International Journal of Educational Studies
ISSN: 2641-533X
Volume 9, Issue 2, pp. 1-71
2026
DOI: 10.53935/2641-533x.v9i2.1156

Bibliometric and Content Analysis of Sustainability Education in Geography for Promoting Sustainable Development at Primary and Secondary Schools and in Teacher Education

Eila Jeronen: *University of Oulu, Erkki Koiso-Kanttilan katu 1, 90570 Oulu, Finland.*

Juha Jeronen: *JAMK University of Applied Sciences, Jyväskylä, Finland*.

ABSTRACT: *Geography education plays an important role for promoting sustainability by integrating a variety of educational strategies and subject content that promote understanding of sustainable development practices. There are very few studies from a holistic didactic and pedagogical viewpoint on the implementation of sustainability education in geography in the context of teacher education and school education for promoting a sustainable future. This study addresses this gap via a bibliometric and content analysis of literature (n = 127 and 114, respectively), based on the categories of sustainable development goals (SDGs), learning objectives, content knowledge, teaching methods, competencies and skills, and assessment methods. Compared to earlier studies performed in the 2010s, teaching and learning methods have become more diverse in contrast to an earlier focus on teacher-centered methods. The most frequently mentioned from the dimensions of SDGs are environmental and social dimensions, and from the learning objectives cognitive learning. Factual and conceptual knowledge, interactive teaching and learning methods, critical thinking, problem solving and dealing with complexity, and formative assessment methods are also emphasized. Institutional dimensions of SDGs, affective learning objectives, metacognitive knowledge, and transdisciplinary skills, alongside diagnostic assessment methods are least mentioned. The findings suggest that pedagogical content knowledge and powerful knowledge need to be emphasized more for moving geography education, from subject matter content knowledge -focused approaches, to applying knowledge in different contexts, and to attitudes that support action outside specific contexts or cases. The conclusion is that aligning with Quality education (SDG 4), geography educators must stress action competence and integrate ethical, technological, and transdisciplinary dimensions, empowering students not only to understand life but to sustain it*.

Key words*: Geography education, sustainability, sustainability education (SE), sustainable development goals (SDGs), transformative teaching and learning.*

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

There are three basic concepts in geographical knowledge: the human and environmental system, the scales and the system components. *The human and environmental system* includes the physical and human geographical system; *the scales* range from local to global; *the system* includes structures (relief, climate, settlement, economy in their spatial organisation, and distribution), function (e.g., the function of climate for vegetation, roadways for settlements, and relief for roadways), and processes (e.g. global climatic change, formation of the mountains, vulcanicity, metropolisation, and regional structural change) (DGfG, 2014, p. 11). Fögele (2016) has expanded the conceptualization with three new basic concepts: sustainability (ecology, economy, social, politics), time (short, medium and long term), and space (as a container, system, construct and perception). The spatial concepts act as analytical lenses to investigate the "human-environment system" (the "stage") within the context of sustainability (Fögele, 2016).

School geography connects the natural sciences with the human and social sciences (Tani et al., 2023). For students of geography, the fundamental concepts form the foundation of a systematic accumulation of knowledge from a subject and a life-world perspective. Sustainability can be seen as a paradigm for thinking about the future, where environmental, social and economic aspects are balanced in the pursuit of a better quality of life (E. Jeronen, 2025).

Sustainable development (SD) focuses on three main areas: people, society and economy. It combines what should be and what needs to be developed (E. Jeronen, 2025). SD depends on the ability and willingness of humans to shift their behavior toward maintaining ecological integrity in human relationships with the Earth. Education has a good chance of influencing this shift when teaching and learning are developed according to action-oriented transformative education. Howlett et al. (2016) have pointed out that educators, as important change agents, need to rethink the learning process to enhance students' understanding of the drastic consequeces for human life resulting from the overexploitation of a planet with finite resources.

The necessary cultural change can be achieved through sustainability education (SE). SE refers to finding sustainable solutions to environmental, social, and economic problems through education (Prabakaran, 2020). It challenges education to actively participate in the creation of environmental, social and economic programs that improve quality of life, increase empowerment, and respect interdependence (Abduganiev & Abdurakhmanov, 2020). The skills needed for a sustainable development breakthrough can be promoted, for example, through transformative teaching and learning (Odell et al., 2019), where the focus is on critical reflection on knowledge in relation to the student's own worldview and preconceptions (Aboytes & Barth, 2020). This requires the development of student participation, agency, and pedagogical solutions, as well as a commitment to sustainable development practices and sustainability education in teaching and learning activities.

In promoting sustainable development (SD), geography education plays an important role by integrating a variety of educational strategies and subject content that promote understanding of sustainable development practices and also, for example, solving issues about food, transport, climate change and threats to health in a sustainable way. Previous studies have focused on e.g. teachers' and students' conceptions on geography content (Fernández Álvarez & Fernández, 2021; Schmäing & Grotjohann, 2021), teaching methods (Anunti, 2023; Hamid, 2023; Kmeť et al., 2024; Mensah et al., 2022; Steingrübl & Budke, 2022; Wadson et al., 2023), and integration of sustainable perspectives in geography education (Leal Filho et al., 2025). However, research suggests that the quality of school-level Earth science teaching, including geography, is poor (King et al., 2021; Orion & Libarkin, 2023).

It is important to gain more information about the key knowledge and skills that students need to develop in geography (Lane & Bourke, 2017). More research is needed on designing a sustainable curriculum (Swift & Rawlings Smith, 2025). Many studies emphasize ecological and economic sustainability, but socio-cultural aspects are often neglected (Nilsson Dahlström, 2025). Little research has also been done on local and context-specific pedagogical approaches (Swift & Rawlings Smith, 2025). Similarly, research is lacking on active student-centered teaching methods in SE and on encouraging student participation in sustainable development initiatives (Correa et al., 2025). Digital tools can enhance SE, but their integration into the curriculum requires further research.

There are very few studies from a holistic didactic and pedagogical point of view on the implementation of SE in geography education in the context of teacher education and school education for promoting SD, although a significant amount of research on SE and geography education has been published. In order to fill this gap, this paper aims: (1) to clarify the state of the art in the domain and (2) to use the insights of this bibliometric and content analysis to propose ideas for integrating SE with geography education. In doing so, it contributes to a deeper understanding of holistic geography education related to SD to shape the development of curricula and teaching practices in geography education in teacher education and at primary and secondary schools.

2. Theoretical Background

In her study, Pauw (2015) described future societies as rapidly changing, interconnected, interdependent, competitive, individualized, and knowledge-intensive. The changing environment requires the development of people's basic knowledge, social skills and technological capabilities, and that there is political will to turn knowledge and competence into action. Geography education, including sustainability education (SE), can

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

support students' understanding of this increasingly complex and unsafe world, as well as their ability to act for a better future.

The approaches and methods of teaching play a central role in promoting sustainable development (SD) (Mulvik et al., 2021; Uitto & Saloranta, 2017). This section first presents visions of scientific literacy and aspects of sustainability and sustainability education (SE), and thereafter the role of geography education in promoting sustainability.

2.1. Visions of Scientific Literacy

The central idea of science education, including geography education, is creating a foundation for the student's scientific (science) literacy (Roberts, 2007). In teacher education and in education at primary and secondary schools, the development of scientific literacy involves three areas of scientific knowledge:

1. *Content knowledge*: knowledge of the subject content of geography.

2. *Procedural knowledge*: knowledge of the standard concepts and procedures essential to scientific enquiry (OECD, 2019). In geography, e.g. how to operate in-laboratory and fieldwork equipment, how to conduct statistical analyses, and how to present data.

3. *Epistemic knowledge*: the process of knowledge building in science (e.g. hypotheses, theories and observations) and their role in justifying the knowledge produced by science (OECD, 2019). In geography, e.g. how to interpret analysis results and build models based on them, in order to explain the phenomenon being studied.

Researchers have developed various visions of science education to structure and implement changes for promoting students' understanding on individual, societal and professional significance of science in the students' own lives. For example, Roberts (2007) distinguishes the mastery of scientific content and methods (Vision I), and how science relates to the real world in different social contexts (Vision II). Vision I focuses on the processes and results of science and seeks to educate individuals who can effectively utilize scientific tools and facts. Vision II, by contrast, embraces the sociocultural applications of science and embeds science in society, culture, and personal experiences. Sjöström and Eilks (2018) expand on this, defining three visions for science education, in which the significance and emphasis of knowledge and skills are different. Interpreting the studies of Roberts (2007) and Sjöström and Eilks (2018), an aim of education is, alongside the basic goals of science education (Vision I, "science literacy"), to emphasize the application skills and usability of scientific knowledge and skills in terms of the student's own life decisions, also outside of school (Vision II, "scientific literacy", cf. "environmental literacy"). Sjöström and Eilks' Vision III ("science for transformation", cf. "ecological literacy" or "ecoliteracy") further pushes the focus into *critical* scientific literacy, which emphasizes reflexivity and scientific and socio-political engagement. Education should aim to foster critical, socially aware, and participating citizens who are able to apply geographical knowledge and skills to complex sustainability challenges (Uitto et al., 2024a).

Vision I includes students' inquiry skills (Siarova et al., 2019), while Visions II and III emphasize the relevance of scientific knowledge in various contexts (Valladares, 2021). The difference is that Vision II highlights the relevance for everyday life, whereas Vision III emphasizes the relevance for critical citizenship and sustainability (Sjöström & Eilks, 2018). Even though the three Visions of scientific literacy are dissimilar in content and purpose, they depend on and enhance each other and overlap to some extent. According to the Visions, the core subject aims in school science are that students learn to critically examine their own assumptions and beliefs, to take emotions into account, and to be aware of and understand contradictions. They need to learn negotiation, problem solving and decision-making skills through discussions about ecological, social, economic, and ethical principles concerning local and global responsibility in their own life.

Transformative science education, including geography, should include Visions I–III (Roberts, 2007; Sjöström & Eilks, 2018). By applying spatial-geographical knowledge and skills to interpret interrelated spatial phenomena (geographical literacy, Lan et al., 2024), students' understanding of the concepts of sustainable development (SD) and the interactions between the environment, society and the economy can be developed (Al-Barakat et al., 2025).

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

2.2. Sustainable Development Goals (SDGs)

The educational development of future educators can be characterized as a journey that should be based on Agenda 2030 and its sustainable development goals (SDGs) (Avelar et al., 2023). Sustainable development (SD) covers four main dimensions: environmental, social, economic and institutional (UN, 2021). *The environmental (ecological) dimension* includes Clean water and sanitation [SDG 6], Affordable and clean energy [SDG 7], Responsible consumption and production [SDG 12], Climate action [SDG 13], Life below water [SDG 14] and Life on land [SDG 15]. The primary goals are reducing the use of non-renewable natural resources, preserving nature, and improving the state of the environment, taking ecological values into account. *The social dimension* consists of No poverty [SDG 1], Zero hunger [SDG 2], Good health and well-being [SDG 3], Quality education [SDG 4], Gender equality [SDG 5] and Reduced inequalities [SDG 10] (UN, 2021). Also cultural sustainability is often defined as part of social sustainability (James & Magee, 2016). Cultural sustainability and social sustainability together form the sociocultural dimension of sustainability. In this case, "culture" means, for example, equity, participation opportunities, awareness of SD, and operational and behavioral models (Vallance et al., 2011). In sociocultural sustainability, the goal is to secure the conditions for well-being for future generations and to equip individuals with the knowledge and skills needed to respond to the challenges of SD (Soini & Birkeland, 2014). Thus, at its core are humans, their physical, psychological and social needs, well-being and attitudes towards nature. *The economic and institutional dimensions* each contain only a couple of SDGs. The economic dimension includes Decent work and economic growth [SDG 8], Industry, innovation and infrastructure [SDG 9] and Sustainable cities and communities [SDG 11] (UN, 2021). Finally, the institutional dimension contains Peace, justice and strong institutions [SDG 16] and Partnerships for the goals [SDG 17] (UN, 2021).

Quality education [SDG 4] is a specific goal that directly impacts on other goals. It enables, for example, actions for SDG 8, SDG 9 and SDG 11. In particular, it focuses on ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all (UNESCO, 2017b). According to Efe and Umdu Topsakali (2025), the characteristics of quality education are: inclusiveness, practicality, and value and skills orientation. The characteristics of quality education are: inclusiveness, practicality, and a focus on values and competences. Quality education helps individuals to take responsibility for their decisions and actions and to be aware of their impact on sustainability. The adoption of values and behaviours that support sustainable development (SD) can be promoted by developing individuals' critical and creative thinking and their competence to utilise scientific expertise and experience in decision-making and action.

2.3. Sustainability competencies and skills

To promote SE in education, United Nations Educational, Scientific and Cultural Organization (UNESCO) and European Union (EU) have developed their own competence frameworks, where subjects such as geography do not have a separately stated significance. The concept of competence refers to an individual's ability, skill, desire and will to utilize the scientific expertise and experience they have developed in decision-making and activities (cf. Sjöström & Eilks, 2018).

The descriptions of competences for sustainable development (SD) in UNESCO (2017a) and in the European Union's GreenComp (Bianchi et al., 2022) are similar, but they have also differences. Both descriptions include the goal of valuing SD, supporting equity as well as individual and community agency to promote sustainability. Both are aimed at educators and policymakers, but UNESCO focuses specifically on curriculum development, while GreenComp has also employers as a key target group. In addition to improving workplace practices, GreenComp emphasizes political agency and readiness to respond to the demands of a green economy (Sourgiadaki & Karkalakos, 2023). This study examines SE in geography education in teacher education and in school teaching based on UNESCO (2017a).

Competencies mean the ability to understand the interdependencies of ecological, social and economic systems (UNESCO, 2017a). In sustainability research and problem solving, it means having the knowledge, skills, and attitudes necessary for successful task performance and problem solving with respect to real-world sustainability challenges and opportunities (Wiek et al., 2011a, b). Competencies are transversal, context independent, multidisciplinary and relevant to all SDGs.

Key competencies enable individuals to relate the different SDGs to each other – to see "the big picture" of the 2030 Agenda for Sustainable Development (UN, 2021). To solve real-world sustainability challenges, five key competencies are introduced: systems-thinking competency, normative competency, strategic

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

competency, anticipatory competency, and interpersonal competency. Interpersonal competency was later renamed collaboration competency, and critical thinking competency, self-awareness competency and integrated problem solving competency were added to the list (UNESCO, 2017a). The key competencies have been considered necessary for students of all ages around the world. In this study, key competencies are understood as distinct, definable competencies concerning different areas of sustainability knowledge. Key competencies and examples of their links to the SDGs are presented in Table 1.

Table 1. Key competencies (UNESCO, 2017a) and examples their links to the SDGs (UN, 2021).

Strategic competency	The ability collectively to develop and implement innovative actions that promote sustainability at the local level and beyond	Sustainable cities and communities [SDG 11]
Anticipatory competency	The ability to understand and assess the possible, probable, and desirable futures, create one's own future prospects and apply the precautionary principle to them, assess the consequences of actions, and deal with risks and changes	Good health and well-being [SDG 3], Clean water and sanitation [SDG 6], Affordable and clean energy [SDG 7]
Collaboration competency	The ability to learn from others; understand and respect the needs, perspectives, and actions of others (empathy); understand and be sensitive to others (empathic leadership) and handle conflicts in a group and facilitate collaboration and participatory problem solving	No poverty [SDG 1], Zero hunger [SDG 2], Peace, justice and strong institutions [SDG 16], Partnerships for the goals [SDG 17]
Critical thinking competency	The ability to question norms, practices, and opinions; examine one's own values, perceptions, and actions and participate in the sustainable development debate	Responsible consumption and production [SDG 12]
Self-awareness competency	The ability to examine one's own role in the local community and (global) society to continuously evaluate and motivate actions, and to process emotions and desires	Quality education [SDG 4]
Integrated problem solving competency	The ability to apply different problem solving frameworks to complex sustainability problems and develop applicable, inclusive, and equitable solutions contributing to sustainable development integrating the above-mentioned competencies	Life below water [SDG 14], Life on land [SDG 15]

In science subjects, including geography, scientific literacy and evolutionary literacy are also seen as important key competencies. *Scientific literacy* includes both conceptual understanding of the processes and epistemology and understanding of the nature of science (Roberts, 2007). The nature of science (NOS, Erduran & Dagher, 2014) refers to the understanding of what the general principles that characterize natural science are and what scientifically valid knowledge acquisition is like. According to Roberts and Bybee (2014), to be scientifically literate means to understand how science works in practice. This includes understanding how scientists conduct research and collect data, as well as understanding the processes scientists use to ensure the validity and reliability of their findings. Scientifically literate citizens understand the nature of symbolic systems of representation and expressions, are aware of their own socioscientific ways of thinking, and know how to relate their actions to their own and society's needs. They are able to apply geographical content knowledge in their everyday lives.

Evolutionary literacy is literacy which is relevant to questions that students may encounter as citizens and to the socio-ethical implications of scientific knowledge (Kampourakis, 2022). It is essential for planning and achieving a sustainable future (UNESCO, 2017b). The development of evolutionary literacy requires the ability and willingness to learn continuously (prospective learning, Vogelstein et al., 2022). It is based on the predictive ability to see cause-and-effect relationships of what actions should be taken to achieve better

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

outcomes (UNESCO, 2017b). Teachers play a key role in interpreting and implementing the curriculum in practice (Gericke et al. 2025; Lambert et al., 2015; Uhlenwinkel et al., 2017).

2.4. Teacher's Content Knowledge

According to Shulman (1986), teachers' content knowledge (CK) includes subject content knowledge (SCK), curricular knowledge, and pedagogical content knowledge (PCK). SCK is the teacher's knowledge of the content and structure of a subject. Curricular knowledge includes knowledge of curricula, learning materials, and knowledge of what is to be taught in the subject area. PCK is information about how the subject matter to be learned should be formulated so that students understand it (Shulman, 1986). Table 2 provides examples of how SCK and PCK relate to different knowledge categories and types.

Table 2. Knowledge categories and types related to subject content knowledge (SCK) and pedagogical content knowledge (PCK) (Cochran et al, 1993; Gudmundsdottir & Shulman, 1987; Shulman, 1986; Yli-Panula et al., 2025).

Knowledge Categories	**Definition**	**Knowledge Types**	**Related to**	
			SCK	**PCK**
Factual and Conceptual knowledge	Factual knowledge is common knowledge about what is needed to be successful to meet a goal. Conceptual knowledge consists of knowing how facts can be organized in meaningful ways. (Krathwohl, 2002.)	Knowledge of classification	×	
		Knowledge of principles and generalizations	×	
		Knowledge of theory, models, and structures	×	
		Knowledge of terminology	×	
		Knowledge of details and basic elements	×	
Methodological knowledge	This knowledge concerns how to do something or how to solve a problem, such as a learning task (Osborne et al., 2018). It is also knowledge about research methods, such as how to make observations and study life phenomena.	Knowledge of skills, technical methods concerning subjects		×
		Knowledge of usage criteria		×
Metacognitive knowledge	This is a teacher's and student's knowledge about how they can manage their own learning and plan their studies (Krathwohl, 2002).	Knowledge of strategies, usage of methods, and self-awareness		×
Evaluative knowledge	This is about systematically collecting and analysing information. It is linked to evaluative thinking, a disciplined approach to inquiry and reflective practice that helps people to make judgements with good evidence by habit (Cole, 2023).	Knowledge of understanding interactions and performance		×
Critical reflection and reflective knowledge	Critical reflection is a 'meaning-making process' that helps people to set goals and use what they have learned to inform future actions and consider the real-life implications of their thinking. It links thinking and doing and can be transformative (Rodgers, 2002; Schön, 1992). Reflective knowledge is an actor's ability to evaluate their epistemic position and the circumstances of knowing. It is part of the belief formation process and confirms the overall process of knowing (Broncano, 2014).	Knowledge of reviewing, reconstructing, re-enacting, and critically analysing	×	×

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Understanding and solving environmental problems requires both SCK and PCK related to planetary boundary conditions (Rockström & Sukhdev, 2016). Planetary boundary conditions are the boundary values that define a safe operating range for humanity within the framework of biological and physical systems (Rockström et al., 2009). Teachers need to have competence that serves the areas of SCK and PCK in the subjects they teach. Critical reflection and reflective knowledge transform static SCK into dynamic PCK. SCK tells the teacher what the subject is, and PCK guides how to teach it effectively, while critical reflection combines them by continuously analyzing, evaluating, and applying both (Cochran et al., 1993). With such competence, teachers can support students' meaningful learning and the ability to make critical decisions (García-Fortes et al., 2024).

2.5. Educational Approaches Promoting Sustainable Development (SD)

An ongoing debate over the last three decades has been how the role of education should be conceptualized when creating sustainability and a sustainable future. The 2030 Agenda proposed a focus on the role of education in achieving sustainable development (SD). Target 4.7 of quality education focuses on global citizenship education and sustainability education (SE) by stating that (UNESCO, 2016):

... 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.

Concerning both the aims and contents, there are several different educational approaches for promoting SD. For example, the concepts "education for sustainable development" (Brundiers & Wiek, 2010, 2017; Corres et al., 2024; Fien, 2001; Jickling & Spork, 1998; Taylor et al., 2019; Tilbury, 1995/2006; Wiek et al., 2011a,b, 2016), "sustainability education" (Sterling, 2001, 2004, 2008), and "sustainable education" (Sterling et al., 2018) differ in that the first one emphasizes the need for change in individual behavior, while the latter two emphasize the need for change in local, national and international organizations' culture (Sterling et al., 2018). However, all three approaches can be understood to integrate the dimensions of SD and to share a common vision of quality education and a society that lives in balance with the carrying capacity of the Earth. They include inter- and multidisciplinary views, societal issues at the local, regional, and global levels, as well as changes in education.

This study examines teaching and learning of SD in geography education from the viewpoint of sustainability education (SE). SE is seen as giving meaning to the teaching and learning of sustainable development. It means promoting both ecoliteracy and an understanding of social justice. It is practical (Kemmis & Mutton, 2012) and critical (Aboytes & Barth, 2020), and encourages students to think for themselves. In SE, a geographical approach connects students' everyday experiences with sustainabity through explicit spatiality, where concepts of place, space, and scale create comparisons, similarities, and contrasts within and between localities (Meadows, 2020). SE is therefore holistic and transformative in nature, aiming to develop students' critical understanding of sustainability and support their reflective thinking and action skills. It is a process in which students develop their own ability to analyse, negotiate, seek alternatives, and make choices. The integration of SE into geography education is a practical way to support students' understanding of sustainable development and to foster transformative sustainable action.

2.6. Geography education promoting sustainable development

Sustainable development (SD) today is a part of the European basic education and upper secondary education, and it needs to be included in the curricula of different subjects, e.g. natural sciences (EC, 2024) including geography. This means that the teaching subjects and subject education plays an important role in promoting SD in teacher education and in education at schools. Different subjects have their own strengths in teaching sustainable development ideas (Uitto & Saloranta, 2017), and in teaching ideas that cross subject boundaries (cross-subject didactics, Sjöström et al., 2024), due to the fact that the subject aims and learning objectives, topics, teaching methods, and also evaluation and assessment methods differ across different subjects. Thus, the nature of the subject (Gericke, 2022; Uitto & Saloranta, 2017) influences how SD and its ecological, social, cultural, and economic dimensions are taught in teacher education and in education at schools. Geography as a subject is well suited to teaching SD and SE while combining scientific, social and cultural knowledge (Tani et al., 2023).

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

This study aims to gain information on how the sustainable development goals (SDGs) and sustainable development (SD) have been implemented in geography education to date. In doing so, it contributes to a deeper understanding of holistic geography education related to sustainability to shape the development of curricula and teaching practices in geography education in teacher education and in education at primary and secondary schools. In this section, geographical knowledge and goals, learning objectives, knowledge categories and types, teaching and learning methods, competencies and skills, and evaluation and assessment promoting sustainable development in geography education are discussed.

