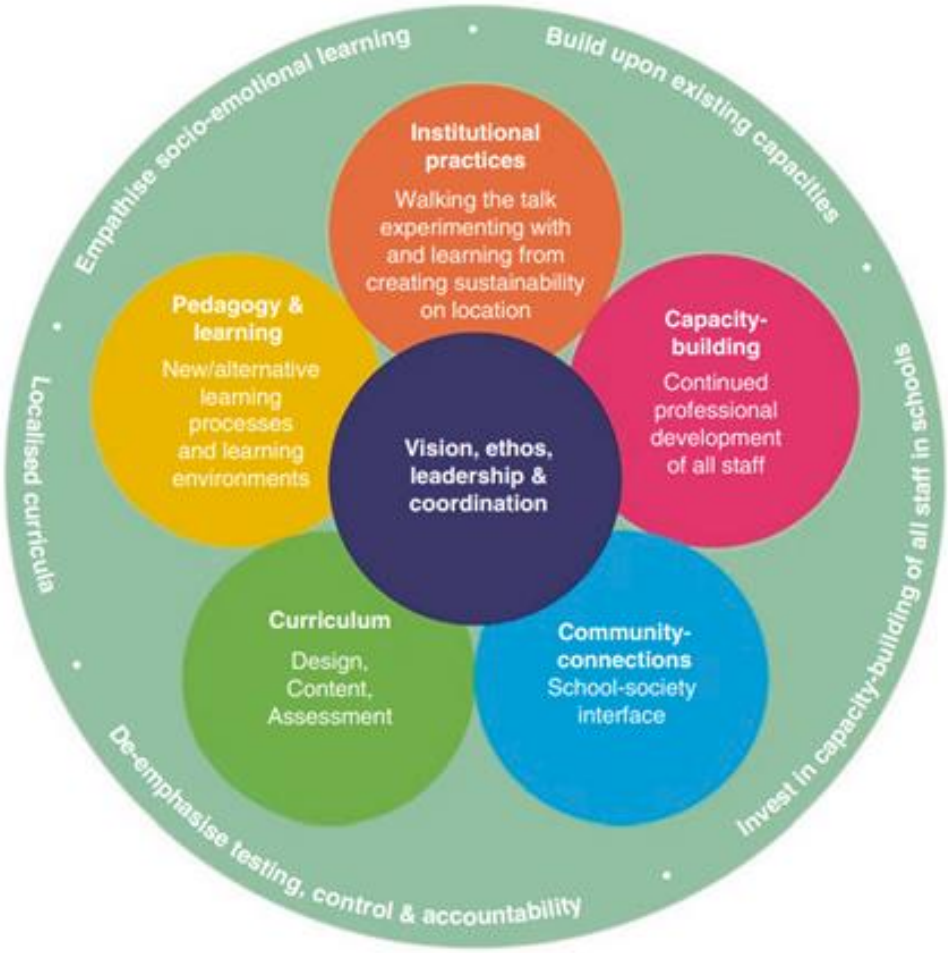


Figure 6. Healthy policies for whole school approaches (Mathie, 2024 p. 28; Mathie and Wals, 2022)

As ESD seeks to promote sustainability action, adopting a WSA may be essential for the successful implementation of ESD initiatives in schools. Existing literature highlights the relevance of collaboration and holistic school approaches for effective sustainability learning (Verhelst et al., 2024). A WSA can enhance intellectual, social, and emotional interaction between students and their surrounding environment to promote the subjective development of action competence, which is facilitated by students rather than following a set of norms (Sass et al., 2020). However, WSAs including the green school movements have had limited impact on student actions due to implementation challenges, such as inadequate resources, and capacity as well as challenges related to commitment and connecting with different stakeholders. Mathie (2024) recommends integrating reflexive monitoring and evaluation (RME) practices into school organisational structures, raising awareness as well as enhancing collaborations with stakeholders and developing methodologies and indicators to evaluate WSAs. These approaches seek to provide an evaluation system that emphasises continuous improvement, thus providing support for schools to lead their own sustainability experiences (Mathie, 2024; Wals and Geerling-eijff, 2008). This highlights the need for school leaders and educators implementing WSAs to develop monitoring and evaluation frameworks and capacity

building programmes to support continuous improvement of WSAs and to overcome the challenges associated with working with diverse stakeholders.