2.6.1. Geographical Knowledge and Goals

Geographical knowledge includes three key areas (Lambert et al., 2015, p. 732): (1) a deep descriptive world knowledge, (2) a critical conceptual knowledge that has explanatory power and systematicity, providing a relational understanding of people living on the planet, and (3) a propensity to think through alternative social, economic, and environmental futures in specific place and locational contexts. According to Hammond et al. (2025, p. 389), in the the first key area, students need to acquire and develop in-depth descriptive and explanatory "world knowledge", covering, for example, countries, capitals, rivers and mountains; as well as the world's wind patterns, population distribution and energy sources. The content and scope of this knowledge is influenced by national and regional cultural contexts (Lambert, 2016, p. 404). In the second key area, students need to develop their relational thinking (Jackson, 2006), which concerns for example, local and global place and space, the interdependence and interaction of the human, physical and environmental contexts (Hammond et al., 2025, p. 389). The third key area, “applied geography”, is crucial for learning geographical thinking (Lambert, 2016, p. 404). Based on it, students need to apply the analysis of alternative social, economic, and environmental futures to specific place contexts, using a range of skills such as decision-making, analysis and evaluation, as well as speculation, imagination, and argumentation (Hammond et al., 2025, p. 389).

Humans have always had a relationship to time, space and multitude, and their relevant combinations (Liodaki et al, 2024). The concept “time” is a dimension that defines the sequence of events allowing an individual to map and refer to current and past events, and to imagine futures. The goal of geography education is that students understand the changes in a thing or phenomenon from the beginning to the future. “Space” is the concept which describes spatial distances, areas and volumes, and spatial scales are also related to density. In geography studies, students deal with spatial scales in relation to issues ranging from elementary particles to space. “Multitude” is a form of a quantity that describes the number of discontinuous entities to be studied. (Liodaki et al, 2024.) It makes possible, for example, to compare large populations, which is a key to understanding issues related to climate change.

Studying geography should help students to understand how places and landscapes are formed, how people and environments interact, what are the consequences that arise from our everyday spatial decisions on Earth’s diverse, and interconnected mosaic of cultures and societies (IGU CGE, 2016). A place includes "interaction between people and groups, institutionalized land uses, political and economic decisions, and the language of representation" (Saar & Palang, 2009, p. 7). It is a multidisciplinary and socially constructed concept. Although places are unique they are connected to other places. The flows *between* places and *through* places are important. Decisions and events at a local level can have global consequences; and global processes can have different effects locally. This is not just physical distance but perceptions of distance as well. The physical and human world are linked with each other and the world is therefore ‘whole’.

Geography provides a foundation for addressing sustainability issues concerning dynamics, complexity, and interactions, which supports an understanding of the spatial and temporal dimensions of sustainability. Through interdisciplinary approaches, it forms a bridge between the natural sciences and the social sciences (Grindsted, 2015; Tani et al., 2023).

From the perspective of SE, an important geographical goal is that students are able to understand the interdependency between humans and nature. Haubrich (2007) stresses that individuals must become aware of the impact of their own behaviour on the environment. Students need to understand what human rights, gender equality, a culture of peace and non-violence, global citizenship, and cultural diversity mean (UNESCO, 2016). Thus alongside development of geographical awareness and geographical consciousness (Çifçi & Koybaşi, 2017), development of environmental sensitivity is also one of the goals in geography education.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

2.6.2. Learning Objectives in Relation to Competency Objectives

Defining learning objectives facilitates the selection and organization of content and enables the assessment of learning outcomes. According to Rodriguez and Albano (2017), there are four types of learning objectives: institutional, program-specific, course-specific, and instructional. Institutional objectives address what students can expect from their studies at an educational institution. Program-specific objectives describe the knowledge and skills students are expected to acquire during their education in their specific program. Course-specific objectives describe what students can expect to learn in a course. Instructional objectives describe what students need to know and be able to do and allow for the assessment of student learning in relation to course objectives.

In this study, the United Nation's Sustainable Development Goals in Agenda 2030 are connected to geography education within the democracy and society discourse. According to Yli-Panula et al. (2024), learning objectives promoting sustainable development (SD) are related to the development of understanding phenomena, functional skills, collaboration skills, critical thinking skills, problem solving skills, and research skills. Competency objectives concerning strategic action are central for defining learning objectives. Examples of how the competency objectives promoting SD can be related to the learning objectives in geography education are presented in Table 3.

Table 3. Examples of competency objectives promoting sustainable development related to learning objectives in geography education.

Examples of Competency Objectives (SDG = Sustainable Development Goal) (UNESCO, 2017a)	**Examples of Learning Objectives in Geography Education (Finnish National Agency for Education, 2016, 2019)**
To develop students' systems thinking and ethical thinking [SDGs 12–15]	To develop geographical thinking skills; to understand to value natural diversity of human activities and cultures, and to respect the diversity of human rights all over the world
To reflect on human well-being and responsibility in relation to nature and other people [SDG 17]	To reflect on human activity and the natural environment, the interaction between them, and to understand the importance of sustainable use of natural resources
To understand the standards for sustainability education stated in curricula [SDG 17]	To develop an active, responsible citizenship committed to a sustainable lifestyle
To develop and implement activities in the school's immediate environment to promote student learning and well-being [SDG 4, 5, 16]	To observe their own environment and the changes taking place in it; to use geographical knowledge and skills in everyday life
To develop student identity by incorporating collaborative, inclusive learning into teaching, promoting collaborative interaction within the school community, and developing collaborative learning environments [SDG 17]	To support interaction and to develop teamwork skills
To develop students' critical observation skills, critical thinking and critical reading skills [SDG 17]	To develop geographical research skills; to follow current events in their own neighbourhood, In Finland and around the world; to reflect on the interaction between human activity and the natural environment
To develop students' problem solving skills, encourage students to engage in problem solving and argumentation [SDG 17]	To develop problem solving skills; to formulate questions and research problems regarding the phenomena under study

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

2.6.3. Geographical Knowledge in Relation to Visions of Science Education

Geography education includes many relevant issues regarding the teaching and learning sustainable development (SD). According to Vision I (Roberts, 2007; Sjöström & Eilks, 2018), knowledge of geography includes understanding of what geographical phenomena are and how they are like, how and why they occur, and how geography as a scientific discipline studies life phenomena using scientific methods. This kind of knowledge can be seen as teachers' subject matter content knowledge (SCK) (Shulman, 1986). In Agenda 21 (UN, 2003) and the 2030 Agenda for Sustainable Development (UN, 2021), the following issues are listed: soil/land degradation; desertification; biodiversity/biodiversity loss; climate change; water/oceans; poverty and justice; health and food; consumption; gender differences/gender equality; and housing/safe, resilient, and sustainable human settlements and participation. The UN (2003) mentions also environment and development; pollution; agriculture; biotechnology; and new technologies. The UN (2021) emphasizes protection of ecosystems, sustainable energy, and sustainable industrialization. In SE, the starting point for learning needs to be learning the names of things (Lisberg Jensen, 2025) because it is the first step toward ecoliteracy.

Ecoliteracy refers to understanding the importance of preserving the environment. It provides a foundation for environmental literacy (Ha et al., 2022) and an understanding of the relationships between humans and nature to promote SD (Hartono, 2020). It includes knowledge and skills related to ecology basing on scientific knowledge and knowledge of SD. For example, the concept of ecosystems is related to environmental issues such as the use of fossil fuels, global warming, population growth, and soil degradation. Ecoliteracy may help people to understand environmental issues at the local, regional, and global levels (Bleier, 2021). It also includes an attitude of caring about the environment and the tendency to act on the basis of environmental knowledge and feelings. It refers to applying ecological knowledge and problem solving approaches, enabling solutions based on ecological science (Lewinsohn et al., 2015).

Previous research has shown that environment-based learning can enhance students' awareness and understanding of sustainability concepts and systems thinking (Kakungulu, 2024). According to Lisberg Jensen (2025), it is important to educate growing generations to be knowledgeable about ecological concepts that bind species, human beings included, together. Systemic concepts regarding food production, natural and human-made climate change, biodiversity, and ecosystem services need to be embraced, like the understanding of systemic interrelatedness in ecosystems, such as thermodynamics and population dynamics (Lisberg Jensen, 2025). Insufficient ecological awareness is closely linked to environmental challenges.

SE has tended to focus on good practices within business-as-usual approaches, such as environmentally friendly consumer choices regarding food, transportation, and recycling (Lisberg Jensen, 2025). However, making environmentally friendly choices does not foster agency outside the private sphere. Therefore models of science education have been developed for supporting education. Competency-based models, such as PISA, focus on key skills: explaining phenomena scientifically, evaluating scientific research, and interpreting evidence in real-world settings regarding the conscious connection of a person's cognitive and linguistic abilities with their sense of place and a well-founded self-awareness of their place in the world (Lisberg Jensen, 2025). At the core of this view is powerful knowledge (PK). According to Young (2009), PK is distinct from common sense knowledge, systematic and specialized. This means that PK can serve as contexts (OECD, 2017). The "contexts" component moves science education from content-focused approaches to applying knowledge in different contexts and to attitudes that support application (Kumar & Kumar Choudhary, 2025). The PISA 2025 framework introduces a "science identity" that emphasizes students' perception of themselves as capable scientific participants (OECD, 2023) to critically address societal issues.

For a deeper understanding of one's own and humans' role and position in relation to the ecosystem and for evoking students' agency as future responsible citizens and decision-makers, according to Vision II (Roberts, 2007; Sjöström & Eilks, 2018), it is important to apply geography knowledge in a person' own life and as a member of society. For this, one needs methodological knowledge (Krathwohl, 2002; Yli-Panula et al., 2020), as well as knowledge about how observations on geographical phenomena are made. One also needs to know how to make critical reflections based on sufficient scientific knowledge, and how problems can be solved.

According to Vision III (Sjöström & Eilks, 2018), the goal of learning is action competence. Competence can generally be defined as having the experience, knowledge, and self-awareness to attend to a task effectively, with agility, under any circumstance, and to do so ethically (Lawrence et al., 2023). These three constructs are interdependent and all equally important. In the case of action competence, competence refers

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

to the ability to acquire the relevant knowledge, along with the willingness (i.e., commitment and passion) to take action, confidence in one's own capacities for change, and confidence to take relevant action (Sass et al., 2020). Action-oriented knowledge can be seen as integrated sustainability competencies and skills, attitudes to solve real-world problems, and scientific knowledge (Demssie et al., 2019). This includes knowledge about the root causes of a problem and knowledge about strategies for change.

Metacognitive knowledge is the teacher's and the student's knowledge about how they manage their own learning and life (Krathwohl, 2002). Evaluative and reflective knowledge are typical for lexical ecoliteracy. The concept provides a basis for generalization and thinking outside specific contexts or cases.

In summary, powerful knowledge (PK) that relates to the goals of Visions II and III supports students to find reliable explanations for phenomena and new ways of looking at the world and possibilities to participate in social and ethical debates. Subject-specific educational content knowledge (Hudson et al., 2023) is essential for teaching and learning science subjects, including geography. Geography content areas such as ecology and biodiversity can be combined with reflections on natural values, human health, and well-being in accordance with Vision II (Yli-Panula et al., 2022). Many topics are connected to ecological, social, and economic sustainability in accordance with Vision III (Yli-Panula et al., 2022). Ecology is related, e.g., to land use, production and consumption of commodities, and ways to protect biodiversity. Social sustainability themes are for example human rights and equality. These topics as well as the topics related to the well-being of humans and nature can be sensitive to be taught while they appeal to attitudes or emotions (Ottander & Simon, 2021). Possibilities of bioeconomy and examining the life cycles of products are examples of economic sustainability (Tani, 2017a). To realize all three visions, teachers need both SCK and PCK.

2.6.4. Teaching and Learning Methods

Based on the classification criteria chosen, teaching and learning methods can be classified in different ways. According to Landøy et al. (2020), due to the large number of activities and their different variations, the same method can belong to different categories. In the most popular classifications, the main criteria are: the person(s) to whom the teaching activity is directed, the type of training/lesson, the type of main activity, the degree of activity or passivity of the students, the prevailing means of communication (oral, written). Based on the degree of activity of the individual at the center of the teaching activity, three teaching and learning methods are distinguished: teacher-centered, interactive, and student-centered methods (Landøy et al., 2020). Table 4 presents examples of different teaching and learning methods.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Table 4. Teaching and learning methods (information and communication technology, ICT; artificial intelligence, AI), (Ghafar, 2023; Kesler, 2020; Landøy et al., 2020).

Teaching and Learning Methods		
Teacher-centered Methods	**Interactive Methods**	**Student-centered Methods**
Lecture-based - oral - written - video - instruction - explanation and demonstration - story telling	Skills based - conversation - discussion - argumentation - exercise (drill and practice) - modeling - field trips - project-based learning - case analysis and case study - field work - experiments - educational games - knowledge building learning - co-operative learning	Methods of organising information and data visualisation - conceptual map - diagrams
		Methods of stimulating creativity - brainstorming - panel discussion - experiential learning - discovery learning - problem-based learning - inquiry-based learning - creative problem solving - collaborative learning - service-design process
		ICT - simulations and animations - design-oriented learning - extended Reality - virtual learning - AI (e.g. ChatGPT)

In teacher-centered (traditional) methods, the teacher is the primary authority and source of information. They set the ground rules for the classroom and present the content to be learned that the students are expected to acquire and remember. The teacher creates both lesson plans and assessments. They explain the objectives of the lesson and provide feedback to students, but the students are responsible for implementing the plans. Examples of this type include lectures and teacher presentations.

Interactive methods refer to methods of teaching that engage the classroom. Unlike memorization, interactive teaching encourages students and teachers to collaborate to foster learning (Wijnia et al., 2011). Interactive methods include, for example, discussions and field trips.

Student-centered methods, on the other hand, are based upon the concept of constructivism, where students can confer meanings to what they learn by relating new information to what they already know. For example, different problem-based teaching and learning methods and problem solving outdoor education are important ways to foster understanding for SD (Yli-Panula et al., 2020).

Woods et al. (2024) propose that learning needs to be done with a place, rather than about it, and the effects of students' own behavior need to be discussed and sustainable actions practiced in local surroundings.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

The students' living environment can be used for observation, testing, experimentation, and research. For example, fieldwork and field trips can support the teaching of various geography topics (urban geography, economic geography, and landscape analysis evaluation). They can be used to increase place-consciousness, i.e. an understanding of how communities and regions function in local and global contexts (Aguado-Moralejo et al., 2020). It might be desirable also in geography education to explore opportunities to increase geography students' contact with nature. Nature has beneficial effects, primarily in relation to learning, but also in terms of academic performance, cognitive function, health, wellbeing and personal development (Brookfield, 2022). In this sense, place-based learning can foster students' awareness of social justice and the concept of sustainability.

Important ways to foster understanding for sustainable development (SD) are student-centered methods. Collaborative learning is an active method for teaching and learning geography. Through it, students are encouraged in the construction of essential knowledge together through open-ended problems, and achieve common goals by self-management and flexible roles among group members, to learn about the various characteristics and transformations that have occurred on Earth (Espinoza Freire, 2022). Collaborative learning has been shown to enhance students' knowledge, social skills, and motivations for learning (Sawyer & Obeid, 2017).

Also in problem-based learning (PBL), students work together, aiming to solve a real-world problem. They may define their own goals and study independently and self-directedly, but thereafter they can return to the group to discuss and refine the knowledge they have acquired. Problem-based activities and learning-by-doing improve students' interest, knowledge, attitudes and behavior concerning sustainability (Liefländer & Bogner, 2018).

Experiential learning is authentic, first-hand, sensory-based learning through a specific experience (Behrendt & Franklin, 2014). It supports deep cognitive understanding by providing hands-on experiences that connect students to local, regional, and global ecosystems (Kiewra et al., 2023). Through active environmental activities with engagement with real-world sustainability challenges, affective experiences can strengthen ecological awareness (Lovren & Jablanovic, 2023) and encourage participation (Firinci Orman, 2024). Personalized, experiential learning allows students to engage with real-world sustainability challenges in authentic and meaningful ways, and offers opportunities to develop deeper understanding of the multifaceted aspects of SD. Immersive experiences likely influence the students' attitudes toward sustainablity (Murti et al., 2025) and foster a deep sense of environmental responsibility (Friman et al., 2024). Through memorable, active processes students can learn to discuss their own value selection and to evaluate phenomena and sources of information critically.

Information and communication technology (ICT) and advanced technologies, as well as students' increased access to digital devices in schools and at home, have opened up new opportunities for visualizing and experimenting with phenomena. Digital literacy (often used as a synonym for digital competence) refers to the literacy skills related to the use of digital technologies, and it requires the mastery of the skills needed to acquire, produce, and share information (Brečko et al., 2014; Hamutoğlu et al., 2019). In addition to basic skills in using technological tools, the concept of digital literacy supports the appropriation of skills and techno-social empowerment, because it requires a context and purpose that connects the tools to the needs of the real world (Brečko et al., 2014). The development of mobile application technology enabled students to have unlimited access to information, databases, and multimedia content, and above all, communication that transcends time and space (Ganguly, 2023). In the context of teaching, ICT integrates technology and user interaction to provide access to educational resources without the constraints of time and space, using devices such as smartphones, tablets, desktop computers, and laptops (Singh & Suri, 2022). In the context of learning, ICT functions as a learning medium to improve critical thinking and student motivation, and increase student self-confidence and satisfaction (Song & Cai, 2024).

Beyond mobile learning, other digital learning technologies have emerged over the decades. Various applications of extended reality (XR) (augmented reality, AR; virtual reality, VR; and mixed reality, MR) offer the opportunity to examine things and phenomena that are otherwise out of reach or to perform various experimental learning tasks (Alnagrat et al., 2022). Teaching discipline-specific content in the spatial science of geography could benefit from an enhanced information representation that mobile AR offers for abstract concepts (Akçayır & Akçayır, 2017), as the subject deals with various complex structures and invisible processes. Furthermore, following the affordances of AR for education (Wu et al., 2013), teaching methods

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

such as inquiry-based learning and fieldwork (Bos et al., 2022; Bourke & Mills, 2022, p. 19) could benefit from situated support in space and location-based 3D perspectives on geographical phenomena. AR can issue crucial, context-specific information about geography, helping students learn while actively connecting with pressing real-world issues like flooding (Safitri et al., 2024).

VR can be used to develop students' critical analytical skills in relation to new visual technologies and the broader implications of VR for the representation of people, places, and landscapes (Bos et al., 2022). For example virtual nature experiences can in some situations be as effective in supporting environmentally friendly behavior as learning situations that take place in real nature (Deringer & Hanley, 2021). VR and MR's immersive capabilities support deeper, more intuitive comprehension of spatial relationships (Macrine & Fugate, 2021; Prasetya et al., 2024).

Artificial intelligence (AI) can be used to promote students' AI literacy, i.e. the ability to understand, use, monitor and critically reflect on AI-generated content (Laupichler et al., 2022). Topic-specific, contextual learning tasks that are appropriate to students' proficiency levels promote meaningful learning (Sharma et al., 2023). Collaborative technology increases students' high-level cognitive and social interaction and deepens their content understanding (Šašinka et al., 2019), ethical thinking and empathy skills (Chiu et al., 2023).

2.6.5. Competencies and Skills in Geography Education

According to García de la Vega (2022), geography competence can be described and articulated as a subset of competencies, underpinned by thinking and reasoning processes and the corresponding skills. Skills are the ability and capacity to carry out processes and use one's existing knowledge to achieve results (EU, 2018). Geography competence can be associated with an array of skills: logical-cognitive skills (concepts and procedures), abstract spatial and geospatial skills (orientation, direction, location), instrumental skills, computational skills, and analogical skills (García de la Vega, 2022).

Geographical thinking (Bakanov et al., 2024) and geographical literacy (Yli-Panula et al., 2020) are key competencies to foster sustainable development (SD) in geography education. Geographical thinking and reasoning are related to geospatial information, such as changes in scale, spatial connections, changes in distance and direction, and location recognition (Golledge et al., 2008). Geographical thinking provides students with information processing, reasoning, questioning, and evaluation, allowing students to consider how and why places have changed over time. This may lead students to think also about decision-making related to active citizenship, supporting lifelong learning (Fisher & Binns, 2016). The term geographical literacy is defined as the ability to use spatial-geographical knowledge, skills, and reasoning, as a means for understanding and interpreting intertwined spatial phenomena (Lan et al., 2024). A significant cognitive ability in geographical literacy is spatial thinking. It is perhaps the most important factor that determines competency in spatially dependent disciplines such as STEM disciplines (science, technology, engineering, and mathematics) (Shea et al., 2001), including geography. Numerous studies have found a significant correlation between spatial thinking and success in spatially dependent tasks, performance in undergraduate science courses, and persistence in science careers (Anderson & Leinhardt, 2002; Black, 2005). Spatial thinking concerns spatial concepts, reasoning processes, and representations (Painho et al., 2010) to define problems related to the Earth's space or geographical space at different scales, identify answers, and provide solutions (Verma & Estaville, 2018). Focusing on key competencies (Yli-Panula et al., 2021), geography education can support students' understanding of and action competence for sustainable development.

Valuable geographical skills are skills which help interaction between students and teachers (Hazen & Alberts, 2021) to explore geographical topics at a range of scales from local to international. Skills based on attitudes and values related to finding solutions to local, regional, national, and international problems based on the Universal Declaration of Human Rights are important. Such skills include creative thinking (Renshaw, 2011; Scoffham, 2013), critical thinking (Bendl & Marada, 2021), problem solving (Hazen & Alberts, 2021; Mondal, 2024; Zhan et al., 2024), and communication and collaboration skills (Hazen & Alberts, 2021).

There are four important features of creativity (cf. Scoffham, 2013): using imagination; pursuing purpose; being original; and judging values. Imagination involves looking at a situation from a different perspective or thinking of alternatives. Pursuing purpose and being original encourage the student to have a set action or intention while conceiving of new ideas.

Creative thinking involves trying new possibilities and rejecting those that do not work. Critical thinking is important from the point of view of meaning and structure when combined with context, for example

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

solving a local problem (Bendl & Marada, 2021). In problem solving, students learn how to analyse a problem, identify relevant facts and generate hypotheses, identify necessary information or knowledge for solving the problem, and make reasonable judgments about solving the problem (Bentil & Ababio, 2020).

Communication and collaboration skills concern respecting other views and arguments; thinking about and evaluating one's own personal motives; contributing to common tasks with one's own competences; determining one's own objectives and tasks, and presenting one's own results, and perceiving problems and phenomena from different perspectives (Haubrich, 2007). Through practicing communication and collaboration skills it is possible to develop a global awareness (Msengi & Growe, 2025).

Another crucial skill for understanding SD is systems thinking (Clayton & Radcliffe, 2018; El Batri et al., 2020). It can refer to structural thinking and generalization, as well as to dynamic and continuity thinking. Valuable skills to be developed are also social skills for exploring important topics in a range of scales, from local to international (UNESCO, 2016). In addition, civic skills are important for developing sustainable lifestyles and for fostering positive images of the future (*Çifçi & Koybaşi, 2017)*. All these skills are parts of action competence for sustainable development, which should be based on value-oriented learning in relation to sustainability (Haubrich, 2007).

Green behavior encompasses a spectrum of practices to reduce the environmental footprint, enhance resource efficiency, and foster sustainable ecological cycles (Al-Sharafi et al., 2023). Comprehensive and environmental knowledge, attitudes, connectedness to nature (Jasim et al., 2025), and environmental awareness of the students (Lovren & Jablanovic, 2023; Rakuasa & Latue, 2024) are important factors affecting students' behaviour. Although students develop a strong sense of environmental awareness, this does not, however, necessarily lead to environmentally friendly actions (Benzehaf et al., 2025). This suggests a value gap between knowledge acquisition and practical application. Translating awareness into actual behavioral change remains challenging due to factors such as students' different knowledge levels, inadequate resources, and time constraints (Amoah-Nuamah et al., 2025).

In geography education, teachers can foster the development of students' knowledge, competencies and skills by using different educational approaches, such as disciplinary, multidisciplinary (Molthan-Hill et al., 2022), interdisciplinary (Lozano et al., 2017; Simon & Graybill, 2010), and transdisciplinary approaches (Miles, 2023; Molthan-Hill et al., 2022). The first and fourth of these have established meanings within geography education, but for multidisciplinary and interdisciplinary approaches, the definitions vary across studies. This study uses the definitions of Blaschke and Merschdorf (2014) and Klein (2017), restating Jantsch (1972).

A disciplinary approach provides detailed insights within a single field, allowing for a deep understanding of specific aspects, such as climate change. In the context of the GeoCapabilities project, Lambert et al. (2015) have identified three levels of powerful knowledge (PK) in geography: a descriptive but also deep "world knowledge"; a critical conceptual knowledge that has explanatory power in enhancing relational understanding of some geographical ideas (such as nature/people, physical/social, local/global, etc.); and a propensity to think through alternative social, economic and environmental futures in spatial context (Lambert et al., 2015, p. 732).

A multidisciplinary approach brings together and compares perspectives from different fields and subjects (Blaschke & Merschdorf, 2014). In the context of geography, a multidisciplinary approach typically includes biology or sociology. Some authors extend the concept to also include, for example, language education, and the integration these insights to form coherent strategies (Persano Adorno et al., 2025). Multidisciplinary themes can be used to target educational aims and challenges that have special social significance (Tani et al., 2018). For example, in the Finnish lower secondary education curriculum, the themes include e.g. well-being and safety; human rights and the conditions for a good life, and sustainable lifestyle (Finnish National Board of Education, 2016, p. 386). In the Finnish upper secondary education curriculum, the themes include e.g. the application of geographical knowledge in professional contexts, promoting well-being and sustainable development, human geography knowledge in society and everyday life, and geomedia in everyday life (Finnish National Board of Education, 2019, pp. 244–249). The geomedia concept is understood more broadly in the Finnish curricula (Finnish National Board of Education, 2019) than in international research. In the former, geomedia includes also listening to a podcast or presenting spatial information orally by a student or teacher (Hilander, 2017; Tani, 2017b), while in the latter, geomedia refers only to digital spatial information

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

programs (e.g. Jekel et al., 2014). In this study, the geomedia concept is applied in the same way as in the Finnish curricula.

An interdisciplinary (cross-disciplinary) approach expands upon the idea, by integrating knowledge, methods, and ways of thinking from two or more disciplines (Blaschke & Merschdorf, 2014) to achieve cognitive progress, such as explaining a phenomenon, solving a problem, or creating a product (ElSayary, 2024). Interdisciplinary teaching is a method or a set of methods that are used to teach across curricular disciplines, by bringing together separate disciplines around common themes, issues, or problems (Blaschke & Merschdorf, 2014; Ellis & Stuen, 1998). By integrating the perceptions of the individual disciplines across the STEM fields, it deepens knowledge, providing a broad understanding needed to solve real environmental problems (White et al., 2024). For example, natural phenomena such as the water cycle or the importance of forests can be explained by considering the connections between geography, ecology, and chemistry. In this way, interdisciplinary learning can create knowledge that is more comprehensive than the knowledge built via discipline-specific studies.

A transdisciplinary approach expands further, enabling the synthesis of social and spatial realities (Lisowski, 2012) by addressing environmental challenges holistically in collaboration with external stakeholders operating in different sectors (Chopra et al., 2019). It integrates epistemologies from different disciplines (Blaschke & Merschdorf, 2014). For example, in transdisciplinary geography teaching at the primary school level, one can observe the weather and consider the relationship between humans and nature. At the secondary school level, one can analyse the power relations of professionally functioning individuals and deal with the relationship of students to structural conditions. In teacher education, using Geographic Information Systems (GIS) and interactive maps, one can consider the place exploration of teachers and students teachers in relation to a wider context by taking into account other geographical factors, such as population distribution, relief and the world's biomes (cf. Di Wilmot et al., 2025).

2.6.6. Evaluation and Assessment

Comprehensive evaluation is an important part of teaching and learning processes. It provides teachers with information on the students' level of interest in the topics covered in geography education and how, as a result of teaching, they have been able to build, for example, values related to sustainable development (SD). Assessment practices are integral to pedagogy and learning outcomes (Vahed et al., 2023). Effective curriculum design requires the integration of assessment, teaching, and feedback to enhance student achievement (Ali, 2018). Assessment tasks provide students with opportunities to reflect on their learning experiences, develop theoretical knowledge, and apply their understanding to real-world contexts.

There are three types of assessment: diagnostic, formative, and summative. Diagnostic assessment maps the starting level of learning and students' preconceptions (Atjonen, 2017). Formative assessment is an ongoing process that focuses on activities during the learning process and supports students in building conceptual understanding (Atjonen et al., 2019; Veugen et al., 2021). Summative assessment, on the other hand, typically takes place at the end of the learning process. It examines how the learning objectives are achieved and at what stage of the process of conceptual change the student is (Atjonen, 2017). It serves purposes such as accountability, ranking, and certifying competence (Schellekens et al., 2021). The interplay between formative and summative assessments underscores the importance of continuous assessment in guiding students toward the ultimate demonstration of knowledge.

Teachers must identify different levels of learning from the content being studied, demanding that the content areas and the teaching and assessment are planned in line with these levels when assessing the construction of the students' conceptual understanding (Bloom et al.,1956; Krathwohl, 2002). In geography, the students' learning according to Vision I (Roberts, 2007) can be assessed, for example, using tests concerning students' geographical factual and conceptual knowledge (e.g. Bijsterbosch et al., 2017; Mishra, 2015), and types of spatial ability, such as spatial perception and spatial visualization (Black, 2005). Tests are mostly targeting the lower cognitive requirement (mainly remembering and, to a lesser extent, comprehension).

More demanding learning tasks are needed in assessing the students' deeper knowledge of the subject and their ability to apply what they have learned. The students' methodological knowledge according to Vision II (Roberts, 2007; Sjöström & Eilks, 2018) can be assessed based on their outputs (Munowenyu, 2007). The students' essays, portfolios and project reports, can be used for assessing how the students apply the

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

knowledge to commonly encountered and important problem-solving situations. By examining how they evaluate, for example, their living environment and its use based on geographical knowledge from the perspective of their experiences and hobbies, it is possible to assess the students' knowledge of the subject, critical evaluation of different perspectives, presentation of arguments based on scientific knowledge, and the ability to apply what has been learned, possibly across subject boundaries.

Learning metacognitive, evaluative and reflective knowledge according to Vision III can be assessed by examining the development of the students' action competence from the perspective of promoting sustainability (Sjöström & Eilks, 2018). For assessing in-depth conceptual understanding and change, open tasks give opportunity to understand the students' thinking. A way to assess deep conceptual understanding and conceptual change is through practical work by focusing on integrated problem solving. In geography teaching, it can be assessed, for example, how the students integrate ecological, social and economic perspectives of sustainability into their activities, how they accept different perspectives (pluralism) and how action-oriented they are (Fadjarajani et al., 2024; Olsson et al., 2022).

According to Lane and Bourke (2017), for assessing geographical understanding an amalgam of methods such as concept mapping, sketch mapping, argumentative writing and free word association are often used. Wehry et al. (2012) have stated that concept mapping techniques enhanced spatial thinking skills and stimulated interest in human geography. Harwood and Rawlings (2001) used students' freehand sketch maps of the world when assessing primary school students' understanding of the spatial arrangement, size and shape of continents. The results revealed the value of this approach when identifying misconceptions and blind spots in students' understanding. Moreover, they showed that the process of constructing freehand sketches and receiving feedback from teachers and peers improve primary students' world knowledge. Essays and argumentative writing are also useful for assessing geographical understanding. According to Atasoy (2009), associative thinking techniques are underused in geography teaching, despite their effectiveness as both an assessment and learning tool to enhance creative thinking. The relative effectiveness of classroom and fieldwork teaching and learning can also be assessed using the Structure of observed learning outcomes (SOLO) taxonomy developed by Biggs and Collis (1982) (Munowenyu, 2007) and the marking schema developed by Lambert (1996).

3. Research Aims and Questions

Whereas many areas of geography education are well-studied, little research exists on geography teaching and learning in teacher education and school teaching that promotes sustainable development (SD) from holistic, didactic and pedagogical viewpoints. In this study, sustainable development goals (SDGs), knowledge and learning objectives, teaching and learning methods, and competencies and skills are examined and described for promoting sustainable development in geography education. In addition, assessment methods are explored for fostering sustainability competencies and skills. Figure 1 presents the research questions of this study in relation to the theoretical background.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

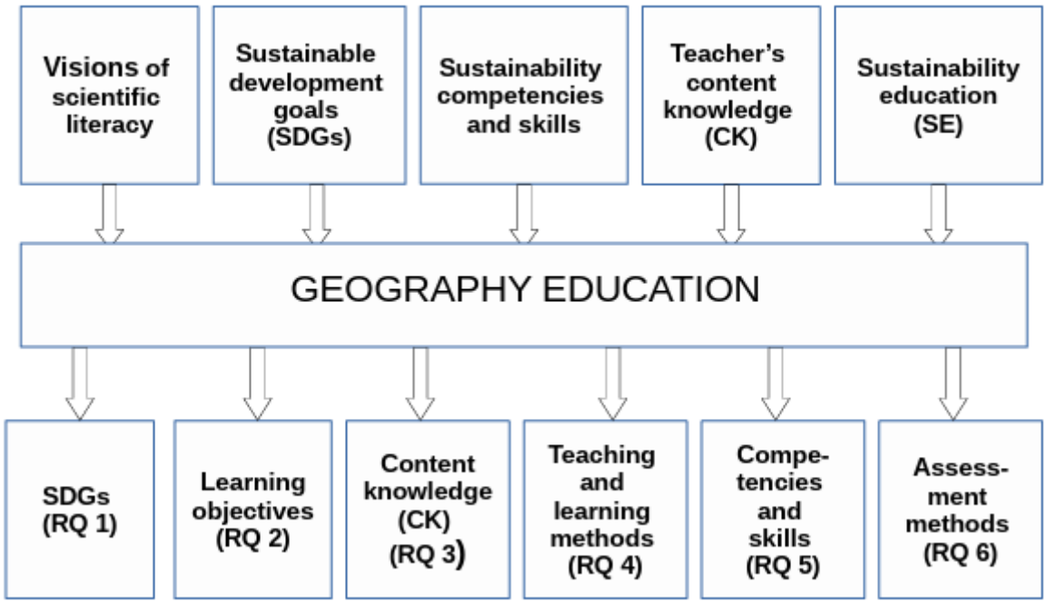


Figure 1. The research questions (RQs) in relation to the theoretical background.

This study is based on the following research questions:

(1) Which of the UN sustainable development goals (SDGs) have been included in geography education?

(2) Which kinds of learning objectives promoting sustainable development (SD) have been included in geography education?

(3) Which kinds of content knowledge (CK) promoting sustainable development (SD) has been included in geography education?

(4) Which kinds of teaching and learning methods promoting sustainable development (SD) have been included in geography education?

(5) Which kinds of competencies and skills promoting sustainable development (SD) have been included in geography education?

(6) Which kinds of assessment methods promoting sustainable development (SD) have been included in geography education?

The findings are expected to contribute to the development of geography education promoting sustainable development (SD) in teacher education and school teaching to support the shift towards sustainable living and well-being.

4. Materials and Methods

In this study, the focus is to clarify how sustainability education (SE) teaching and learning ideas have been incorporated into sustainable development (SD) focused geography education. The detailed steps in conducting data analysis are illustrated in Figure 2.

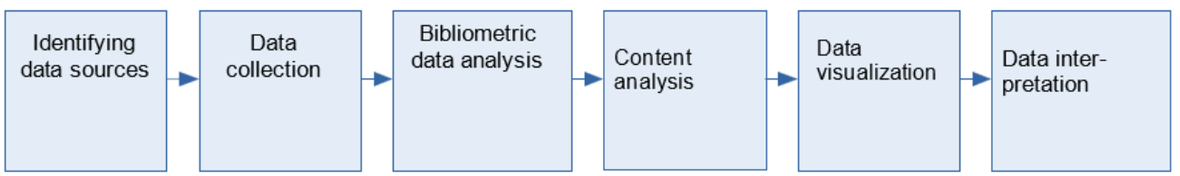


Figure 2. Steps in conducting data analysis.

4.1. Selection of the Materials

The material was selected by applying the method presented by Àlvarez-Garcia et al. (2015). For a systematic review, peer-reviewed documents were selected using a consistent search strategy, criteria were

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

established for the selection of documents to be considered, and the documents were analysed based on clear and precise criteria and aspects (Green et al., 2011).

D*ocuments published between 1st January 2000 and 31st December 2024 were searched from the database Scopus.* Scopus is a comprehensive multidisciplinary abstract and citation database covering multiple scientific disciplines, including social, physical, health, and life sciences. Compared to more restricted databases, it offers extensive, comprehensive coverage of peer-reviewed literature, conference proceedings, and other scholarly sources (Donthu et al., 2020).

The search strategy was based on a systematic organization, categorization, and selection of keywords related to geography education, geography curriculum, teaching and learning objectives, powerful knowledge (PK), teaching methods, evaluation and assessment, students' outcomes and competencies, implications and impacts, research gaps, sustainability, sustainable development (SD), sustainable development goals (SDGs) and the UN 2030 Agenda. Using these keywords, a hierarchical search strategy was applied, starting from the simplest expression (one term) to the most complex form (combinations of terms using Boolean operations). All searches were done in English between 4th and 18th May 2025.

When selecting material for the analyses, the following criteria were used:

(a) Language: English;
(b) Period: 2000–2024;
(c) Scope: national and international publications;
(d) Educational levels: primary, secondary and higher education;
(e) Types of studies: documents in geography education that give concrete support to the development of geography curricula and teaching;
(f) Quality: academic studies.

The sample selection process adhered to the flowchart shown in Figure 3, which aligns with the previous study by Yli-Panula et al. (2020). During the first phase (Identification), 1014 documents were retrieved from the Scopus database using each key term's "article title, abstract, and keywords" search option without limiting the document type. In the second phase (Screening), the search was

refined to include only the articles, book chapters, and books with sufficient pertinence or adequate interdisciplinary coherence, reducing the number of documents to 127 (107 articles, 18 book chapters, 2 books). Mixed types of sources were selected for the data analysis in order to obtain the most comprehensive picture of the current situation in geography education for supporting sustainable development (SD) in teacher education and primary and secondary school education.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

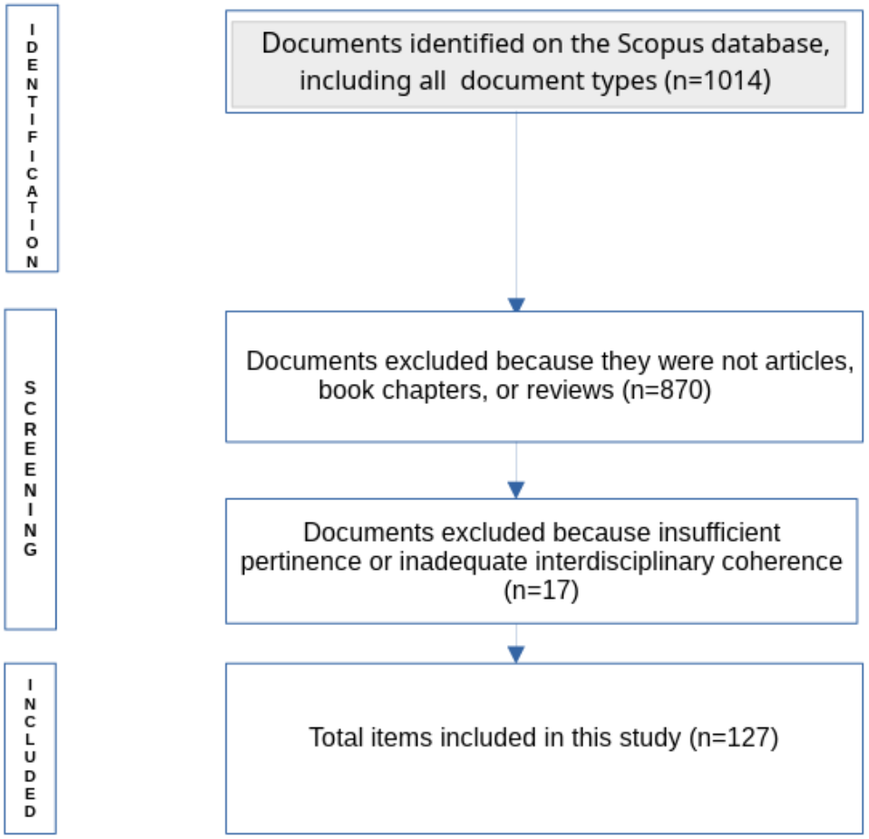


Figure 3. The process of selecting publications for bibliometric analysis.

4.2. Analysis Methods

The data analysis was carried out in two phases: a bibliometric analysis, followed by a qualitative content analysis. The clusters produced by the bibliometric analysis produced a general description of the research topics. Then, content analysis was used to search for meaningful views on the phenomenon under study and to find ideas for developing geography education focused on sustainable development (SD) in teacher education and school teaching.

4.2.1. Bibliometric Analysis

To identify the state of SE in geography education studies, a bibliometric analysis based on the titles and abstracts of the studies was performed. The metadata of the selected studies is entered into a BibTeX database (Patashnik & Lamport, 1985). BibTeX is a popular digital open interchange format for scholarly citations. The metadata included the authors, year, title, and abstract of each item.

The bibliometric analysis process used in this study is implemented in Raven-visualizer (J. Jeronen, 2024), which is an open-source, visual topic analysis tool for exploration of scientific literature. The methods are based on high-dimensional semantic embeddings, clustering algorithms, and dimension reduction, enabling semantic similarity detection and classification.

For a detailed explanation of the analysis process, see E. Jeronen and J. Jeronen (2026). However, as an exception to the process reported there, in this study the automatic keyword detection for the detected clusters is based on using an LLM (large language model) as a judge. For this purpose, a locally hosted LLM is sufficient; there is no need to use a cloud LLM. In this study, the LLM used was Qwen3-30B-A3B using a 4-bit quantization, enabling the model to run on a single 24 GB GPU.

Comparing to the previous cluster keyword detection method used in E. Jeronen and J. Jeronen (2026), that was based on classical NLP (natural language processing) methods, the new LLM (large language model) based method provides clearly better accuracy. As an additional advantage, it leverages the wide general

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

knowledge base of the LLM, enabling the synthesis of keywords from context in a way roughly similar to how a human would do it. For example, if different studies refer to the same phenomenon using different names and descriptions, an LLM can suggest a standard term that covers them all, whether or not that term appears in the dataset.

The titles of all items in a detected cluster are provided to the LLM, and it is prompted to suggest up to six keywords describing that cluster. These keywords are collected for display in the visualizer user interface, and from there, used in the manual analysis phase to help describe what kind of studies each cluster contains.

The final result from the bibliometric analysis step is a two-dimensional semantic map. This map clusters semantically similar studies together, facilitating the content analysis step. The semantic map is then visualized interactively in Raven-visualizer, displaying both the two-dimensional data together with the corresponding metadata of the studies (from the original BibTeX dataset), as shown in Figure 4.



Figure 4. The two-dimensional semantic map for the dataset of this study (n = 127). In the visualizer, the dataset can be explored interactively. Semantically similar items are located near each other in the semantic map. The map is colored by the detected final clusters.

Additionally, a word cloud was generated from the dataset. The words were automatically collected from the titles and abstracts, stopworded (omitting common filler words such as “the” and “of”), lowercased (including also acronyms), stemmed with spaCy (Montani et al., 2023), and then plotted as a word cloud. The stemming algorithm reduces each word to its stem (e.g. “thinking” becomes “think”), thereby more clearly bringing out unique words. The result is shown in Figure 5.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

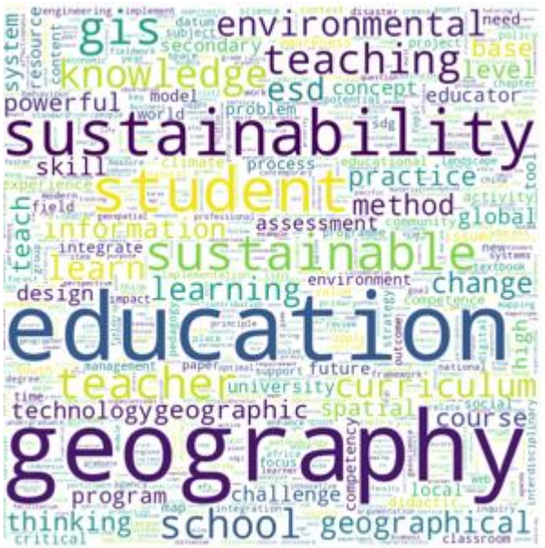


Figure 5. Word cloud, computed from the full dataset (n = 127). The words were automatically collected from the titles and abstracts, automatically cleaned up, and then plotted as a word cloud.

Co-occurrence analysis of the title and abstract was performed on these documents, revealing seven clusters discussed in the next section. Additionally there were 13 outliers (individual data points), which did not fall into any cluster. *The topics of each cluster were extracted by manual content analysis. There are a total of 127 clustered studies. The clustered studies, topics of cluster items with the number in each items, count of the cluster items and cluster numbers and top-level topics are presented in Table 5.*

Table 5. Clustered studies, topics of cluster items with the number of each cluster items, count of the cluster items, and cluster numbers and top-level topics.

Clustered studies	**Item Topics *(n)***	**Count *(n)***	**Cluster Numbers and Top-Level Topics**
Boehm et al. (2024); Jedelhauser, & Grob, (2024); Lewis, (2019); Maude (2016); Maude (2020); Roberts (2014); Roberts (2023); Solem et al. (2024); Tani et al. (2020); Windsor & Kriewaldt (2023); Winter et al. (2024)	Powerful knowledge (PK) (11)	11	#0 Subject content knowledge (SCK)
Davis-Morrison (2018); Gilbertz et al. (2022); Fuertes-Camacho et al. (2019); Hane & Korfmacher (2020); Kiely et al. (2021); Miao et al. (2022); Muliaina (2018); Nicholson et al. (2023); Papageorgiou et al. (2024); Remington-Doucette & Musgrove (2015); Shay & Caplow (2017)	Integration of sustainability (11)	16	#1 Curriculum
Burian (2010); Chou (2018); Kiassat (2024); Park et al. (2024); Trad (2019)	Outliers (5)		
Brown et al. (2024); Chernisheva et al. (2024); Cheung et al. (2011); Esteves & Rocha (2015); Favier & Van Der Schee (2012); González González & Pisabarro	Geography information system (GIS) (21)	29	#2 Digital teaching methods

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

(2024); Huang & Cheng (2022); Huang et al. (2020); Hwang (2013); Kim & Lee (2012); Kouziokas (2015); Labianca (2021); Lam et al. (2009); Li et al. (2022); Milson et al. (2012); Mkhongi & Musakwa (2020); Roulston (2013); Shakhislam et al. (2024); van der Schee & Scholten (2009); Zhang et al. (2010); Özgen (2009)			
Abdimanapov et al. (2024); Diolaiuti et al. (2021); Michaeli et al. (2016); Ormand et al. (2017); Paraskevas et al. (2010)	Information and communication technology (ICT) (5)		
Albăstroiu et al. (2014); Paul et al. (2016); Suptelo & Niemets, 2024	Outliers (3)		
Danaher et al. (2021); Kitagawa (2023); Perkins et al. (2018); Robinson (2015)	Climate change and sustainability (4)	4	#3 Climate change education
Davidson et al. (2021)	Assessment and evaluation (1)	16	#4 Teaching methods, assessment and evaluation
Brody & Ryu (2006); Domaćinović & Vuk (2022); France & Haigh (2018); Guo et al. (2018); Grindsted & Nielsen (2022); Härmä et al. (2021); Kurniawan et al. (2024); Mahat et al. (2024); Maude (2023); Mulyanie & Setiawan (2024); Pretorius et al. (2016); Ramirez-Salgado & Wright (2023)	Teaching methods (12)		
Aikens et al. (2016); Jeong & González-Gómez (2021); Navarro et al. (2020)	Outliers (3)		
Walshe (2017)	Interdisciplinary approach (1)	33	#5 Geography education and sustainability
Abalahin & Chang (2019); Rodway-Dyer & Barr (2024); Urbańska et al. (2022)	Evaluation (3)		
Daniele (2022); de Lázaro-Torres et al. (2023)	ICT (2)		
Boehn & Hamann (2016); Cabral & Kaivola (2005); de la Vega (2022); Duggan et al. (2015); Fru & Ndaba (2023); Gryl (2023); Hawa (2021); Higgitt (2006); Hoffmann (2021); Hoffmann (2022); Martínez-Hernández & Robles-Moral (2023); Nokelaynen (2021); Palacios et al. (2017); Pike (2021); Reid (2005); Sánchez (2010); Skarstein &Wolff (2020); Solem & Weiguo (2018); Vasileva (2020); Westermark & Jansund (2019)	Approaches fostering sustainable development and sustainability (20)		

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Alkaabi et al. (2023); Martínez-Hernández & Mínguez (2023); Martínez-Hernández & Mínguez (2024); Rosado-González et al. (2023); Varjas (2022)	SDGs (5)		
Luttenberger & Mandić (2022); Wang et al. (2019)	Outliers (2)		
Affolderbach (2022); Bagoly-Simó (2018); Bagoly-Simó (2023); Boehm et al. (2024); Cassar & Mifsud (2023); Cassar & Mifsud (2024); Castellanos et al. (2021); Corney (2006); Granados-Sánchez (2022); Kolenc-Kolnik (2009); Kowasch & Lippe (2019); Raath & Hay (2019)	ESD or SE (12)	18	#6 ESD or SE -related geography education
Fattizzi & Grigione (2023); Kovačič & Brečko Grubar (2016); Widener et al. (2016)	Assessment and evaluation (3)		
Radulović et al. (2023); Stacchiotti et al. (2019)	Teaching methods (2)		
Thenga et al. (2020)	In-service education (1)		

The first cluster (#0) is named ‘Subject content knowledge (SCK)’ and it includes the item ‘Powerful knowledge (PK)’. The studies discusses the characteristics and meaning of powerful knowledge in geography education.