Another recommendation is to align WSAs with existing school organisational structures rather than making external changes, for instance, making internal improvements using existing frameworks such as the Scherp school organisation model. The latter is based on four improvement areas which are; developing holistic goals for students learning outcomes, protecting routines and systems from disturbances, professional development, and pedagogies that involve students in the development of learning platforms (Gericke, 2022; Mogren et al., 2019; Verhelst et al., 2024). The Scherp model reflects the understanding that education should equip students to reflect on the relevant and required knowledge to solve problems (Mogren et al., 2019), which is similar to educating students to be autonomous individual thinkers and actors (Biesta, 2009). Similarly, ESD aims to develop students' ability to think and act independently (Sass et al., 2020). Besides, the Scherp model is an effective framework school organisations can utilise to determine the progress of WSAs (Gericke, 2022; Verhelst et al., 2024). Furthermore, WSAs can be implemented through an initial process led by school leaders and a gradual transition to a student-centred approach (Gericke, 2022). Additionally, school organisations can promote sustainability initiatives through sustainable leadership, pluralistic communication, democratic decision-making, shared vision, and adaptability (Verhelst et al., 2024). These elements emphasise the need to develop a common vision and promote dialogues and interaction between schools and external stakeholders and partners.

One of the main findings of the review is that while holistic school approaches are essential for promoting sustainability throughout the entire school system, their impact on student action will depend on the school's ability to work collaboratively with stakeholders and establish an effective organisational framework that prioritises student-centred learning, and democratic decision-making and effective monitoring and evaluation tools. Notwithstanding, most of the papers in the review focused on individual sustainability courses and actions, indicating a research gap in how WSAs can develop action competence. Although Torsdottir et al., (2024b), found an association between WSA and students' self-perceived action competence, further research is needed on the components within the WSA and how they foster action competence.

4.4. Motivation and learning strategies

Self-efficacy and confidence were the most identified motivation students developed from action-oriented and real-world learning as well as student-led activities and interactions with experts and communities. Increased self-efficacy was manifested through students' intentions to start personal sustainability initiatives and teach ESD and EE. Self-efficacy is interpreted by the information people have about themselves based on their past successes and failures (mastery), vicarious experiences (learning from models), verbal persuasions, and physiological and affective states (Bandura, 1997). Learning aimed at developing mastery requires practical instructional activities and sharing feedback (Guskey, 2007), which represents participatory and action-oriented approaches to ESD. From the review, students monitored their success and activities through reflection, feedback exercises, and photovoice (participatory action research). These monitoring activities enable students to remember their successes, which can increase self-efficacy (Bandura, 1997). Furthermore, self-efficacy can be developed contextually from the learning environment through diverse cognitive learning strategies and processes, which can enhance an individual's beliefs about their capacity to perform (Macakova et al., 2020). Application of cognitive and metacognitive strategies such as critical thinking and self-regulation

can enhance one's self-efficacy, which in turn influences how an individual utilises these learning strategies. According to Pintrich and De Groot (1990) and Schunk and Ertmer (2000) effective self-regulation depends on students' self-efficacy and other factors such as goals, outcome expectancy, among others. Self-efficacy beliefs also guides people's action, including individual's choices, cognitive processes, motivation, and emotional responses (Bandura, 1993; Macakova et al., 2020). Thus, students' motivation, goals, and choices are shaped by confidence in their ability to regulate and master learning activities.

Students' intrinsic motivation influences the activities they choose to engage in. Bandura (1997) highlights student preferences and choices for activities that promote a sense of competence and personal satisfaction. Thus, motivational factors like self-efficacy, which can influence students' choices, can be developed in a positive and engaging learning environment. This implies that fostering a participatory and supportive learning environment in schools can enhance students' self-efficacy and increase pro-environmental choices and actions. Studies by Yoong et al. (2018) indicated that people with high self-efficacy and confidence are more likely to adopt pro-environmental habits because they can handle the challenges associated with such actions. Consequently, designing student-centred and participatory curricula, teaching materials, and pedagogies can enhance students' confidence and self-efficacy, which can ultimately increase sustainability choices and actions.

From the review, collaboration and cognitive strategies, including critical thinking and self-regulation, were the dominant learning strategy utilised in real-world sustainability courses. These learning strategies enabled students to transfer knowledge and skills into different contexts (De Corte, 2011). Real-world learning enables students to recognise and engage in different forms of collaboration with peers, teachers, communities, state agencies and NGOs to solve sustainability challenges directly and indirectly at different levels (Brundiers et al., 2010). Besides, these collaborations have both personal and collective benefits. For example, student co-learning with community stakeholders and practitioners provided a sense of belongingness as well as value for collaborative learning, and an opportunity for practitioners to gain theoretical understanding of sustainability concepts (Reeves, 2019). Similarly, integrating social capital, which involves developing a set of norms and group relationships with real-world learning, can enhance universities' ability to contribute to the social dimension of sustainability (Rey-Garcia and Mato-Santiso, 2020; Thompson and Carolina, 2008). Such approaches help students to feel part of a larger system while promoting higher cognitive learning and dynamic interactions (Molderez and Fonseca, 2018; Frisk and Larson, 2011). Additionally, students' ability to strive for agency and self-efficacy requires cognitive and self-regulation strategies, including goal setting, implementing, and monitoring progress toward goals while adjusting strategies and exercising control over tasks (Bandura, 1997; Chawla and Cushing, 2007; Schunk and Dibenedetto, 2020). Cognitive learning strategies influence people's sustainability actions and the ability to handle the impact of their actions (Hansmann, 2010). Critical thinking skills enable people to act effectively by directing and validating their actions (Mogensen and Schnack,2010). Moreover, collaborative and peer learning enables students to develop solutions to complex sustainability challenges (Sass et al., 2020). Other learning strategies, such as metacognitive self-regulation, foster a deep understanding of the causes of sustainability challenges and the required actions to address them (Hanisch and Eirdosh, 2023).