The second cluster (#1) is named ‘Curriculum’ and it includes the items ‘Integration of sustainability’ and ‘Outliers’. The items include studies examining how sustainability can be embedded into the geography curricula. The item ‘Outliers’ includes the studies of Burian (2010), Chou (2018), Kiassat (2024), Park et al. (2024), and Trad (2019). These studies have been excluded from the following content analysis because upon closer inspection they did not refer to geography education in teacher education or school education.

The third cluster (#2) is named ‘Digital teaching methods’. It includes the items ‘*Geography information system (*GIS)’, ‘Information and communication technology (ICT)’, and ‘Outliers’. The studies in the first two items describe how digital educational technology can be used to support teaching and learning processes in geography education. The outlier studies, Albăstroiu et al. (2014), Paul et al. (2016), and Suptelo and Niemets (2024), do not refer to geography education in teacher education or school education, and they have been excluded from the following content analysis.

The fourth cluster (#3) is named ‘Climate change education’. It includes the item ‘Climate change and sustainability’ which describes approaches of climate change education related to sustainability.

The fifth cluster (#4) is named ‘Teaching methods, assessment and evaluation’, and it includes items ‘Assessment and evaluation’, ‘Teaching methods’, and ‘Outliers’. The studies in two first items describe planning, teaching, and assessment in geography education. The item ‘Outliers’ includes the studies of Aikens et al. (2016), Jeong and González-Gómez (2021) and Navarro et al. (2020). Because they do not refer to teacher education or school education, they have been excluded from the following content analysis.

The sixth cluster (#5) is named ‘Geography education and sustainability’ and its items are ‘Interdisciplinary approach’, ‘Evaluation’, ‘ICT’, ‘Approaches fostering sustainable development and sustainability’ ‘SDGs’, and ‘Outliers’. Except ‘Outliers’, these describe different approaches to how sustainability is integrated and carried out in geography education. The outlier studies Luttenberger and Mandić (2022) and Wang et al. (2019) do not refer to geography education, they have been excluded from the following content analysis.

The seventh cluster (#6) is named ‘ESD or SE -related geography education’. It includes the items ‘ESD or SE’, ‘Assessment and evaluation’, ‘Teaching methods’, and ‘In-service education’. The studies in these items discuss how the approaches of ESD or SE are integrated in geography education in teacher education and at schools.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

4.2.2. Content Analysis

The bibliometric technique predominantly offers quantitative insights and does not facilitate a comprehensive examination of the specific content or context of individual studies. Therefore, to gain a more detailed understanding of the implementation of SE across different educational views on geography education, qualitative systematic reviews on sustainable development (SD) were carried out from the clustered material (n = 127). Based on manual checking, 13 studies (marked as outliers in the bibliometric step) were rejected, because they were not focused on teaching geography in teacher education or in education at primary and secondary schools (see Attachment 1). This process resulted in a refined selection of 114 studies directly related to teaching and learning in geography education. The studies examined geography teaching at different educational levels in 46 countries (Table 6). The largest number of studies concerned higher education (n = 85), and the smallest number concerned primary level teaching (n = 40). From all studies concerning higher education, the majority concerned geography teaching in the UK and in the USA (both n = 11) and in Spain (n = 10). At the secondary education level, the countries with the most studies were the USA (n = 11), China (n = 9), and the UK (n = 6). The remaining studies were fairly evenly distributed across the world.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Table 6. The countries and educational levels of the studies.

Countries	**Studies in Educational Levels *(n)***			**Countries**	**Studies in Educational Levels *(n)***		
	Primary	**Secondary**	**University**		**Primary**	**Secondary**	**University**
Australia	3	3	3	Mexico			2
Austria	1	1	1	Netherlands		2	1
Brasília			2	Norway	1	1	1
Bulgaria	1	1		Poland			1
Chile	1	1		Portugal	1	1	1
China	2	9	4	Republic of Fiji			1
Colombia			1	Romania			1
Croatia	1	1	1	Russia		1	
Czech Republic			1	Saudi Arabia			1
Denmark			1	Serbia			1
Finland	1	5	1	Singapore	1		1
Germany	4	2	4	Slovak Republic			1
Greece	1	1	2	Slovenia	1	1	1
Hungary	1	1	1	South Africa		3	3
Indonesia	2	2	3	South Korea		1	1
Ireland		3		Spain	2	2	10
Italy		2	2	Sweden	2	2	2
Jamaica		1		Turkey	1	1	
Japan		1		UK	5	6	11
Kazakhstan	2	2	1	Ukraine	1	1	1
Latvia	1	1	1	United Arab Emirates			1
Malaysia	1	1		Uruguay			1
Malta			2	USA	3	11	11
				Total *(n)*	40	71	85

The studies were analysed following the method of content analysis (*Elo & Kyngäs, 2008*). Content analysis is a well-established research technique that systematically focuses on the content of studies. The approach involves an examination of the objectives, key findings, and implications of each study, keeping the research questions in mind, to identify recurring themes related to SE in geography education. The themes are thereafter summarised and organised in a tabular format (Elo & Kyngäs, 2008).

In this study, the retrieved data were analysed qualitatively to map pedagogical innovations and conceptual linkages among the core sustainability elements. A deductive content analysis (Elo & Kyngäs, 2008) was used as the only analysis method to determine sustainable development goals (SDGs), learning objectives, and subject matter content knowledge (SCK) in geography education. It was also used in the first analysis phase to determine teaching and learning methods, and competencies and skills. In the deductive analyses used criteria are described in the Findings section. In the second analysis phase, beside the deductive analyse method, teaching and learning methods, and competencies and skills were analysed using the inductive content analysis method (Elo & Kyngäs, 2008). Inductive content analysis was used as the only method to determine powerful knowledge (PK), pedagogical content knowledge (PCK), and assessment methods.

The generalizability of the findings relates to the selection of the analysed data. Researcher triangulation was a part of the analysis process. To ensure that the categorization decisions were based on comprehensive

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

understanding of the studies, one researcher carefully read all the articles thrice, and another researcher also familiarized himself with the entire material. Thereafter, in order to ensure the reliability of the process, the researchers checked the selections together. As such, decisions always include elements of subjective interpretation. Thus joint discussions between the researchers concerning the studies are essential. Therefore, the valid findings and the conflicting views of the analysts were addressed. The discussion continued until clear arguments were found and a consensus was reached on points to be deleted or added. Based on the discussions, the researchers made the selections together. This ensured that decisions were not based on the first impression of one person on studies, but on reasoned joint discussions. Thus the analysis is based on what the authors of the articles have explicitly written, and not on what the authors of this study could read between the lines as the researchers' intentions. Because inter-rater reliability is the degree of agreement among independent observers who rate, code, or assess the same phenomenon (Saal et al., 1980), there was no need to calculate inter-rater reliability in this study due to the dialogical nature of the analysis.

The study is conducted respecting the general ethical principles presented in Finnish National Board on Research Integrity TENK guidelines. TENK (2019, p. 22) states that no ethical review statement from a human sciences ethics committee is needed when the research is based only on public information, archive data or registry and documentary data, without the data security risks associated with data that is combined from several sources.

5. Findings

Teaching aims and learning objectives guide and influence all kinds of teaching and learning in the cognitive, affective and psychomotor domains (cf. Bloom et al., 1956). Traditional geography teaching is deductive and involves the principles and methods used by teachers. In this teacher-centered learning approach, teachers are the authorities and students are the recipients of information giving lectures or presentations. Learning is often measured using objectively scored tests and assessments.

Alternative teaching methods are inductive. According to Prince and Felder (2006), inductive teaching and learning is an umbrella term that encompasses a range of instructional methods, including e.g. inquiry learning, problem-based learning, project-based learning, case-based teaching, discovery learning, and just-in-time teaching. In this student-centered learning approach, teachers and students have an equally active role in the learning process. During their studies, students discuss issues together (co-operative and collaborative learning) and solve problems (active learning) inside or outside the classroom.

5.1. Sustainable Development Goals (SDGs) (RQ 1)

To determine sustainable development goals (SDGs) included in *geography* education, the mentions in the analysed studies are collected and classified using a deductive content analysis (Elo & Kyngäs, 2008) based on the UNESCO's (2017a) definitions.

In total, there are 235 mentions of SDGs in the analysed studies. The most mentioned dimensions of SDGs are environmental and social dimensions (n = 87 and 83 respectively) (Figure 6). Economic and institutional dimensions are mentioned clearly less frequently (n = 41 and 24 respectively). Out of single SDGs, Quality education [SDG 4] is mentioned the most often (n = 18). Also responsible consumption and production [SDG 12], Climate action [SDG 13] (n = 16, both), Life on land [SDG 15], and Reduced inequalities [SDG 10] are mentioned (n = 15, both) often. Zero hunger [SDG 2], Good health and well-being [SDG 3], Clean water and sanitation [SDG 6], Peace, justice and strong institutions [SDG 16] and Partnership for the goals [SDG 17] are relatively rarely reflected (n = 12 each).

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

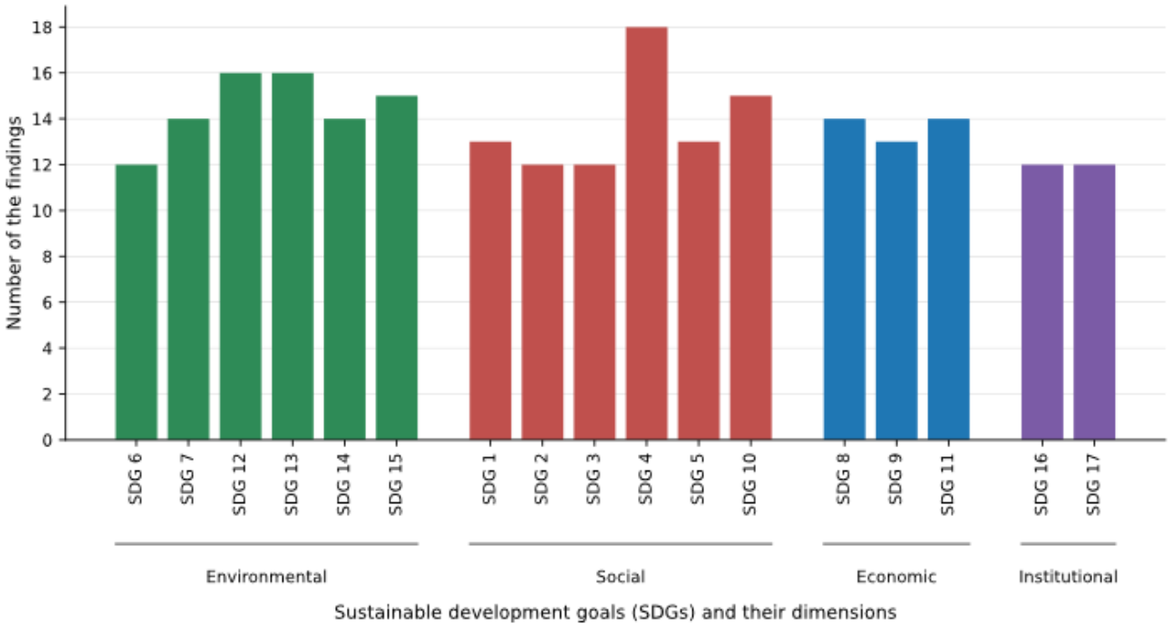


Figure 6. The sustainable development goals (SDGs) and their dimensions included in *geography* education promoting sustainable development (SD) based on deductive content analysis (Elo & Kyngäs, 2008) according to UNESCO (2017a). The total number of the reviewed studies is 114.

The findings suggest that quality education (SDG4) and the integration of SDG knowledge are important in geography education. By integrating sustainable development dimensions into geography teaching and learning, educators can promote students' understanding of the structure and function of ecological, social, and economic systems.

5.2. Learning Objectives Promoting Sustainable Development (SD) in Geography Education (RQ 2)

To determine learning objectives promoting sustainable development (SD) in geography education, the mentions in the analysed studies are collected and classified using a deductive content analysis (Elo & Kyngäs, 2008) based on the taxonomy of learning objectives (Bloom et al., 1956; Krathwohl, 2002).

Bloom et al. (1956) identified three domains of learning objectives: cognitive (intellectual), affective (emotional), and psychomotor (behavioral). Cognitive learning involves the acquisition of factual knowledge and the development of intellectual skills, abilities, and thought processes (thinking skills). Affective learning involves the ways in which people emotionally process information and stimuli. Emotional learning and development are essential to the construction of the learner's feelings, values, and motives, and are at the foundation of one's receptivity to information. Psychomotor learning involves behavior and activity connected with one's perceptual responses to inputs, to the activity of imitation (modeling and vicarious learning), and to the manipulation of one's environment (instrumental learning). Vicarious learning is a form of social learning that does not require direct personal experience (learning by doing), but rather by observing, listening to, or reading about the performance of others.

Krathwohl revised Bloom's taxonomy in 2002. The revised taxonomy is a hierarchy in the sense that the six major categories of the cognitive process dimension are believed to differ in their complexity, with the *remember* category being less complex than the *understand* category, which is less complex than the *apply* category, and so on (Table 7).

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Table 7. The cognitive process dimensions of the revised taxonomy (Krathwohl, 2002).

Criteria	Cognitive Process Dimensions
Retrieving relevant knowledge from long-term memory	Remember
Determining the meaning of instructional messages, including oral, written, and graphic communication	Understand
Carrying out or using a procedure in a given situation	Apply
Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose	Analyse
Making judgments based on criteria and standards	Evaluation
Putting elements together to form a novel, coherent whole or make an original product	Create

In total, there are 903 mentions of learning objectives in the analysed studies (Figure 7). The most frequently mentioned learning objectives are related to cognitive learning (n = 730). By contrast, there is weak coverage of psychomotor learning and affective learning (n = 120 and 53, respectively). From the single learning subdimensions, remember, understand, apply, and facts are mentioned the most often (n = 104, 104, 101, 102, respectively). Instrumental learning, emotional learning, and create are mentioned quite rarely (n = 82, 53 and 54, respectively), and vicarious learning very rarely (n = 38).

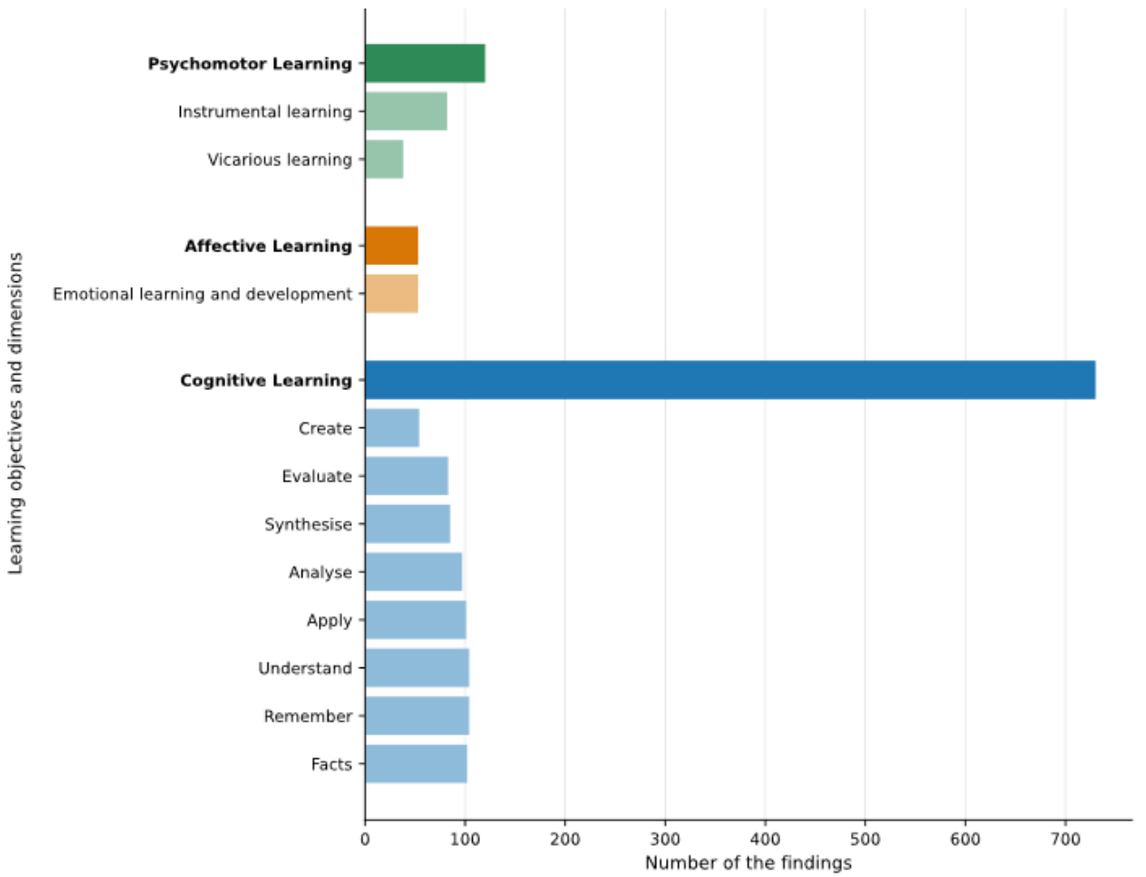


Figure 7. Learning objectives (bolded, dark) and their dimensions (light) in *geography* education promoting sustainable development (SD) collected and classified based on deductive content analysis (Elo & Kyngäs, 2008) according to Bloom et al. (1956) and Krathwohl (2002). The total number of the reviewed studies is 114.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Cognitive learning objectives are important, but alongside them educators need to emphasize also psychomotor and affective learning objectives in geography education (cf. Yli-Panula et al., 2024). By integrating these learning objectives, educators can support students' action competence and awareness of their own impact on environmental issues.

5.3. Content Knowledge Promoting Sustainable Development (SD) in Geography Education (RQ 3)

Content knowledge (CK) consists of s*ubject matter content knowledge (SCK), powerful knowledge (PK),* and *pedagogical content knowledge (PCK).* Of these, SCK is the teacher's knowledge of the content and structure of geography (Shulman, 1986). PK in geography consists of systematic world knowledge that has explanatory power as well as propensity to consider alternative solutions in a spatial context (Lambert et al., 2015, p. 732). PCK considers how the subject matter should be formulated so that students understand it (Shulman, 1986).

In the first content knowledge analysis phase, to determine the types and levels of *SCK* promoting sustainable development (SD), the mentions in the analysed studies are collected and classified using a deductive content analysis (Elo & Kyngäs, 2008) based on Bloom's new taxonomy (Krathwohl, 2002) according to Aksela et al. (2012) (Table 8). In this analysis, the next knowledge level always includes the previous one/the previous ones. For example, conceptual (concept) knowledge includes factual (fact) knowledge, and methodological (procedural) knowledge includes both factual and conceptual knowledge.

Table 8. The new taxonomy of Bloom (Krathwohl, 2002) according to Aksela et al. (2012).

Criteria	**Knowledge level**
Terminology of geography	Factual (fact) knowledge
Classification of geographical knowledge; theories, models, structures	Conceptual (concept) knowledge
Problem solving, research methods and techniques	Methodological (procedural) knowledge
Making summaries, self-knowledge	Metacognitive knowledge

In addition, the levels of thinking skills achieved during the learning processes are analysed using the verbs defined by Stanny (2016) (Table 9). These verbs are applied as background information to support interpretation, if the taxonomy level is not clearly stated in the study or is not represented in verb form.

Thereafter PK and PCK are collected and classified using inductive content analysis (Elo & Kyngäs, 2008).

Table 9. Bloom's taxonomy verbs used to support the analysis (Stanny, 2016).

Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Arrange	Articulate	Act	Analyze	Appraise	Arrange
Choose	Associate	Adapt	Appraise	Argue	Assemble
Cite	Characterizise	Apply	Break	Arrange	Categorize
Copy	Cite	Back/back	Break down	Assess	Choose
Define	Clarify	up	Calculate	Attach	Collect
Describe	Classify	Calculate	Categorize	Choose	Combine
Draw	Compare	Change	Classify	Compare	Compile
Duplicate	Contrast	Choose	Compare	Conclude	Compose
Identify	Convert	Classify	Conclude	Contrast	Construct
Indicate	Defend	Complete	Contrast	Core	Create
Label	Demonstrate	Compute	Correlate	Counsel	Design
List	Describe	Construct	Criticize	Create	Develop
Locate	Differentiate	Demonstrate	Debate	Criticize	Devise
Match	Discuss	Develop	Deduce	Critique	Estimate
Memorize	Distinguish	Discover	Detect	Decide	Evaluate
Name	Estimate	Dramatize	Diagnose	Defend	Explain
Order	Explain	Employ	Diagram	Describe	Facilitate

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Outline	Express	Experiment	Differentiate	Design	Formulate
Quote	Extend	Explain	Discover	Determine	Generalize
Read	Extrapolate	Generalize	Disseminate	Discriminate	Generate
Recall	Generalize	Identify	Dissect	Estimate	Hypothesize
Recite	Give	Illustrate	Distinguish	Evaluate	Inprove
Recognize	Give examples	Implement	Devide	Explain	Integrate
Record	Identify	Interpret	Evaluate	Grade	Invent
Relate	Illustrate	Interview	Examine	Invent	Make
Repeat	Indicate	Manipulate	Experiment	Judge	Manage
Reproduce	Infer	Modify	Figure	Manage	Modify
Review	Interpolate	Operate	Group	Mediate	Organize
Select	Interpret	Organize	Identify	Prepare	Originate
State	Locate	Paint	Illustrate	Probe	Plan
Tabulate	Match	Practice	Infer	Rate	Predict
Tell	Observe	Predict	Inspect	Rearrange	Prepare
Underline	Organize	Prepare	Inventory	Reconcile	Produce
		Produce			

In total, there are 443 mentions of *content knowledge* (CK) in the analysed studies. There are 386 mentions concerning the levels of subject content knowledge (SCK). Factual and conceptual knowledge (n = 107 and 106, respectively) are the most frequently mentioned levels (Figure 8). Methodological knowledge and metacognitive knowledge (n = 101 and 72, respectively) are reflected less often. Powerful knowledge (PK) is explicitly mentioned 21 times and pedagogical content knowledge (PCK) 36 times in the analysed studies.

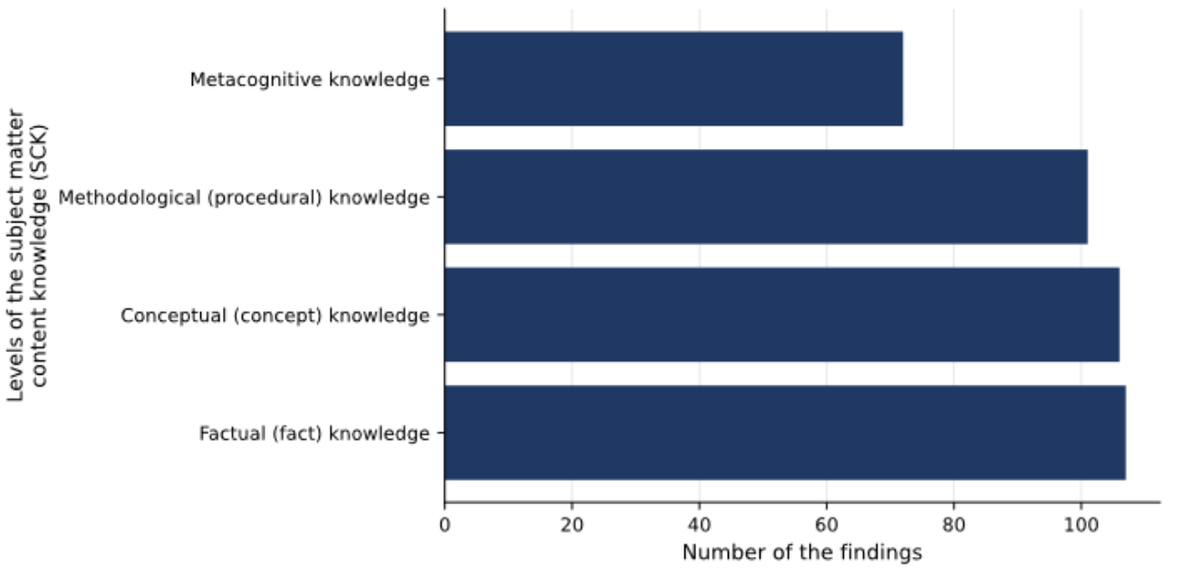


Figure 8. Levels of the subject matter *content* knowledge (SCK) in *geography* education promoting sustainable development (SD) based on deductive content analysis (Elo & Kyngäs, 2008) according to Aksela et al. (2012). The total number of the reviewed studies is 114.

The findings show that geography education currently emphasizes acquiring factual and conceptual knowledge more than other knowledge types. To support students in developing a holistic perspective, educators need to emphasize metacognitive knowledge, so that students can be aware of their own or others' cognitive functions, thinking, learning and knowing, for example, regarding phenomena in everyday life. Educators need to use PCK to support students in finding powerful knowledge (PK) and in applying it to find

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

new ways of looking at things and reliable explanations, as well as in finding opportunities to participate in societal and ethical discussions in line with Visions II and III.

5.4. Teaching and Learning Methods Promoting Sustainable Development (SD) in Geography Education (RQ 4)

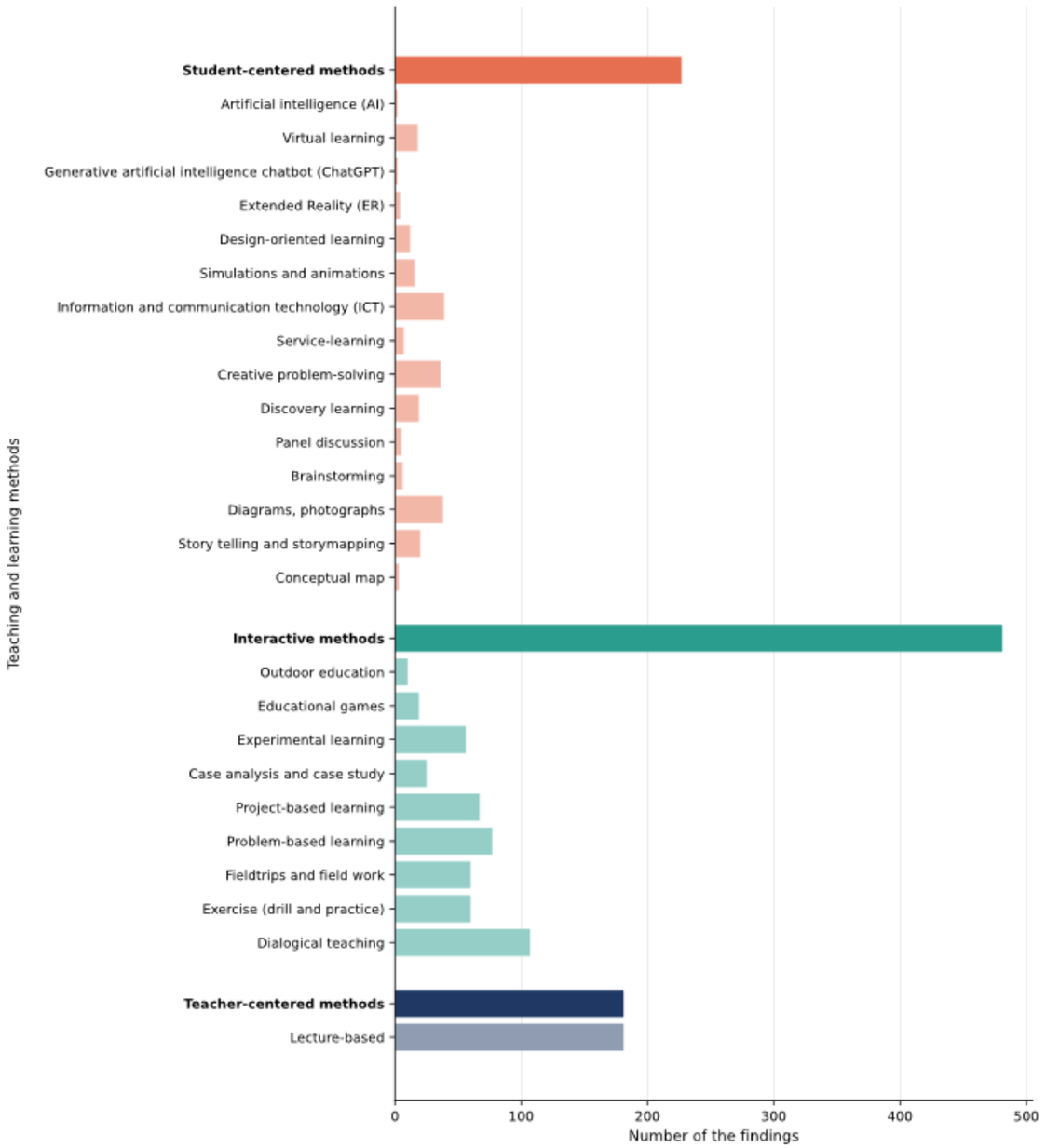
To determine the teaching and learning methods promoting sustainable development (SD) in geography education, the mentions in the analysed studies are collected and classified first using a deductive content analysis (Elo & Kyngäs, 2008) based on Ghafar (2023), Kesler (2020), Landøy et al. (2020), and Yli-Panula et al. (2020), and thereafter using an inductive content analysis (Elo & Kyngäs, 2008).

In total, there are 1327 mentions of teaching and learning methods in the analysed studies. The findings of the deductive content analysis are shown in Figure 9a, and the findings of the inductive content analysis in Figure 9b.

Based on the findings, the most popular teaching and learning methods are interactive methods (n = 732), followed by student-centered methods (n = 385). Teacher-centered methods (n = 210) are the least popular. Out of single teaching and learning methods, lecture based methods (n = 181) are mentioned the most often. They include different kinds of presentations, explanations and demonstrations using e.g. videos and movies. They are followed by dialogical methods (n = 107) such as conversations, discussions and argumentations. Information and communication technology (ICT) with different applications (e.g. Geographic Information systems (GIS); virtual learning; simulations and animations) are mentioned often (n = 119), with the exception of artificial intelligence (AI). AI is one of the least mentioned teaching and learning methods (n = 2). Problem-based and project-based methods (n =77 and 67, respectively) are mentioned often. Popular methods are also co-operation and collaboration (n = 63), field trips and field work (n = 60), exercise (n = 60), experiential learning (n = 59) and experimental learning (n = 56), as well the scientific inquiry method (n = 49). Less frequently mentioned methods include e.g. outdoor education, service learning, and panel discussions (n = 10, 7, 5).

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

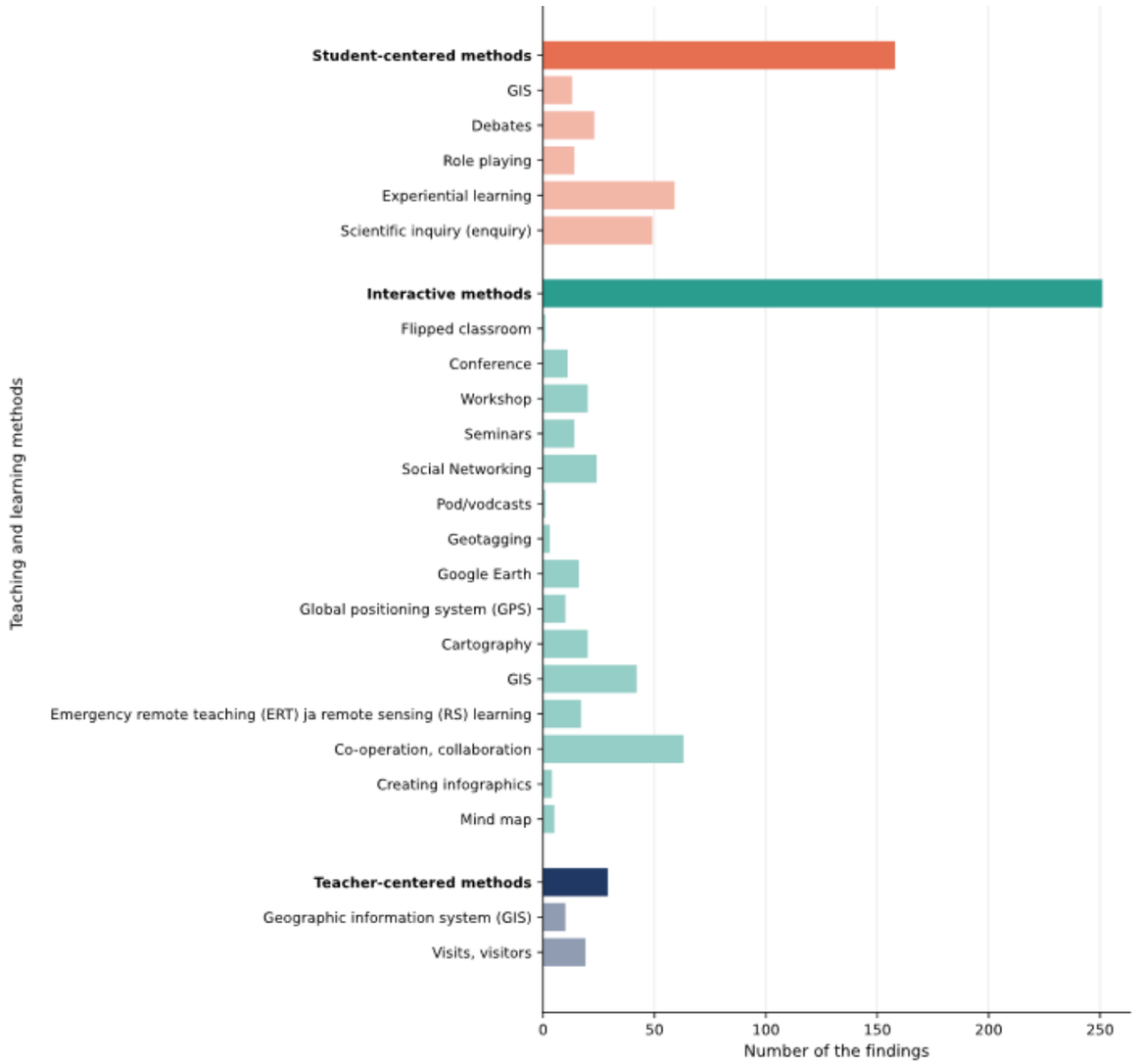
Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).



(a)

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).



(b)

Figure 9. Teaching and learning methods in geography education promoting sustainable development (SD). The total number of the reviewed studies is 114. Method groups dark and bolded; single methods light. **(a).** Results based on deductive content analysis (Elo & Kyngäs, 2008) according to Ghafar (2023), Kesler (2020), Landøy et al. (2020), and Yli-Panula et al. (2020). **(b).** Results based on inductive content analysis (Elo & Kyngäs, 2008).

Based on the findings, the most popular teaching and learning methods are research-based, student participation and agency promoting ones. Lecture-based and dialogic methods are also popular. For promoting sustainability, educators need to use different teaching methods together in school education to reach the SDGs and to support all four (environmental, social, economic, and cultural) dimensions of sustainable development (SD).

5.5. Competencies and Skills Promoting Sustainable Development (SD) in Geography Education (RQ 5)

To determine competencies and skills promoting sustainable development (SD) in *geography* education, the mentions in the reviewed studies are collected and classified first using a deductive content analysis (Elo & Kyngäs, 2008) based on Sposab and Rieckmann (2024), UNESCO (2017a), Wehry et al. (2012), and Wiek and Redman (2022); and thereafter using an inductive content analysis (Elo & Kyngäs, 2008).

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

In total, there are 956 mentions about competencies and skills in the analysed studies. The findings of the deductive content analysis are shown in Figure 10 (n = 920). In addition, there are 36 findings based on inductive content analysis.

The most mentioned competencies and skills are critical thinking, and problem solving and dealing with complexity (n = 73 and 71, respectively) (Figure 10). These are followed by spatial thinking, and planning and implementation (n = 64 and 63, respectively). Also, communication, futures thinking, collaborative decision making, reflection, and systems thinking are mentioned frequently (n = 60, 58, 57, 52, 52 respectively). Integrated problem-solving competency, action competence, and empathy are the least mentioned (n = 39, 35 and 23, respectively). In addition, alongside the competencies and skills mentioned in Figure 10, also 21 mentions of temporal thinking skills, 13 mentions of cartographic skills, and two mentions of transdisciplinary skills are found in the inductive content analysis.

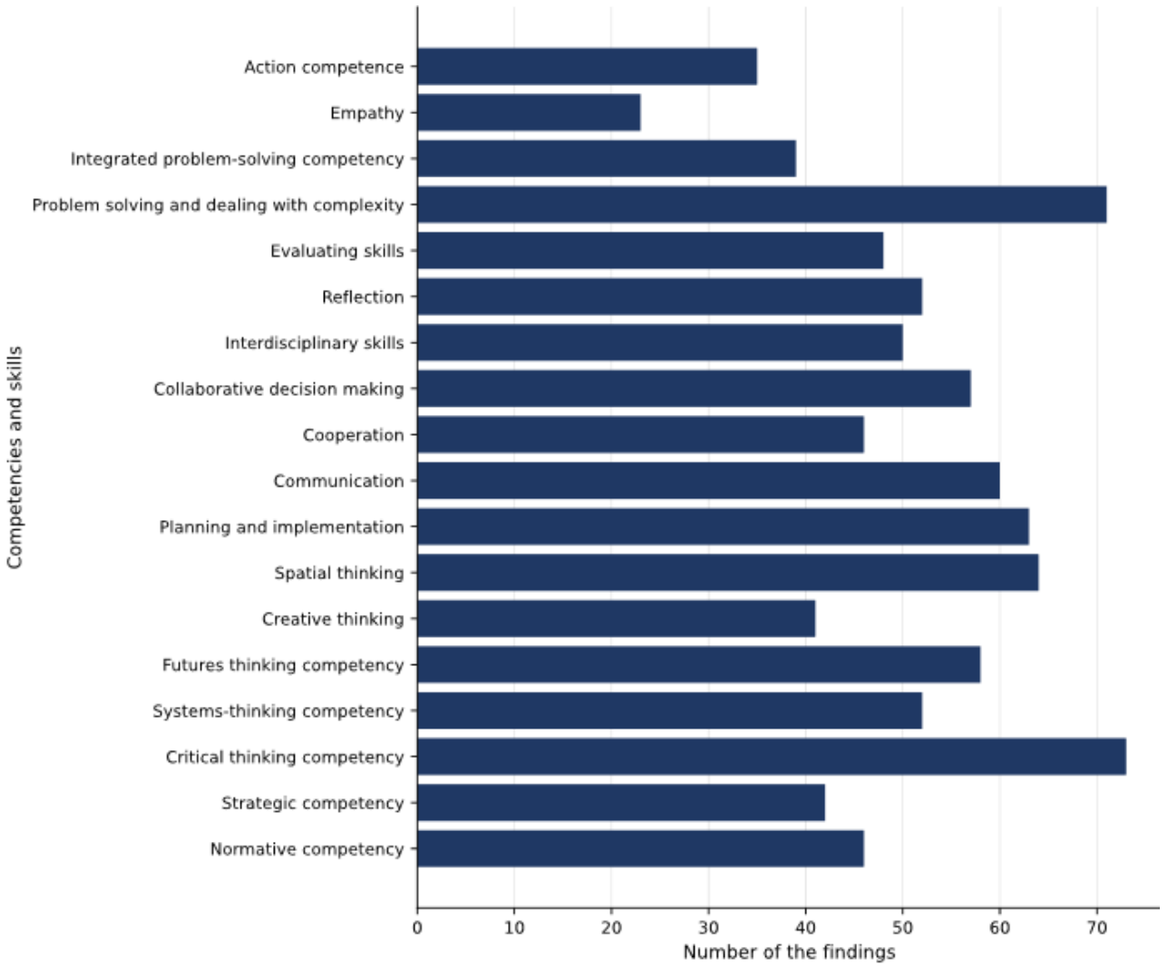


Figure 10. Competencies and skills in *geography* education promoting sustainable development (SD) based on deductive content analysis (Elo & Kyngäs, 2008) according to Sposab and Rieckmann (2024), UNESCO (2017a), Wehry et al. (2012), and Wiek and Redman (2022). The total number of the reviewed studies is 114.

The findings suggest that critical thinking, and problem-solving and dealing with complexity are the most popular competencies and skills for promoting sustainable development (SD) in geography education. They are needed, among other things, for engaging students in decision-making and developing appropriate behavior in controversial issues (Lindström, 2024). Geographical thinking and reasoning are related to geospatial information. Alongside spatial skills, educators need to pay more attention to temporal thinking skills. They also need to further stress action competence, transdisciplinarity, and empathy in geography

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

teaching, because these competencies promote holistic approaches, enabling a more effective response to complex environmental and societal challenges and a commitment to equality and justice (Persano Adorno et al., 2025).

5.6. Assessment Methods Promoting Sustainable Development (SD) in Geography Education (RQ 6)

To determine different assessment methods promoting sustainable development (SD) included in *geography* education, the mentions in the analysed studies are collected and classified using an inductive content analysis (Elo & Kyngäs, 2008).

Based on the findings, assessment methods of sustainable development (SD) in *geography* education are mentioned 104 times in total. Formative and summative methods are mentioned the most often, and diagnostic methods very rarely (n = 50, 43, and 11, respectively) (Figure 11). In formative assessment, popular methods, alongside continuous, observation-based feedback from the teacher, are peer assessment, and student self-assessment when evaluating students' essays, PowerPoint presentations, and posters. Web-GIS and the Moodle platform have been used during classroom teaching, but also during distance learning. In summative assessment, tests and exams are the assessment types mentioned the most often, but alongside them, also different student outputs (e.g. diaries, portfolios, reports) have been assessed. In addition, evaluative, retrospective discussions between the teacher and students are used – but rarely. In diagnostic assessment, tests and preparatory discussions are the only mentioned assessment types.

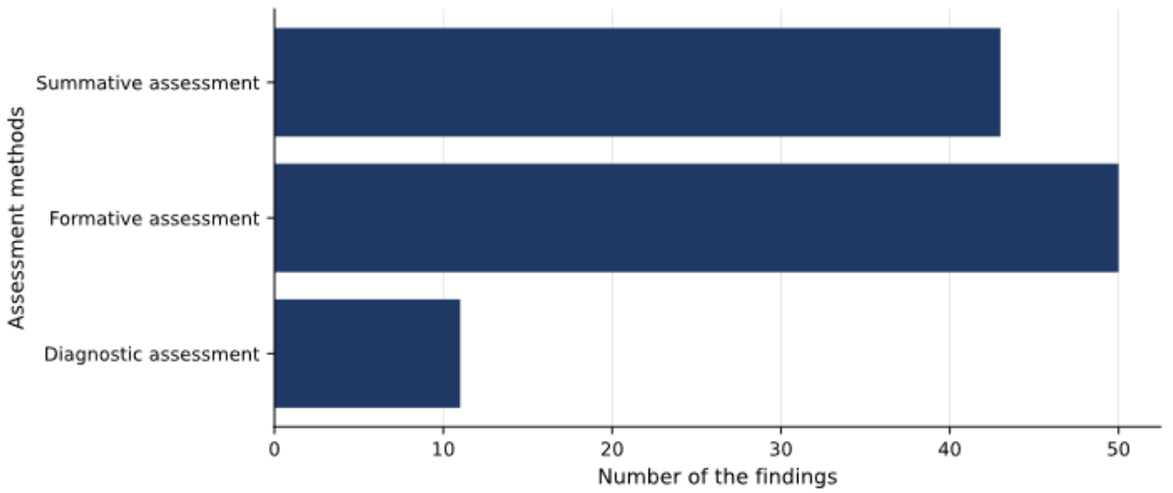


Figure 11. Assessment methods in geography education promoting sustainable development (SD) based on inductive content analysis (Elo & Kyngäs, 2008). The total number of the reviewed studies is 114.

Various types of assessment methods used to assess students' knowledge are mentioned, allowing to map the levels of knowledge and thinking skills of the students during or at the end of the teaching and learning situations. The findings show, however, that little attention is currently paid to assessment. Moreover, there is an overemphasis on formative and summative methods relative to diagnostic methods. Educators need to emphasize diagnostic assessment more, because it supports both the design of teaching and learning processes, and the development of curriculum based on students' actual knowledge (Lyon, 2013).

6. Discussion

Geography is the ideal subject to foster sustainability education (SE), because it combines elements of science (i.e. physical geography) with those of social science (i.e. human geography) (McKeown & Hopkins, 2007). It has a special place in schools in developing students' critical multi-literacy skills, as it covers various information sources: text-based information, visual materials such as maps, diagrams, graphics, images and videos, as well as oral expert information. A holistic view of the educational processes is needed for understanding all the educational effects. This study explores recent research findings on pedagogical and didactic approaches of geography education from a sustainable development (SD) perspective in teacher

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

education and at primary and secondary schools. The study offers insights to improve didactic and pedagogical approaches in geography education for promoting SD.

As for the trustworthiness of the study (Elo et al., 2014), the design and implementation of the study were negotiated among the researchers throughout the research process. Searches of data were carried out with numerous keyword combinations. The analysis of the data was carried out by using first a bibliometric analysis, followed by deductive and inductive content analyses. The findings were validated through joint discussions between the researchers. The results were also compared with previous studies.

However, all teaching and learning situations are context- and topic-specific, and therefore, when selecting and applying teaching approaches, cultural as well as current phenomena and issues need to be taken into account. The findings highlight some challenges to adopting active student-centered didactic approaches in the integration of sustainable education (SE) in geography education. They should be discussed from the perspective of the development of geography education promoting sustainable development (SD) to support the shift towards sustainable living and well-being.

6.1. Sustainable Development Goals (SDGs)

Sustainable development goals (SDGs) provide a concrete operational framework for sustainability education (SE), translating abstract sustainability principles into measurable global objectives. In this context, geography education serves as a bridge between global sustainability agendas and local learning experiences. In total, there are 235 mentions of SDGs across the 114 studies reviewed. As in the study of Yli-Panula et al. (2020), the most often expressed dimensions of sustainable development (SD) in this study are the environmental and social ones, while the economic and institutional dimensions are seldom reflected.

During geography lessons, earthquakes, tsunamis, sustainable urban development, and climate change are frequently discussed topics. These real-world issues are directly linked with the following SDGs, mentioned quite often in this study: Sustainable cities and communities [SDG 11], Industry, innovation and infrastructure [SDG 9], Climate action [SDG 13], Life below water [SDG 14], and Life on land [SDG 15]. The findings support the study of Abu (2026). When students analyse spatial data about these phenomena, they learn systems thinking, and develop an understanding of complex phenomena and the interdependencies between natural and human systems. Emphasizing these issues in geography teaching is important for equipping students to act in accordance with Visions I and II.

As in the study of Yli-Panula et al. (2020), SDGs other than Quality education [SDG 4] are clearly less reflected. SDG 4 has generated much debate around the world today (e.g., Efe & Umdu Topsakal, 2025; Ölçer-Çevik & Kozaner, 2025; Villarosa, 2025). The reason is that the UN General Assembly Resolution 74/233 (UN, 2020) reinforced education for sustainable development (ESD) as an essential part of SDG 4, and emphasized SDG 4 as a key enabler of all the other SDGs, calling for countries to strengthen its implementation. SDG 4 is indeed crucial, because it provides the foundation for all other SDGs to educate professionals with a global perspective and social and economic responsibility (Boeren, 2019; Espinosa-Gutirrez et al., 2025). The findings of this study show that the SDGs related to ethical and interdisciplinary issues under SDG 4 are not sufficiently addressed, as, for example, mentions of good health and well-being [SDG 3], peace, justice and strong institutions [SDG 16] and partnerships for achieving the goals [SDG 17] are relatively few. Emphasizing these issues in geography teaching is important for equipping students to act in accordance with Vision III. International research stresses that integration of the SDGs in geography education is most effective when sustainability is treated as a cross-cutting theme embedded throughout the curriculum (Abu, 2026).