Furthermore, learning is situated and contextual, meaning that the strategies adopted depend on the specific learning environment and the context in which the learning occurs. Collaboration and exchanges among students enable them to share similar experiences, develop action strategies, while sharing inspiration

and motivational experiences (Chawla and Cushing, 2007). Encouraging interaction and collaboration among students and teachers and between schools, communities, and state institutions enables students to observe and learn from other students and experts (Alt, 2015). Also, a self-regulated learning environment that is characterised by open ended activities such as research activities enable students to learn independently (Perry and Vandekamp, 2000). This highlights the need for teachers and educators to develop learning environments that enable students to utilise cognitive and meta-cognitive strategies. Teachers play a key role in creating effective learning spaces by using assessments and custom-made learning approaches, which increase student participation, motivation, and self-directed learning (Jager et al., 2007; Petere, 2016). Considering the relevance of collaborative and cognitive strategies in facilitating real-world learning, educators should prioritise these learning experiences. This approach enables students to work with peers, teachers, school staff and communities to develop sustainability solutions.

5. Conclusion and implications for future studies

This study aimed to identify the factors that promote the development of action competence from ESD and EE courses at the formal school level, and the motivation and learning strategies associated with the development of action competence. The study found four main factors that are relevant for fostering action competence; action-oriented and participatory pedagogies; holistic teaching and learning materials; teacher education and training; and school organisations. The study identified that real-world and hands-on ESD courses and interventions enhanced students' self-efficacy, and confidence, as well as value and positive emotions for sustainability related issues. Additionally, students employed collaborative and peer learning strategies and cognitive and metacognitive strategies such as self-regulation and critical thinking in the learning process. The study revealed that holistic integration of ESD into the school system, including curriculum, pedagogy, and learning practices, promoting community engagement, capacity building and professional development for teachers, and supportive leadership, are essential for the development of action competence (Henderson and Tilbury, 2004; Mathie and Wals, 2022). The study characterises the WSA to ESD as a holistic and participatory framework that fosters integration of sustainability into the curricula, facilitates professional development for teachers and promotes students' connection with their environment, and key stakeholders, including communities, institutions, and state agencies. However, there are notable gaps in the effectiveness of existing WSAs, particularly their ability to influence students' sustainability actions. The implementation of the WSA can influence sustainability actions through developing comprehensive strategies such as holistic learning objectives and outcomes, learning platforms co-designed by students and teachers, promoting participatory communication, and effective monitoring and evaluation frameworks. Additionally, institutional policies that promote resource allocation, teacher development and foster partnerships should be implemented to strengthen WSAs. However, the study found limited research on school organisations and how they contribute to the development of action competence. Future studies should identify the organisational characteristics that foster action competence and the immediate and the long-term effect of WSAs on the development of students' action competence. Furthermore, future studies should examine the impact of real-world learning experiences on students' motivation, cognitive strategies and emotional response to sustainability related challenges and action. As continuous engagement is required to sustain students' long-term sustainability actions, further studies should explore continuous engagement and follow-up strategies that can be adopted by teachers in

different educational contexts including informal and non-formal settings to reinforce students action competence from sustainability courses.

Although this study has significantly contributed to the limited systematic literature reviews on ACiSD, it has some limitations. The study focused on ESD and EE courses at the formal education level and papers published between 2000 to 2023. Even though the study examined the learning outcomes and relevant elements that contribute to the development of ACiSD and associated concepts such as PACesd, future studies should broaden the scope of the study by including additional keywords and databases such as Google Scholar and earlier research on ACiSD. Moreover, the role of informal and non-formal education, as well as the external influences from family, culture, and environment, on the development of students' ACiSD should be studied. Despite these limitations, this study makes a significant contribution to the existing body of systematic reviews on ACiSD by providing an overview of the factors that contribute to its development, and the relevant motivation and learning strategies required for the enhancement of ACiSD.

Declarations

Data availability

The datasets used for the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

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