SDGs have been criticized for preparing students to maintain the status quo, although the goal should be empowering students to question their personal and socially established norms, values, ethical and political views (cf. Spaiser et al., 2016). SDGs should provide students with opportunities to imagine future situations, weigh possible courses of action, and the consequences of different actions, but a view of alternative courses of action is lacking from SDGs. In particular, the goals for environmental sustainability and socio-economic sustainability are inconsistent, and they are not regionally and internationally binding (Spaiser et al., 2016). Furthermore, according to Swain (2018), the source(s) and scale of financial resources and investments needed to achieve SDGs are unclear.

By integrating the SDGs into geography teaching and learning, educators can promote students' understanding of the structure and function of ecological, social, cultural, and economic systems. This

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

approach allows students to discuss sustainable development concepts in different geographical contexts, and to strengthen their understanding about sustainability issues in and out of school, and to support students' conceptions and envisions what the world like today and might look in the future.

6.2. Learning Objectives Promoting Sustainable Development (SD) in Geography Education

Learning objectives focus the curriculum, facilitate the selection and organization of content, and make it possible to evaluate learning outcomes. In total, there are 903 learning objectives mentioned in the analysed studies. Cognitive learning is well represented, whereas psychomotor and affective learning are not. The finding supports the studies of Lovren and Jablanovic (2023) and Sharma (2021).

From cognitive learning, the lowest-level subdomain, factual learning, is often mentioned, and the facts tend to be remembered, understood and also applied. By contrast, the highest-level subdomain, create, is very rarely mentioned. The findings are in line with previous studies, which state that traditional science education remains predominantly compartmentalized, focusing on isolated scientific concepts rather than broader integrative applications of knowledge (Yücel & Çalışkan, 2025).

In addition to cognitive learning, psychomotor and affective learning are important to take into account in geography education. Novak's (2010) theory of constructivism suggests that meaningful learning should involve thinking, feeling, and acting, implying that good learning activities integrate the three domains of learning. Greater consideration of the psychomotor and affective domains in parallel to cognitive learning could therefore improve learning experiences. Psychomotor learning encompasses hands-on learning and ranges from reflex movements and physical abilities to the performance of skilled movements. Affective learning with social skills is important to emphasize for collaboration, negotiation, and communication to promote SDGs, as well as self-reflection skills, values, attitudes, and motivation for enabling students to develop themselves. The affective skills of spatial perception are needed for understanding the bigger, geographical picture, exploring interconnections of geographical processes and gaining respect for nature and the environment (Holton, 2017).

Based on the findings of this study, cognitive learning objectives are overrepresented compared to psychomotor and affective learning objectives. In order to promote students' sustainability mindset and cognitive flexibility, educators need to consider psychomotor and affective learning objectives alongside cognitive objectives in geography teaching (cf. Yli-Panula et al., 2024). This requires instilling the importance of environmental stewardship, environmental awareness, and the importance of sustainable practices (Sipos et al., 2008). Educators need to define all three learning objective types clearly, so that students have an understanding of what is expected of them in terms of sustainability competence. In this way, the students' ability to act on as well as their awareness of their own impact on environmental issues can be supported.

6.3. Content Knowledge Promoting Sustainable Development (SD) in Geography Education

In total, there are 443 mentions of content knowledge (CK) in the analysed studies: 386 mentions of the levels of subject content knowledge (SCK) found by deductive content analysis; and 21 mentions of powerful knowledge (PK) and 36 mentions of pedagogical content knowledge (PCK), found by inductive content analysis.

The analysed studies focus mainly on the lower levels of SCK (factual and conceptual knowledge), while the higher level of SCK (metacognitive knowledge) is rarely discussed. The findings support the studies of Virranmäki et al. (2021), Grmuša et al. (2024) and Yli-Panula et al. (2025). There are many reasons for these findings. E.g. Virranmäki et al. (2021) have stated in their study that Finnish upper secondary geography curricula, do not support the learning of higher-order metacognitive knowledge related to the highest level of thinking skill, creating. The second reason may be that some teachers and student teachers have significant gaps in their knowledge and skills in teaching science (Backman et al., 2019; Efe & Umdu Topsakal, 2025; Robinson, 2011), including geography (Dem & Seden, 2025). Thirdly, teaching sustainable development (SD) has not been sufficiently supported in teacher education (Albion et al., 2025), especially in geography (Dem & Seden, 2025). In other words, the students understand geographical and sustainability concepts, and have developed critical thinking skills, but they are unable to create solutions in practice, due to a lack of guidance and channels. Teacher education has an important role to play in reversing this trend.

Powerful knowledge (PK) is rarely mentioned in the analysed studies. This shows that further improvements are needed to fully realise its transformative potential. PK encompasses specialised, theoretical

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

knowledge that transcends everyday experiences, and enables educators to foster equity, empower learners, and achieve inclusivity in education (Young, 2013; Young & Muller, 2013). PK supports the creation of more comprehensive and culturally relevant sustainability strategies, as it provides three types of knowledge: descriptive "world" knowledge, critical conceptual knowledge, and knowledge about alternative futures in spatial contexts (Lambert et al., 2015, p. 732). Building on Young's (2009) ideas, Lambert et al. (2015) suggest that powerful geographical knowledge in practice includes:

- Knowledge of how knowledge is developed and tested in the discipline;
- Meta-concepts (e.g. place, space, environment) to enhance geographical thinking;
- Knowledge about the world;
- Knowledge that provides students with effective ways to analyse, understand and explain the world;
- Knowledge that gives students some power over their own geographical knowledge;
- Knowledge that enables young people to follow and participate in discussions about local,national, and global issues;
- New ways of thinking about the world (cf. Tani et al., 2018).

In school geography education, the concept of PK is especially important because it allows educators to identify the types of knowledge that most contribute to the development of students' intellectual powers or abilities (Maude, 2017, pp. 10–11). According to Hilander and Tani (2026, p. 333), the key content of PK includes three knowledge levels: (1) basic knowledge of the world (basic concepts, key terminology, understanding the origin of geographical phenomena); (2) the "grammar" of geography, with geographical thinking at its core (understanding the relationships between phenomena); (3) the ability to use the language of geography (producing, analyzing and interpreting geographical data, the ability to critically evaluate sources of information, and the ability to envision alternative futures). PK enables thus students to find reliable explanations for world phenomena as well as different ways of looking at the world, and to find ways of acting that enable them to participate in societal and ethical debates.

In geography teaching and learning, PK is relevant concerning all Visions I–III (Roberts, 2007; Sjöström & Eilks, 2018). Many topics intersect with ecological, social and economic sustainability (Jeronen et al., 2024; Yli-Panula et al., 2022). In Vision I, ecological knowledge is related to, among other things, the loss of nature and ways to protect biodiversity. In Vision II, the issues are for example, related to land use and the production and consumption of commodities in relation to human health and well-being (Naeem et al., 2016). In Vision III, geography topics can be linked to themes, attitudes, or emotions of social sustainability, such as human rights and equality (Ottander & Simon, 2021). By applying the concept of PK to structuring the geography curriculum, arranging the curriculum according to the revised Bloom's taxonomy is a possibility for improving students' learning outcomes (Grmuša et al., 2024).

The study of Dem and Seden (2025) revealed that both geography teachers and students have a comprehensive understanding of pedagogical content knowledge (PCK) and its critical role in effective content delivery. PCK is, however, rarely mentioned in the analysed studies. This shows that educators need to make more use of its transformative potential. PCK is essential for supporting the students' understanding of sustainability issues, and the acquisition of knowledge and skills for sustainable action according to Visions II and III (Rockström & Sukhdev, 2016). Geography teaching has transformative power when students are able to form new views on existing concepts and conceptual connections related to their living environment based on their observations and insights (Muller & Young, 2019). While Dem and Seden (2025) expressed positive perceptions of teachers' PCK, they identified also significant challenges, including limited subject knowledge, resource constraints, and time limitations, underscoring the need for continuous professional development. They presented various strategies to address these challenges, such as leveraging social media, co-teaching, and engaging in self-reflection.

The knowledge of both teachers and students influences what is taught and learned in school, and curricula transform over time via a three-stage process (cf. Gericke et al., 2025). In the first stage, teachers transform curricular knowledge into taught knowledge, thereby creating their own interpretation. In the second stage, students learn a version of the taught knowledge and apply the knowledge they have learned in their lives outside of school. On the other hand, the students bring their experiences outside of school back into the classroom, which influences their acquisition of new knowledge at school. In the third stage, this

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

influences curriculum design, because measurements of learning outcomes are used as inputs by curriculum designers (Gericke et al., 2018).

Teaching and learning sustainability requires content knowledge from a variety of fields of science, including geography. This enables students to understand what must be taken into account when considering questions of sustainability, in line with Vision I (Roberts, 2007; Sjöström & Eilks, 2018).

Understanding local environmental conditions supports individuals to connect with and take responsibility for the surrounding nature. Local knowledge enriches insights and encourages concrete actions, for example, to maintain regional biodiversity and ecosystem stability (Szczytko et al., 2018). This enables students to find new perspectives and reliable explanations, as well as opportunities to participate in societal and ethical discussions for development of environmental literacy, in line with Vision II (Roberts, 2007; Sjöström & Eilks, 2018).

To support students in developing a holistic perspective, educators need to place more emphasis on metacognitive, reflective and creative knowledge, and invest in PCK to be able to support the students in finding PK. By supporting the development of the students' ecoliteracy (ecological literacy), educators can help students to form a holistic view of relationships of ecosystems and human beings (van de Wetering et al., 2022), and give them the possibility to participate in activities, in line with Vision III (Roberts, 2007; Sjöström & Eilks, 2018).

6.4. Teaching and Learning Methods Promoting Sustainable Development (SD) in Geography Education

In total, there are 1327 mentions about teaching and learning methods in the analysed studies. Interactive methods are mentioned the most often, followed by student-centered methods. Teacher-centered methods are mentioned the least often. The findings differ from those of Kocalar and Demirkaya (2017), who found that teachers do not favor new and different methods and do not apply them in teaching-learning situations. Based on the analyses of this study, it can be argued that there is a shift in geography teaching towards interactive and student-centered methods, as Yli-Panula et al. (2020) have also shown. The different findings and conclusions may be due to differences in the research methods used. For example, in the first study geography teachers' interviews were analysed, while in the latter, peer-reviewed articles published in scientific journals were analysed.

In the analysed studies, 45 different teaching and learning methods are mentioned. Out of single teaching and learning methods, lecture based methods are most mentioned ones. This finding is in line with the study of Kocalar and Demirkaya (2017), which showed that the method of narration and the method of question-answer are the most common methods used by teachers. However, based on the other findings of our study, it can be stated that teachers favour new methods and apply them according to the relevant topic. In the following sections, based on the findings, the most commonly used methods in geography education are discussed, starting with those mentioned most frequently, namely problem-based learning, project-based learning, cooperative learning, collaborative learning, and discussion. Participatory teaching methods, such as these four, can support transformative engagement and the development of active citizenship.

The finding, from this study, that problem-based learning (PBL) is popular, supports the studies of Caeiro and Simão (2025) and Santos et al. (2025). PBL can promote critical and systems thinking (Chen et al., 2022), problem-solving (Cavadas & Linhares, 2023; Hazen & Alberts, 2021; Liu & Pásztor, 2022; Mondal, 2024), and collaboration (Cavadas & Linhares, 2023; Liu & Pásztor, 2022). It can also develop environmental and self-awareness skills (Wang, 2021). Based on student-centered learning, PBL offers an excellent approach to promoting students' cognitive and psychological flexibility, which is needed *for* achieving sustainability *(Cavadas, & Linhares, 2023)*. According to Fuchs et al. (2024), cognitive flexibility is defined as the ability to adapt one's thinking and problem-solving methods in the face of new, evolving circumstances. Psychological flexibility is the ability to shape emotional and behavioral responses in accordance with shared values and goals despite challenges or stressors. These forms of flexibility are related to critical thinking, problem-solving, creativity, and emotional intelligence which are key skills for success in a rapidly changing global situation (Demssie et al., 2019). Based on previous research (Wahelo et al., 2025), there are barriers to implementing PBL such as large class sizes, the prevalence of traditional methods, and the time-consuming nature of PBL. In addition, curriculum rigidity, student resistance, and limited resources can hinder practical implementation. Diversifying teacher education, making curricula more flexible, and supporting teachers can promote the use of PBL in SE included in geography education.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

The finding regarding the popularity of project-based learning (PjBL) supports the study of White et al. (2024) but differs from the study of Al-Nofli et al. (2026). PjBL can promote active students' engagement and a deeper understanding of environmental challenges by incorporating hands-on creative activities into learning situations in real-world contexts (White et al., 2024). It may encourage students to identify environmental problems, design creative solutions, and implement them through collaboration, often with local communities or relevant stakeholders. Through multidisciplinary (Persano Adorno et al., 2025) and interdisciplinary (*Chernyatin, 2019;* White et al., 2024) strategies, the gap between scientific principles and real-world sustainability issues can be bridged for strengthening the students' environmental awareness (Lovren & Jablanovic, 2023). When students' understanding about the interactions between ecosystem components and human environmental impacts broadens, their sustainability skills may increase (Caeiro & Simão, 2025), and awareness of the importance of maintaining ecosystem sustainability and balance may deepen (White et al., 2024). The application of PjBL faces a number of complex challenges related to regulatory, organizational, social, and contextual factors. One of the main problems is the uncertainty about the successful acquisition of knowledge and development of key skills through PjBL (Djordjevic et al., 2026). This uncertainty is exacerbated by the lack of sufficient material, technological, and financial resources (Darling-Hammond et al., 2017). Although research evidence shows that PBjL can improve problem-solving skills, promote student engagement, and facilitate deeper learning experiences (Strobel et al., 2009; Walker et Leary, 2009), the overall impact of PjBL is still unknown (Sánchez-García et al., 2025).

Cooperative and collaborative learning are commonly mentioned in the analysed studies, which supports the study of Yli-Panula et al. (2020). These learning methods, in the face of global development progress, provide students globally with competencies, self-regulation, and the tools for resource-sharing and -learning, thus facilitating beneficial changes in the educational environment (Zhou et al., 2025).

Cooperative learning emphasizes that students work in small groups together to achieve shared goals within the framework of defined group roles sharing responsibility to achieve common goals (Johnson & Johnson, 2009). The results of the previous studies on cooperative learning are mixed. The study of Slavin et al. (2022) show that cooperative learning has a significant positive effect on student learning levels, while some other studies show that its effects are varied or even negative. For example, a meta-analysis by Springer et al. (2022) show that cooperative learning has no significant effect on students' learning levels in higher education. Cooperative learning requires cooperation and input from each group member; otherwise, it can lead to negative interdependence, where students prevent each other from achieving a common goal (Johnson & Johnson, 2009). To develop positive interdependence, teachers need to structure goals and interactive tasks from a perspective that promotes cooperation. For example, by assigning students alternating roles such as leader, recorder, checker, and time-keeper, the teacher can support the students' cooperation in achieving the desired learning objectives.

Collaborative learning (commonly confusingly referred to as cooperative learning) is also commonly used in the analyzed studies. In collaborative learning, the level of commitment to achieving the shared goal is higher than in cooperative learning. According to Wangdi et al. (2024), collaborative learning is an encouraging strategy for enhancing student engagement and achievement. It fosters a sense of teamwork and cooperation among students, allowing them to learn from each other and to develop a deeper understanding of the topic. Working in groups, students seek to construct knowledge together through open-ended problems and achieve shared goals through self-direction and flexible roles for group members (Davidson & Major, 2014). Collaborative learning enhances students' communication and reasoning skills by fostering dialogue, critical thinking, and problem-solving through peer interaction (Kausar, 2025). Collaboration inside schools and with local communities or organizations allows students to participate for example, in species preservation or recycling programs, offering opportunities to apply theoretical knowledge to practical scenarios. Gaining first-hand experiences and beginning to see the impact of environmental action on the local ecosystem may deepen the students' understanding on sustainable development. First-hand experiences can promote their ecological awareness and environmental responsibility. This way, students may find solutions to reduce the impact of human activity on the environment for protecting and preserving their living environment.

In fostering collaborative learning, previous studies have shown some challenges. Cohen (1994) ascertains that students in groups may waste time in off-task behavior, engaging in social loafing, in which some of the students in a group do little or none of the work, relying instead on others to do the work for them. In addition, group settings may exhibit unequal interactions, in which some students talk most of the time, and/or some

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

students participate very little or not at all. Collaborative work can also be hindered by students' negative feelings, especially in a virtual reality environment (Shen et al., 2022). To avoid such challenges, students need special support in teaching and learning situations, and ways need to be found to adapt collaborative sessions or the learning environment to reduce negative feelings.

In this study, discussion is seen to be a popular method as in the studies of Yli-Panula et al. (2020) and Al-Nofli et al. (2026). Most teachers use the discussion teaching strategy in geography teaching, applying different aspects, such as small group work, large group work, and panel discussion (Ongek et al., 2025). Discussion includes open collaborative exchanges of ideas between the teacher and students, or among students, with the aim of promoting student thinking, learning, problem solving, understanding, or appreciation of the subject matter being taught. Students may discuss in pairs, small groups, or with the entire class, and the discussion may be led by the teacher or by the students. Participants present perspectives, comment, and reflect on their own and others' ideas, in an effort to build their knowledge, understanding, or interpretation of the topic being discussed, whether it be a written text or a problem, question, or issue. Considering improving students' critical thinking and communication skills, discussion is more effective and result-oriented as a teaching strategy than traditional lecturing (Saira & Hafeez, 2021). The use of group discussions as a teaching method may be hindered by teachers' insufficient knowledge and skills in student-centered pedagogy, especially in practical lessons such as map reading, graphing, and fieldwork (Kagoda, 2009).

In the following sections, some other teaching and learning methods are discussed that were mentioned less frequently in the studies analysed than the methods discussed above. These consist of information and communication technologies (ICTs), place-based methods (fieldwork and field trips), experiential learning, experimental learning, inquiry-based learning (IBL), and role-playing and educational games.

The use of *information and communication technologies (ICTs)* is mentioned often in the analysed studies. The findings support the study by Kadhim and Cochrane (2025), but differ from the study of Al-Nofli et al. (2026), which found that teachers place less emphasis on for example, geographical information systems (GIS) and remote sensing as teaching resources.

Previous studies have shown that ICT applications can support teaching and learning in many ways. They enhance teachers' ability to plan lessons, organize interactive learning, and foster students' digital literacy and critical thinking skills (Alimkulov, 2025). According to Goga and Roşu (2021), interactive lessons supports students' motivation for learning and understanding the information more quickly and easily. The use of technologies helps students to format and consolidate knowledge, enabling deeper exploration of difficult concepts and topics (Wu et al., 2013). For example, multimedia technologies improve students' spatial understanding by supporting students in the skill of visualizing (Hagevik, 2003; Vronskis & Vronska, 2015), and in territory-centred spatial thinking (Hagevik, 2003) or critical spatial thinking (Kim & Bednarz, 2013), and in evaluating the impacts of human activities on the environment (Vronskis & Vronska, 2015). Through digital simulations and GIS, students can be engaged in authentic sustainability issues (Di Wilmot et al., 2025). ICTs are used e.g. to explore issues related to urbanization, environmental pollution, and climate resilience (Wu, et al., 2013). This may enable the discovery of new behaviors and actions that promote sustainable development (Goga & Roşu, 2021).

Previous studies have shown that the novelty value of the strategies and methods used may influence the students' learning. At the beginning of the introduction of a new technology, students' increased motivation may due to the short duration of the intervention, and disappear when ICT applications are used continuously (Ajit et al., 2021; Garzón et al., 2019; Sırakaya & Alsancak Sırakaya, 2022). Chang et al. (2022), in their part, have stated that a large-scale and long-term intervention can improve students' cognitive and affective learning. ICTs teaching and learning also faces many obstacles, such as lack of additional teacher training, limited time, limited technical resources, and infrastructure (Mwaluko et al., 2023; Panjaitan et al., 2023). Therefore, teacher education in ICTs need to be increased; digital literacy needs to be more clearly integrated into geography curricula; and educational technology infrastructure needs to be improved.

In previous studies, it has been stated that it is important to offer personal experiences and real-life issues in authentic environments to students (Fu et al., 2025; Yli-Panula et al., 2020). *Place-based education* is an excellent way to promote the idea of spatial, embodied, and contextual learning about natural or human environments (Semken et al., 2017). Place-based learning such as field work (Asilevi et al, 2026; Ballang, & Ababio, 2021; Boyle et al, 2007) and field trips (Ballang & Ababio, 2021; Behrendt, & Franklin, 2014; Boyle

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

et al, 2007; Garcia de la Vega, 2022) are crucial in helping students contextualize sustainability issues and apply their knowledge to real-world scenarios. They appear to have positive effects on students' attitudes and behavior toward sustainable development (SD) (Liefländer et al., 2013). They may also strengthen students' relationships with and connections to nature (Braun & Dierkes, 2017; Lankenau, 2018; Liefländer et al., 2013), foster students' environmental awareness (Nazir & Pedretti, 2016; Rakuasa, & Latue, 2024), and enhance students' understanding of science and its relevance to their futures (Asilevi et al., 2026).

In the analysed studies, *fieldwork and field trips* are mentioned quite rarely. The finding supports the studies of Ballang and Ababio (2021) and Al-Nofli et al. (2026). The low number of the mentions may be due to the fact that, according to Lynch et al. (2025), although the program is designed to support and enhance teaching and learning, teachers and students may not believe that these methods directly contribute to students' subject content learning.

Several studies have found that integrating fieldwork is challenging. For example, students often view the place-based program as a social opportunity rather than an academic one. Teacher capacity and assessment instruments are often insufficient, particularly in low-resource contexts (Obi & Ojo, 2026). Limited resources, time constraints and curriculum requirements may hinder place-based education (Ballang & Ababio, 2021). The location of schools and the lack of natural environment around them makes it difficult or impossible to implement teaching outside the classroom (Nkuna & Mawela, 2025). Also a lack of support from management, parents and guardians may be an issue (Ballang & Ababio, 2021). Barth et al. (2016) and Wiggan et al. (2021) highlight global budget cuts in public education, which may lead to increased class sizes, increased teacher workload and burnout. Virtual field trips may be a solution concerning these obstacles. The study of Kadhim and Cochrane (2025) show that through them, students' enthusiasm for learning geography enhances and increases.

Experiential learning is mentioned rarely in the analysed studies, which is in line with the studies of Blom and Karrow (2024) and Yli-Panula et al. (2020). Experiential learning can encourage students to learn through real-life experiences by participating in activities that are designed to promote critical thinking and reflection (Fu et al., 2025). Interactions with nature and communities can enrich students' ecological knowledge, emotional attachment, and pro-environmental behavior (Zhao et al., 2024). According to Friman et al. (2024), experiential learning not only affects students' acquisition of knowledge but also produces a significant shift in their perceptions and attitudes toward sustainability as well as changes in behavior and action, indicating a broader societal impact. Studies have also shown that students' ecological awareness (Ardoin et al., 2018), scientific literacy (Scholten et al., 2025), and their digital literacy can be improved (Yeon et al., 2025). According to Savage et al. (2015), an experiential problem-based approach can develop the five key competencies identified by Wiek et al. (2011c): systems thinking, anticipatory, strategic, interpersonal, and normative thinking. In addition, experiential learning may support personal competence, which is important in supporting the development of key competencies in sustainability. However, if geography teachers rely on interactive experiential learning too much, rather than focusing on student-centered activities, there is a risk of a decline in students' critical problem-solving skills related to geography topics (Said et al., 2021).

Experimental learning is mentioned rarely in the analysed studies. The finding is in line with the study of Yli-Panula et al. (2020). Through experimental learning, students can conduct scientific experiments, aiming to gain new knowledge or to confirm existing knowledge by researching the influence of different variables (Kolb, 1984). They can engage in a learning process in which they reflect on their experiences to gain insights into problems and to apply new knowledge to real-life situations. Experimental learning enhances learning and builds self-confidence and critical thinking. According to Sumleth and Walpuski (2012), experimental learning can also be carried out online. Geomedia resources are useful in teaching geographic knowledge and skills, especially when the teacher guides the learning situations. For example, story mapping promotes the development of information retrieval skills, student-centered participation, and the production of multimedia content (Anunti, 2023; Polo-Martín, 2026). Jahnke (2012) states that online experimental learning is a special case of socio-technical learning, which is the process of research-based learning that combines individual and cooperative learning with opportunities to interact with other community members online or face-to-face. In the context of online experimental learning, the most important barriers to learning are technological challenges (Anunti, 2023).

Inquiry-based learning (IBL) is also mentioned quite rarely in this study, agreeing with the studies of Scholten et al. (2025) and Yli-Panula et al. (2020) but differing from the study of Al-Nofli et al. (2026). Low

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

use of the method poses a challenge to achieve a holistic geographical perspective and scientific literacy. IBL aims to develop the students' understanding of scientific ideas and the nature of science (NOS). It can facilitate the understanding and use of scientific practices in conjunction with learning subject matter ideas and principles (Tal et al., 2019). It offers several benefits for students, including improved geographical thinking on temporal and spatial issues (cf. Bendl et al., 2024). Opportunities to participate in authentic scientific inquiry, research, and experimental science may encourage students to active involvement, to see connections between the content being taught and "real-world" problems, to think critically, and to develop their conceptual comprehension and experimental skills (Brundiers, & Wiek, 2010; Kotsis, 2024). IBL with ICT applications (virtual learning, simulations, and animations) can offer new learning experiences by using a virtual laboratory. Augmented reality (AR) offers spatial learning opportunities by making abstract concepts more accessible and supporting extracurricular learning. It may display virtual content in a natural environment (Bengel, 2023) and make possible, for example, the examination of places and time dimensions (e.g. melting glaciers). Digital literacy—that is, the acquisition of information, as well as the understanding and investigation of geographical concepts and phenomena using digital tools—has emerged as a core skill in geography education. According to Passon and Schlesinger (2019), challenges in IBL, especially in higher education, are limited time frames within educational programs, the lack of resources, and the lack of subject-didactic education.

Role-playing and educational games are rarely mentioned in the analysed studies, which is in line with Yli-Panula et al. (2020). Previous studies have assessed the effectiveness of gamification techniques in relation to students' personality traits (e.g. openness, conscientiousness, extraversion) and motivation levels (e.g., high achievers, low achievers, underachievers) (Li et al., 2023). The effects of gamification on students' behavior and views on the curriculum have also been studied (Ouariachi et al., 2020). Research findings suggest that the effects of gamification on learning vary depending on the context and type of game (Dikmen, 2021).

According to Maddrell (1994), role-playing as a teaching method is a type of educational simulation which consists of activities that contain common elements of characters, problem situations, and student interaction. The effectiveness of role-playing depends on choosing the most appropriate type of role-playing game for the learning needs of a particular group of students. A good role-playing game can be an emancipatory learning experience for students and instructors in many ways. However, applying the skills learned in role-play to practice poses several challenges. First, schooling and learning are currently mostly assessed through student performance and tests that examine measurable skills in mathematics, science or language, while skills such as teamwork and responsibility are not formally examined or assessed (Care et al., 2018). Furthermore, although teachers strive to integrate social skills learning into subjects, they often lack the appropriate tools and methods to do so (Parker & Thomsen, 2019). Part of the solution to these challenges may be found in virtual pedagogical tools such as TAT Me and MyCity, which aim to combine both content learning and students' personal development.

Different educational games (e.g. location-based games, story telling, simulation, and AR games) offer creative ways to engage students with spatial and environmental concepts (Robinson et al., 2021). In location-based games, players have to cooperate with one another. Thus, the game supports all three major potential benefits studied: exercise, social interaction, and cartographic skill development (Laato et al., 2020). Location-based games motivate learners to explore their environment while completing geographical tasks, leveraging e.g. Global Positioning System (GPS) technology to connect students with their physical surroundings, promoting place-based learning (cf. Deringer & Hanley, 2021). Story mapping enhances public understanding of complex urban processes, supports participatory planning, and provides a bridge between technical analyses and community engagement (Polo-Martín, 2026). Story mapping is a powerful communication tool and also a valuable geotechnological solution for sustainable landscape planning, complementing traditional GIS approaches and promoting interdisciplinary perspectives in urban studies. Story telling combine multimedia and web tools to develop digital narratives that have an added advantage for teaching and learning (Giannakou & Klonari, 2019). They can be modified with creative geographical content that fosters critical thinking. Simulations imitate the real-world environment and processes, delivering firsthand learning experiences that make geography applicable and engaging. Students develop critical thinking, decision-making skills, and a deeper understanding of geographical concepts by immersing themselves in realistic scenarios. AR games stimulate interest in urban geography and other disciplines (Kim

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

& Shin, 2015). They involve goal-oriented activities that require creativity, imagination, and decision-making skills, and test the students' knowledge of geographical concepts. They can include individual work or teamwork, where each student has a specific role to solve a problem. Achieving a goal provides a positive experience.

The use of games in classroom instruction poses several challenges for teachers, including successfully integrating the game into the curriculum and ensuring that educational content is emphasized or extracted during the lesson without limiting the fun of playing the game (Brysch et al., 2012). Problems can be reduced with gamification education (Greaves & Vlachopoulos, 2022), clear instructions for using resources and tools (Sabornido et al., 2022), and collaborative approaches between teachers, such as pedagogical sharing and experimentation (Greaves & Vlachopoulos, 2022).

Finally, traditional teaching methods, while effective in conveying content, often fail to fully engage students, foster curiosity, or encourage them to think critically and solve real-world problems. Effective geography education for sustainability involves interdisciplinary approaches and the use of digital tools to help students understand and navigate complex sustainability patterns. New methods often have a strong student-centered approach, which is in line with the constructivist paradigm of Novak (2010). They include varying degrees of student-centered practices, where students take more responsibility for acquiring knowledge, competencies, and skills than in traditional teaching methods. In geography education, innovation is crucial to making learning more interactive, meaningful, and engaging. Innovative teaching methods, such as project-based learning, inquiry-based learning, and technology integration, provide opportunities for students to actively explore geographical issues, develop problem-solving skills, and connect what they are learning to their own lives. Educators can help students to develop an integrative approach to geographical phenomena, and discover new perspectives and practices promoting sustainable development (SD), by using diverse teaching and learning methods that activate students and are contextualized to real-life situations. By using modern approaches, they can make geography lessons more dynamic and stimulating, encouraging students to see the subject as a living evolving discipline rather than a collection of static facts.

Based on the analysed studies, the most popular teaching and learning methods are interactive and student-centered methods. Educators need to apply different teaching methods together to acquire deeper geographical knowledge (Simonyi & Homoki, 2020) and achieve the SDGs, as well as support students in connecting the impacts of their own and society's actions to all four dimensions of sustainable development (environmental, social, cultural, and economic) (Yli-Panula et al., 2020).

6.5. Competencies and Skills Promoting Sustainable Development (SD) in Geography Education

In the analysed studies, there are in total 956 mentions of competencies and skills promoting sustainable development (SD). The most frequently mentioned competencies and skills are critical thinking, and problem-solving and dealing with complexity. Also, communication, collaborative decision making, reflection, creative thinking, systems thinking, and futures thinking are mentioned frequently. Empathy, temporal thinking skills, cartographic skills, and transdisciplinary skills are the least mentioned. The following sections discuss the competencies and skills that are commonly mentioned in geography education, starting with those most frequently mentioned.

In this study, the most frequently mentioned competence is critical thinking, matching the study by Caeiro and Simão (2025). The role of critical thinking in creating a better future has been discussed since the early days of SD (cf. Elkington, 1998/2007; Kumar & Kumar Choudhary, 2025). Critical thinking includes, among other things, involving students in decision-making, and developing appropriate behavior in the context of controversial issues (Lindström, 2024). It allows for in-depth analysis of environmental issues with an objective and evidence-based approach, and makes it possible to make wise decisions in the face of ecological challenges (van de Wetering et al., 2022). Critical thinking is key to understanding different scientific questions and stakeholder perspectives. Geography teachers play a key role in helping students understand the broader context of environmental challenges and in emphasizing the need for sustainable practices.

Three interdisciplinary learning and innovative skills can help students with geography for confronting the challenges of tomorrow: problem-solving and creative thinking; creativity and innovation; and communication and collaboration skills (Nagel, 2008). Interdisciplinary learning aims to transfer learning responsibility to students, and to actively involve students in learning together with the teacher and other students (Cheng et al., 2019).

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

The findings of this study match those of Ölçer-Çevik and Kozaner (2025), stating that problem-solving is a popular skill. Problem-solving skills are seen as important for achieving the sustainable development transition (ElSayary, 2024; Hazen & Alberts, 2021; Kesler et al., 2024; Mondal, 2024), because the rapid development of science generates technologies that increasingly affect people's lives and raise increasingly complex moral and ethical questions (Chowdhury, 2016).

Practicing creative thinking may foster students' creative problem-solving to develop innovations in their own living environments (Renshaw, 2011; Scoffham, 2013). According to Zhan et al. (2024), the influence of creative thinking is stronger in primary school students than in middle school, high school, university and work-based learning students. The reason may be that primary school students are more likely to be affected by problem solving pedagogy because they have not yet developed stereotypes, or their socialization and herd mentality have not yet developed.

The analysed studies contain many mentions that students need to reflect on their own actions and their consequences from geographical perspectives. The findings support previous studies, which show that reflection has a meaningful role in acquiring the knowledge and skills needed to solve the complex challenges of sustainable development (SD) (Colomer et al., 2020; Whalen & Paez, 2021). Citizens should be able to critically evaluate scientific information and base their decisions and action on scientific information both in their private lives as well as in their professional and social activities. Systems thinking and futures-thinking, as well as temporal and cartographic skills, are important for increasing the knowledge and understanding of major natural systems of the Earth (landforms, soils, water bodies, climate, vegetation), in order to understand the interaction within and between ecosystems, and major socio-economic systems of the Earth (agriculture, settlement, transport, industry, trade, energy, population, and others) (Yli-Panula et al., 2020). The acquired knowledge, values and attitudes are important for perceiving sustainability and finding solutions to problems (Zhou et al., 2025). They also affect cooperation and a sense of responsibility, as well as the ability to solve complex problems. In an increasingly complex world, systemic thinking and future thinking are basic skills for every citizen. Temporal and cartographic skills are basic skills of geography, and educators need to emphasize them more. Sustainability cannot be understood without these skills (cf. Gilissen et al., 2020).

Empathy is one of the least mentioned competencies in the analysed studies. Educators need to take into account the design and implementation of educational processes related to the conditions under which both emotional and rational relationships can be created between the student and the moral object (Zeidler et al., 2019). Constructs related to empathy are related to moral reasoning and are linked to personal values (Silfver et al., 2008). Since values act as guiding principles in people's lives, individual differences in value priorities may be related to the types of schemas they use to interpret the social world. Many SD themes, such as human rights, animal rights and natural values, are value-based, and they are also included in geography education. Values are mentioned separately in Vision I, but they are also included in Vision II (Roberts, 2007; Sjöström & Eilks, 2018) and Vision III (Sjöström & Eilks, 2018). Vision II emphasizes contextual learning and the application of knowledge and skills in the individual's own life situations and as a member of their community. Vision III emphasizes critical thinking skills, reflection, and value thinking to promote sustainable development (SD) (Uitto et al., 2024a). Value thinking is important, especially for promoting commitment to equality and justice (Persano Adorno et al., 2025). Sustainability-related, value-oriented learning (Haubrich, 2007) needs to be better accounted for in geography education. It helps to understand one's own relationship with other people as well as the relationship between humans and nature. It may also support students' continuous self-development, responsible action, and active participation in the development and implementation of sustainable practices, and in preparing for the future. Students may be reluctant to adopt sustainable behavior change, especially if their parents are hesitant to encourage it (Ai et al., 2025). Shephard (2022) has suggested that sustainability issues could be communicated more effectively if the term "competent" were replaced by the terms "able" and "willing." This change in terminology could perhaps make it easier to explain the goals of sustainability education to students and their parents.

The term "competence" is used when aiming to promote sustainability based on international competence frameworks for sustainability education (SE) (UNESCO, 2017a,b; Bianchi et al., 2022). By implementing cognitive, affective, and functional competencies, educators can awaken a sense of agency and responsibility in their students and empower them to promote meaningful change. Södervik et al. (2026) argue, that newly introduced sustainability competencies generally lack depth, predominantly focusing on lower cognitive levels such as remembering and understanding, rather than on higher cognitive levels such as analysis and synthesis.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Shephard (2022), on his part, questions the role of competence concerning SE. He argues that the definitions of competence that are widely used in SE confuse cognitive and affective goals related to the ability to do something and the willingness to do the same thing in a way that is not useful in teaching and learning environments. According to Shephard, teaching students the ability to act in accordance with sustainable development (SD) and teaching the same students the willingness to behave in a sustainable way are different teaching tasks, which require different teaching and learning methods, different assessments, and perhaps even different teachers.

The findings suggest that critical thinking, problem-solving and dealing with complexity are most popular competencies and skills for promoting SD in geography education. Contextual problem-based outdoor education can foster these skills and also creativity, communication, and collaboration skills (Suwarno et al., 2026). Educators need to further emphasize action competence, transdisciplinarity, and empathy in geography teaching for promoting holistic approaches, enabling a more effective response to complex environmental and societal challenges as well as a commitment to equality and justice (Persano Adorno et al., 2025).

6.6. Assessment Methods Promoting Sustainable Development (SD) in Geography Education

In the analysed studies, assessment methods of sustainable development (SD) in geography education are mentioned only 104 times. This agrees with the study of Annelin and Boström (2023), which states that students' sustainability skills are inadequately assessed.

Moreover, there is an overemphasis on formative and summative methods relative to diagnostic methods, which is in line with the study of Lambert (2011). Educators need better to consider both objective-based assessment of the learning process in general and the role of diagnostic assessment in the learning process. This would support both the design and implementation of teaching and learning processes and the development of students' actual knowledge (Lyon, 2013).

In terms of diagnostic assessment, tests and preparatory discussions are the only mentioned assessment types. In contrast, the studies analysed mention a wide range of formative and summative assessment methods.

In terms of formative assessment, the findings support the studies of Lane and Bourke (2017) and Harwood and Rawlings (2001), which show that alongside tests and exams, the teachers continuously monitor students' learning progress and give feedback based on it. In the analysed studies, it is mentioned that learning is measured using both formal and informal forms of assessment, including e.g. group projects, student portfolios and class participation. This finding agrees with Prince and Felder (2006). It is also mentioned that sometimes students' performance is assessed not only by the teacher, but also by their peers and by self-assessment using Web-GIS and the Moodle platform. A combination of lessons and various learning environments can make possible to improve learning outcomes through in-depth reflection (Baßeng & Budke, 2024). For example, formative assessment, combined with students' inquiry learning in their own living environment, can achieve effective learning outcomes (Weeden, 2013). Timely and effective feedback allows educators to adapt their teaching to students' learning needs, which can increase student motivation and improve learning outcomes (Lane & Bourke, 2017; Merchant et al., 2014). However, there are very few studies on the effectiveness of formative assessment in geography education in the context of teacher education and school education (Morris et al., 2021); hence, this is a topic that requires more research.

In terms of summative assessment, tests and exams are the most often mentioned types of assessment in the analysed studies. Alongside them, evaluation of students' outputs (e.g. reflection diaries, portfolios, reports), and evaluative, retrospective discussions between the teacher and students regarding students' knowledge and skills are mentioned. Studies by Edelson et al. (2013) and Bijsterbosch et al. (2017) have revealed widespread problems with the quality of tasks. According to Bijsterbosch et al. (2017), most test items are based on rote learning, focusing primarily on memorizing factual and conceptual information. Educators need to include more assessment tasks in their teaching that allow students to demonstrate evidence-based reasoning skills and knowledge of key models and theories.

All three assessment types are needed in order for the teacher to obtain a complete picture of the students' skill and knowledge levels. When assessment is based for example, on the *Structure of the observed learning outcome* (SOLO) taxonomy (Biggs & Collis, 1982), students' cognitive skills can be examined at the higher levels of thinking skills, such as analysis, synthesis, evaluation, and creation (Munowenyu, 2007).

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Sustainable development (SD) and sustainability education (SE) are broad and multidimensional topics, and assessing their learning is challenging. In addition, for assessing knowledge and skills according to the criteria defined in the curricula, the key assessment objectives include thinking, argumentation, and research skills, including the ability to critically evaluate information (Uitto et al., 2024b). By employing active participation and interactivity, collaborative learning environments, and comprehensive evaluation tools, teacher educators and school teachers can effectively measure and enhance the impact of SE in geography education, ensuring that students' knowledge, skills, attitudes, and action to address environmental challenges can be developed. In order for assessment to support the work of teachers and students and serve as a tool for improving teaching and learning, assessment must be regular, and assessment strategies must be developed based on learning objectives in relation to student needs. Assessment must provide students with information about their performance in relation to curriculum objectives. Educators need to use various assessment methods, for supporting not only the development of teaching and learning processes but also the development of curricula (Lyon, 2013). The shift in assessment culture from assessment of learning to assessment for learning (Bryan & Clegg, 2006) needs to be emphasized further.

6.7. Transformative teaching and learning in geography education for sustainability

Meadows (2020) has stated that geography can be considered a science of sustainable development (SD), as the nature of geography allows for the collection and integration of vast amounts of data to understand global complexity and interdependence (Massey, 2014). Geography is characterized by a holistic approach, a contextual nature, and a synthesis in relation to space, places, regions, and the planet as a whole. Modern geography is interdisciplinary, transdisciplinary, and transformative combining natural and social sciences to address global environmental challenges (Grindsted, 2015; Gunderson, 2024; Tani et al., 2023).

The interdisciplinary approach promotes the development of critical and creative thinking and the adoption of values and behaviors that support sustainable development (SD) (Blom & Karrow, 2024; Espinosa-Gutirrez et al., 2025). Successful geography education includes, in addition to subject knowledge, methodological frameworks that develop ecological thinking at both vertical and horizontal levels of integration (Gunderson, 2019). Digital tools significantly enhance this learning process. For example, GIS has been shown to promote interdisciplinary connections between history, natural sciences and geography, helping future teachers to develop spatial analysis and systemic thinking (Ribeiro et al., 2016).

The transdisciplinary approach is a scientific approach that transcends disciplinary boundaries (Holbrook et al., 2020), such as the natural sciences including geography, the social sciences, and the arts. It incorporates political perspectives and integrates epistemological pluralism of knowledge. Its main goal is to produce new knowledge that contributes to both scientific and societal progress. In transdisciplinarity, actors from different fields define and solve problems together. Transdisciplinary teaching involves a paradigm shift seeking a balance between knowledge and transdisciplinary skills, but argues for an emphasis on skills, encompassing social relatedness, research skills, and the enhancement of thinking, communication, and self-management skills (Holbrook et al., 2020). It enables students to actively shape their own lives by participating in the development of sustainable and socially acceptable solutions in their communities. By actively addressing socially relevant issues in their own lives and engaging in dialogue with partners outside of school from science, politics, and other sectors of their communities, students develop the skills required for responsible citizenship (Kubisch et al., 2021).

Transformative education includes agency, participation, and a solution-oriented approach (Jeronen et al., 2022). It supports the understanding and application of scientific knowledge and methods, as well as commitment to actions that strengthen sustainable development (SD) (Sjöström & Eilks, 2018). As Roberts (2023, p. 5) writes, "If geographical education is to be powerful, then it needs to have an enduring, transformative impact on students' geographical imaginations, the ways in which they see, make sense of and understand the world." Transformative teaching and learning need to be focused on critical reflection on knowledge to move students' learning from adding knowledge and skills to reflecting on and working on one's own worldview and preconceptions (Aboytes & Barth, 2020; Odell et al., 2019).

Transformative teaching should call for a transformative action-oriented education that supports interdisciplinarity, transdisciplinarity, participation, collaboration, problem orientation, and self-directed learning (UNESCO, 2017a). According to Lotz-Sisitka (2024, p. 559), transformative learning is:

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

- Transformative – encouraging cognitive and emotional perspective shifts necessary for care and protection of biodiversity,
- Transgressive (emancipatory) – challenging normalized practices, cultures, and oppressive systems with critique, reflexivity, empathy, and renewing sensitivities,
- Transdisciplinary – crossing boundaries to co-create new concepts and forms of human activity in iterative and collaborative ways, connecting interdisciplinary synthesis to reality through transformative praxis,
- Together – working with others to strengthen collective agency and ethical-political commitments to the common good, and system-wide change.
- According to (Di Wilmot et al., 2025, p. 258), transformative learning needs to:
- Promote participatory, active, social, and collective learning,
- Engage with risk and uncertainty, and with "wicked" or difficult to resolve problems concerning sustainability,
- Envision new sustainable futures and engage future-oriented actions and practices,
- Affirm the situated nature of learning, and build on local contexts and experiences, indigenous and local knowledge, and communities of practice,
- Support new knowledge, skills, and ethics through activities including mapping, games and simulations, project work, field work, data analysis, and GIS,
- Develop reflexivity and critical perspectives in societies, including questioning the way things are and hegemonic practices.

Transformative learning (renewing learning) may thus help students to become aware of previously unquestioned assumptions, or frames of reference, and thus transform them to become more open and reflective (Balsiger et al., 2017).

Transformative geography education for promoting sustainable development (SD) can be summarized as presented in Figure 12.

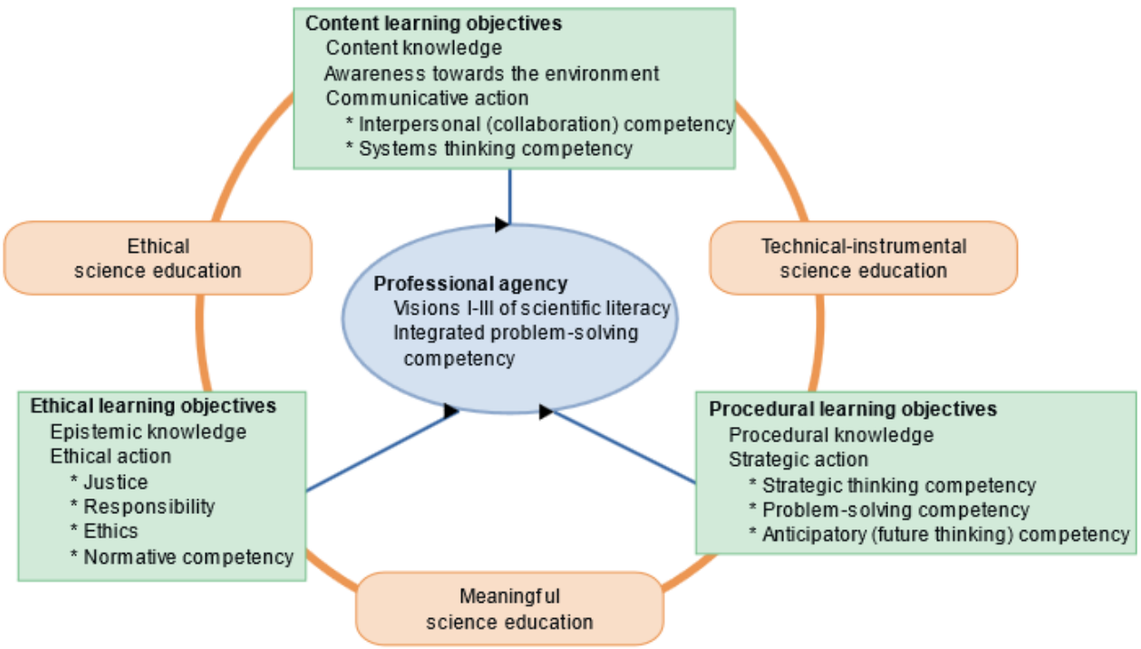


Figure 12. Transformative geography education for promoting sustainable development (SD). Three kinds of learning objectives (green) and three areas of science education (orange) are essential for the professional agency of the teacher. (cf. E. Jeronen & J. Jeronen, 2026; Jeronen et al., 2024).

According to Jeronen et al. (2024), knowledge of environmental and scientific issues is the starting point for transformative science education, including geography education, for promoting sustainable development

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

(SD). Considering Visions I–III (Roberts, 2007; Sjöström & Eilks, 2018) and integrated problem-solving competency (UNESCO, 2017a), three kinds of learning objectives and three areas of science education are essential for the professional agency of the teacher.

Each area of science education connects two kinds of learning objectives. *Technical-instrumental science education* is a pedagogical approach that focuses on mastering the procedural "how-to" of science – such as laboratory techniques, measurement, and data analysis (Kotsis, 2024). It includes content knowledge and procedural knowledge, bridging the gap between theoretical knowledge and real-world situations (Brundiers & Wiek, 2017). In addition, in practice, teaching also needs to link the learning objectives of the content and procedural kinds.

Content learning objectives include research-based scientific knowledge, as well as awareness towards the environment, and communicative action, which includes e.g. interpersonal and systems thinking competencies. The development of these competencies can improve the ability to convey messages, build positive relationships, and communicate in ways that respond to challenges, find solutions, and encourage collaboration.

Procedural learning objectives, in transformative education, refer to the combined, action-oriented "know-how" required to integrate methods, tools, and practices from multiple disciplines to solve complex problems (cf. Muukkonen & Kajamaa, 2024).

Meaningful science education connects procedural learning objectives with ethical learning objectives, particularly epistemic knowledge, fostering curiosity and scientific literacy rather than rote memorization (Stevens et al., 2013). Epistemic knowledge requires the ability to distinguish between the essence of truth and the process of justification, as well as the management and research of factual information (Knight et al., 2014).

Ethical learning objectives cover intellectual virtues, justice, ethics, social scientific reasoning, and democratic participation. Ethical principles and their application in research and professional practice should be at the core of science education (Resnik, 2018). The ethical/epistemic nexus refers to the relationship between practices (ethics) and knowledge (epistemology) (Semetsky, 2003a,b). Scientific knowledge and moral reasoning are intertwined domains – the values inherent in good scientific thinking (rigor, honesty, humility, fairness) are also moral virtues (Hajek et al., 2024), and therefore science education has an inherent ethical dimension. Epistemic norms (rigor, honesty, humility) are also moral norms; science exists in a social context shaped by power and values; and scientifically literate citizens must be able to reason across the fact/value boundary (Potter, 2022). Integrating ethical principles into the scientific curriculum should be a focal point, particularly regarding their application in research and professional practice (Resnik, 2018).

This forms the basis for *ethical science education*, which integrates research integrity, social responsibility, and ethical reasoning into science education, including geography education, to ensure responsible conduct, covering topics like data integrity, environmental impact, and human rights (ALLEA, 2013).

Comprehensive learning objectives that enhance instructional strategies across all three types – content, procedural and ethical – allow the students to evaluate the content knowledge from an holistic perspective, and develop their conceptions based on reflection.

As a part of transformative science education, geography education, including sustainability education (SE), is important in increasing students' awareness and understanding of sustainable development (SD). Teacher engagement plays a crucial role in students' behavioural change due to the teacher's role. The teacher must know how to integrate the subject's epistemological natural and human science content with didactic and pedagogical approaches for example, in preparing learning materials and teaching image interpretation skills (Trahorsch & Bláha, 2022). In order to achieve SD in practical geography teaching, both development of teaching materials, professional, consistent and contextually relevant teacher education and institutional support (Verma & Dhaigude, 2026), and flexible curricula (Oraby, 2026) are needed.

All teaching situations are context- and subject-specific, and it is not possible to compile a general list of the most or least effective teaching principles and ideas. Even if an individual has a strong concern for the environment, they face obstacles that make it difficult to act in an environmentally responsible manner. Thinking and envisioning the future involves making decisions based on uncertain information. Limited information processing and thinking skills can hinder learning and the belief in one's own potential for influence. Lack of motivation and support from parents or school, frustration and other unpleasant feelings,

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

limited opportunities for influence, lack of concrete ways of acting, social norms, and the concidering the media being a more significant source of environmental information than the information learned at school can hinder sustainability learning (Huoponen, 2025). SE itself can also become an obstacle. As due to its ethical and normative nature, it may lead to directive actions instead of promoting critical thinking and personal moral development (cf. Shrivastava et al., 2020). Encouraging pluralistic and interconnected perspectives may support students develop their own moral compass and understand the complexities of sustainability. Addressing ethical challenges and empowering teachers are essential for transformative geography education for promoting sustainability. Making these changes in teaching and learning requires a significant shift in educational perspectives concerning students' cognitive engagement (building knowledge, understanding and critical thinking), socio-emotional development (developing shared values, empathy, solidarity and respect for all living beings) and behavior (taking action).

6.8. Limitations

The limitations of the study are as follows. C*oncerning* the scope, the analysis is based only on published research. To obtain a fully up-to-date view, other research methods could be used, such as interviews of teachers and students, as well as monitoring of teaching and learning processes.

The findings are only based on the studies listed in the bibliographical database Scopus. Other databases could also be used to improve and compare the results. Also, due to the fact that Scopus includes mostly articles that are written in English and the search was conducted only in English, there is language bias. Also, the uneven distribution of research volumes between the USA and other countries may bias the interpretation of the results.

During the bibliometric analysis step, the automatic semantic clustering method left a few data points as outliers. Other clustering methods may result in different groupings of the studies reviewed.

The bibliometric analysis step was based on titles and abstracts only. This could be extended to include the studies' keywords. However, because all studies do not necessarily provide keywords in their metadata and datasets can be large, an automatic method to extract keywords from free-form text (abstracts or full text) is needed. Possible approaches include classical frequency-analysis-based methods and AI-based methods, such as performing free-form text analysis of each study with a large language model (LLM).

As for keyword generation for the detected clusters, the keywords were automatically suggested by an LLM. The drawback of this method is speed, as LLM inference is relatively slow, costing several seconds of wall time per cluster. This limits the automatic analysis throughput especially if there are many clusters.

6.9. Future Research

Future research could advance the theory of innovative geography curricula and classroom practice based on sustainable development goals (SDGs) by seeking a more holistic understanding of the underlying processes and feedback loops between natural and social systems, and by revealing the relationships between the structures, functional properties, and interactions of human and environmental systems at different levels (Fu & Li, 2016; Wang et al., 2018). Applying transdisciplinary theories makes it possible to develop more comprehensive and systematic frameworks for curricula, improving the theoretical depth and breadth of geography teaching.

Future research needs to focus on different pedagogical and didactic approaches in geography education for fostering sustainable development (SD) in teacher education and at schools. The findings show that the use of teacher-centered methods is lower than the use of interactive and student-centered methods. This suggests that the importance of teacher-centered methods has decreased. New methods based on the constructivist paradigm may better support sustainability education (SE), as they place more responsibility on students for acquiring knowledge and skills than previous methods. However, further research is needed to confirm this.

There is a need for more research on the role of the teacher's knowledge and professional empowerment to enable students to become informed and critical citizens, and to explore how, through SE in geography education, students' sustainability thinking and competencies can be effectively developed and assessed in classroom settings. The integration of digital technologies, such as virtual learning environments and AI applications, into geography education fostering SE needs to be explored. The findings also emphasize a need for comparative studies of pedagogical and didactic approaches and their evaluation in relation to the expected learning outcomes. Longitudinal studies are crucial for assessing the long-term impact of SE in geography

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

education on students' attitudes and behaviors toward sustainability. Future research needs to explore strategies and more rigorous approaches to embedding sustainability deeply and comprehensively across curricula in teacher education and in school teaching, ensuring that students are well-equipped to tackle sustainability challenges.

References

Abalahin, M. R., & Chang, C.-H. (2019). Sustainability in primary geography. In C.-H. Chang, G. Kidman, & A. Wi [incomplete surname] (Eds.), *Issues in teaching and learning of education for sustainability: Theory into practice* (pp. 17–35). Routledge. https://doi.org/10.4324/9780429450433-2

Abdimanapov, B., Kumarbekuly, S., & Gaisin, I. (2024). Technology for achieving learning objectives through a system-activity approach and the development of critical thinking in geography studies. *Journal of Ecohumanism, 3*(8), 3032–3046. https://doi.org/10.62754/joe.v3i8.5797

Affolderbach, J. (2022). Translating green economy concepts into practice: Idea pitches as learning tools for sustainability education. *Journal of Geography in Higher Education, 46*(1), 43–60. https://doi.org/10.1080/03098265.2020.1849063

Aikens, K., McKenzie, M., & Vaughter, P. (2016). Environmental and sustainability education policy research: A systematic review of methodological and thematic trends. *Environmental Education Research, 22*(3), 333–359. https://doi.org/10.1080/13504622.2015.1135418

Albăstroiu, I., Felea, M., & Vasiliu, C. (2014). Geographic information system – Modern teaching method in business administration. *Amfiteatru Economic, 16*(37), 770–783. https://hdl.handle.net/10419/168856

Alkaabi, K., Mehmood, K., Bhattacharyya, P., & Aldhaheri, H. (2023). Sustainable development goals from theory to practice using spatial data infrastructure: A case study of UAEU undergraduate students. *Sustainability, 15*(16), Article 12394. https://doi.org/10.3390/su151612394

Bagoly-Simó, P. (2018). Education for sustainable development and geographical education [Bildung für nachhaltige Entwicklung und geographische Bildung: Nationale und internationale Perspektiven]. *Geographische Rundschau, 70*(10), 10–15. https://doi.org/10.23741/RRGE120131

Bagoly-Simó, P. (2023). Geography's unkept promises of education for sustainable development (ESD): On geography's wasted potential to educate for a more sustainable future. *International Research in Geographical and Environmental Education, 32*(1), 53–68. https://doi.org/10.1080/10382046.2023.2158631

Boehm, R. G., Zadrozny, J., & Blanchard, D. (2024). The foundation and evolution of powerful geography in K–12 education: An introduction. In M. Solem, R. G. Boehm, & J. Zadrozny (Eds.), *Powerful geography* (pp. 1–30). Springer. https://doi.org/10.1007/978-3-031-54845-1_1

Boehn, D., & Hamann, B. (2011). Approaches to sustainability: Examples from geography textbook analysis in Germany. *European Journal of Geography, 2*(1), 1–10. https://eurogeojournal.eu/articles/2_1_APPROACHES%20TO%20SUSTAINABILITY_BOEHN_HAMANN.pdf

Brody, S. D., & Ryu, H. (2006). Measuring the educational impacts of a graduate course on sustainable development. *Environmental Education Research, 12*(2), 179–199. https://doi.org/10.1080/13504620600688955

Brown, S., Küçük, Z. D., Rickard, A., Lonergan, J., Abernethy, R., McNerney, L., McNerney, E., Foley, R., Behan, A., Byrne, A., Essel, B., Ffrench, J., Faull, J., & Cahalane, C. (2024). The role of teacher agency in using GIS to teach sustainability: An evaluation of a lower secondary school story mapping GIS initiative in Ireland. *International Research in Geographical and Environmental Education, 33*(1), 56–71. https://doi.org/10.1080/10382046.2023.2214044

Burian, S. (2010). Teaching sustainability and sustainable engineering practice in the civil engineering curriculum. *ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--16539

Cabral, S., & Kaivola, T. (2005). Imagine the world. *Teaching Geography, 30*(2), 86–90. https://www.jstor.org/stable/44633441

Cassar, R., & Mifsud, M. (2023). Moving towards sustainability through geographical education in Malta. In W. Leal Filho, A. Lange Salvia, E. Pallant, B. Choate, & K. Pearce (Eds.), *Educating the sustainability leaders of the future* (pp. 281–296). Springer. https://doi.org/10.1007/978-3-031-22856-8_16

Cassar, R., & Mifsud, M. (2024). The integration of ESD in geography syllabi at higher education level in Malta. In W. Leal Filho, T. Dibbern, S. R. de Maya, Md. C. Alarcón-del-Amo, & L. M. Rives (Eds.), *The contribution of universities towards education for sustainable development* (pp. 105–123). Springer. https://doi.org/10.1007/978-3-031-49853-4_8

Castellanos, J. M. C., de Castro, A. R., & Girona, M. R. M. (2021). Trends and perspectives in education for sustainable development in the teaching of geography in Spain. *Sustainability, 13*(23), Article 13118. https://doi.org/10.3390/su132313118

Chernisheva M., Urazmetov I., Ulengov R., Yarullina L., & Sharipov S. (2024). Geoinformation Technologies as a Means of Developing. International Multidisciplinary Scientific GeoConference: Surveying Geology and Mining Ecology Management (SGEM), 24(5.1), 759–764. DOI: 10.5593/sgem2024/5.1/s22.93

Cheung, Y., Pang, M., Lin, H., & Lee, C. K. J. (2011). Enable spatial thinking using GIS and satellite remote sensing: A teacher-friendly approach. *Procedia – Social and Behavioral Sciences, 21*, 130–138. https://doi.org/10.1016/j.sbspro.2011.07.014

Chou, R.-J. (2018). Going out into the field: An experience of the landscape architecture studio incorporating service-learning and participatory design in Taiwan. *Landscape Research, 43*(6), 784–797. https://doi.org/10.1080/01426397.2017.1386290

Corney, G. (2006). Education for sustainable development: An empirical study of the tensions and challenges faced by geography student teachers. *International Research in Geographical and Environmental Education, 15*(3), 224–240. https://doi.org/10.2167/irgee194.0

Danaher, M., Wu, J., & Hewson, M. (2021). Sustainability: A regional Australian experience of educating secondary geography teachers. *Education Sciences, 11*(3), Article 126. https://doi.org/10.3390/educsci11030126

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*

Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Daniele, M. (2022). Using geobrowsers and VR platforms to empower students' awareness of sustainability issues. *J-Reading, 1*, 75–82. https://doi.org/10.4458/5116-06

Davidson, J., Prahalad, V., & Harwood, A. (2021). Design precepts for online experiential learning programs to address wicked sustainability problems. *Journal of Geography in Higher Education, 45*(3), 319–341. https://doi.org/10.1080/03098265.2020.1849061

Davis-Morrison, V. (2018). Geography and education for sustainable development: A Jamaican case study of the CSEC revised geography. *Caribbean Geography, 23*, 58–76. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85068341294&partnerID=40&md5=17bc38cbe6188f3e7772aa34d87b8b5c

de Lázaro-Torres, M.-L., Puertas-Aguilar, M.-Á., & Álvarez-Otero, J. (2023). Education for sustainability using cloud-based geographic information systems at university. In K. C. Koutsopoulos, R. De Miguel González, & D. Schmeinck (Eds.), *Key challenges in geography* (pp. 137–152). Springer. https://doi.org/10.1007/978-3-031-40747-5_8

de la Vega, A. G. (2022). A proposal for geography competence assessment in geography fieldtrips for sustainable education. *Sustainability, 14*(3), Article 1429. https://doi.org/10.3390/su14031429

Diolaiuti, G., Maugeri, M., Senese, A., Panizza, M., Ambrosini, R., Ficetola, G. F., Parolini, M., Fugazza, D., Traversa, G., Scaccia, D., Franceschini, M., Citron, L., & Pelfini, M. (2021). Immersive and virtual tools to see and understand climate change impacts on glaciers: A new challenge for scientific dissemination and inclusive education. *Geografia Fisica e Dinamica Quaternaria, 44*(1), 67–77. https://doi.org/10.4461/GFDQ.2021.44.6

Domaćinović, F., & Vuk, R. (2022). Research on the frequency and effectiveness of teaching methods in geography classes: An example of self-observation of teaching practices. *Journal of the Geographical Institute Jovan Cvijić SASA, 72*(3), 307–322. https://doi.org/10.2298/IJGI2203307D

Duggan, M. S., Smith, T. F., & Thomsen, D. C. (2015). Organizational approaches to the facilitation of education for sustainability: An interpretive case study. *Sustainability, 7*(6), 7011–7030. https://doi.org/10.3390/su7067011

Esteves, M. H., & Rocha, J. (2015). Geographical information systems in Portuguese geography education. *European Journal of Geography, 6*(3), 6–15. https://repositorio.ulisboa.pt/bitstream/10451/35671/1/Esteves%20Helena_2015.pdf

Fattizzi, S., & Grigione, M. M. (2023). Sustainability curriculum in secondary education: Two case studies assess progress. In R. Brinkmann (Ed.), *The Palgrave handbook of global sustainability* (pp. 1213–1224). Palgrave Macmillan. https://doi.org/10.1007/978-3-031-01949-4_81

Favier, T. T., & Van Der Schee, J. A. (2012). Exploring the characteristics of an optimal design for inquiry-based geography education with geographic information systems. *Computers & Education, 58*(1), 666–677. https://doi.org/10.1016/j.compedu.2011.09.007

France, D., & Haigh, M. (2018). Fieldwork@40: Fieldwork in geography higher education. *Journal of Geography in Higher Education, 42*(4), 498–514. https://doi.org/10.1080/03098265.2018.1515187

Fru, R. N., & Ndaba, T. L. (2023). Educators' perceptions and approaches to environmental education and pro-environmental behaviour in South African secondary schools. *International Journal of Learning, Teaching and Educational Research, 22*(5), 359–373. https://doi.org/10.26803/ijlter.22.5

Fuertes-Camacho, M. T., Graell-Martín, M., Fuentes-Loss, M., & Balaguer-Fàbregas, M. C. (2019). Integrating sustainability into higher education curricula through the project method: A global learning strategy. *Sustainability, 11*(3), Article 767. https://doi.org/10.3390/su11030767

Gilbertz, S., Wood, B., Craig, C., Karabas, I., Petrun Sayers, E., & McCormick, B. (2022). Integrating and evaluating interdisciplinary sustainability and STEM curriculum in geographical education: A case of three teaching modalities. *Journal of Geography, 121*(2), 77–85. https://doi.org/10.1080/00221341.2022.2059099

González González, M. J., & Pisabarro, A. (2024). Developing a holistic strategy based on GIS and story mapping for learning and communicating geography. *Journal of Settlements and Spatial Planning, 15*(2), 109–119. https://doi.org/10.24193/JSSP.2024.2.03

Granados-Sánchez, J. (2022). Levels of transformation in sustainable curricula: The case of geography education. *Sustainability, 14*(8), Article 4481. https://doi.org/10.3390/su14084481

Grindsted, T. S., & Nielsen, T. T. (2022). Spaces of learning—Practising the SDGs through geographical fieldwork methods in a nature park. *International Journal of Sustainability in Higher Education, 23*(8), 105–119. https://doi.org/10.1108/IJSHE-04-2021-0132

Gryl, I. (2023). The role of geography education in sustainability in a digital age. In L. Keller, G. Michelsen, M. Dür, S. Bachri, & M. Zint (Eds.), *Digitalization, new media, and education for sustainable development* (pp. 29–42). IGI Global. https://doi.org/10.4018/978-1-7998-5033-5.ch003

Guo, F., Lane, J., Duan, Y., Stoltman, J. P., Khlebosolova, O., Lei, H., & Zhou, W. (2018). Sustainable development in geography education for middle school in China. *Sustainability, 10*, Article 3896. https://doi.org/10.3390/su10113896

Hane, E., & Korfmacher, K. (2020). Integrating multiple perspectives in an urban ecology course. *Landscape Online, 82*, 1–14. https://doi.org/10.3097/LO.202082

Hawa, N. N., Zakaria, S. Z. S., Razman, M. R., & Majid, N. A. (2021). Geography education for promoting sustainability in Indonesia. *Sustainability, 13*, Article 4340. https://doi.org/10.3390/su13084340

Higgitt, D. (2006). Finding space for education for sustainable development in the enterprise economy. *Journal of Geography in Higher Education, 30*(2), 251–262. https://doi.org/10.1080/03098260600717331

Hoffmann, T. (2021). How to teach global challenges? A solution-focused approach. *Southern African Journal of Environmental Education, 37*(1), 143–157. https://doi.org/10.15488/11669

Hoffmann, T. (2022). Should Alexander von Humboldt be part of contemporary geography education? In G. C. Falk, M. R. Strecker, & S. Schneider (Eds.), *Alexander von Humboldt* (pp. not provided). Springer. https://doi.org/10.1007/978-3-030-94008-9_6

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Huang, H., & Cheng, E. W. L. (2022). Sustainability education in China: Lessons learnt from the teaching of geography. *Sustainability, 14*(1), Article 513. https://doi.org/10.3390/su14010513

Huang, Y., Qu, Y., & Chen, Y. (2020). Research on sustainable science development education of Chinese geography textbook based on GIS visualization system. *IOP Conference Series: Earth and Environmental Science, 440*(5), Article 052034. https://doi.org/10.1088/1755-1315/440/5/052034

Hwang, S. (2013). Placing GIS in sustainability education. *Journal of Geography in Higher Education, 37*(2), 276–291. https://doi.org/10.1080/03098265.2013.769090

Härmä, K., Kärkkäinen, S., & Jeronen, E. (2021). The dramatic arc in the development of argumentation skills of upper secondary school students in geography education. *Education Sciences, 11*(11), Article 734. https://doi.org/10.3390/educsci11110734

Jedelhauser, A., & Grob, R. (2024). Powerful geography in Switzerland: Potential and challenges. In M. Solem, R. G. Boehm, & J. Zadrozny (Eds.), *Powerful geography* (pp. 203–216). Springer. https://doi.org/10.1007/978-3-031-54845-1_11

Jeong, J. S., & González-Gómez, D. (2021). Multi-criteria decision analysis methods for sustainability assessment of renewable energy systems and its potential application to sustainable STEM education. In J. Ren (Ed.), *Energy systems evaluation* (Vol. 2, pp. 39–62). Springer. https://doi.org/10.1007/978-3-030-67376-5_3

Kiassat, C. (2024). Reimagining industrial engineering: Embedding sustainability and societal impact in course design. *ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--47935

Kiely, L., Parajuly, K., Green, J. A., & Fitzpatrick, C. (2021). Education for UN Sustainable Development Goal 12: A cross-curricular program for secondary level students. *Frontiers in Sustainability, 2*, Article 638294. https://doi.org/10.3389/frsus.2021.638294

Kim, M., & Lee, S.-I. (2012). South Korea: GIS implementation profiles among secondary geography teachers. In A. J. Milson, A. Demirci, & J. J. Kerski (Eds.), *International perspectives on teaching and learning with GIS in secondary schools* (pp. 233–241). Springer. https://sangillee.snu.ac.kr/papers/2012_01_IPTLGISSS_Kim_Lee.pdf

Kitagawa, K. (2023). Learning and teaching of climate change, sustainability and disaster risk reduction in teacher education in England and Japan. *Journal of Teacher Education for Sustainability, 25*(2), 5–20. https://doi.org/10.2478/jtes-2023-0013

Kolenc-Kolnik, K. (2009). Contribution of geography teaching to education for sustainable development [Prispevek geografije k izobraževanju za trajnostni razvoj]. *Geografija v Šoli, 18*(1), 11–18. https://www.scopus.com/inward/record.uri?eid=2-s2.0-69249107406&partnerID=40&md5=6bd83eaed48bd855f7166f28c1e0c80a

Kouziokas, G. N. (2015). Development of an information system as a GIS-based learning environment for geoscience and geography education. *International Journal of Technologies in Learning, 22*(4), 68–82. https://doi.org/10.18848/2327-0144/CGP/v22i04/49081

Kovačič, G., & Brečko Grubar, V. (2016). Knowledge of sustainable development among geography students in Slovenia [Poznavanje trajnostnega razvoja med študenti geografije v Sloveniji]. *Acta Geographica Slovenica, 56*(1), 101–119. https://doi.org/10.3986/AGS.1633

Kowasch, M., & Lippe, D. F. (2019). Moral impasses in sustainability education? Empirical results from school geography in Austria and Germany. *Environmental Education Research, 25*(7), 1066–1082. https://doi.org/10.1080/13504622.2018.1557112

Kurniawan, E., Syifauddin, M., Sholeh, M., & Sari, S. N. (2024). Environmental problem-solving learning model with Geographic Information System-based learning media. *International Journal of Environmental Impacts, 7*(3), 381–394. https://doi.org/10.18280/ijei.070301

Labianca, M. (2021). Can GIS foster conscious and critical learning in geography? An application from students to a real case included in the national strategy for inner areas: Monti Dauni, Apulia (Italy). *Sustainability, 13*(16), Article 9246. https://doi.org/10.3390/su13169246

Lam, C.-C., Lai, E., & Wong, J. (2009). Implementation of Geographic Information System (GIS) in secondary geography curriculum in Hong Kong: Current situations and future directions. *International Research in Geographical and Environmental Education, 18*(1), 57–74. https://doi.org/10.1080/10382040802591555

Lewis, N. (2019). Education. In A. Kobayashi (Ed.), *International encyclopedia of human geography* (2nd ed., pp. 69–76). Elsevier. https://doi.org/10.1016/B978-0-08-102295-5.10255-0

Li, J., Xia, H., Qin, Y., Fu, P., Guo, X., Li, R., & Zhao, X. (2022). Web GIS for sustainable education: Towards natural disaster education for high school students. *Sustainability, 14*(5), Article 2694. https://doi.org/10.3390/su14052694

Luttenberger, L. R., & Mandić, N. (2022). Coastal risks and resilience learning. *Pomorstvo, 36*(2), 195–203. https://doi.org/10.31217/p.36.2.3

Mahat, H., Silamat, E. A., Saleh, Y., & Nayan, N. (2024). Comics as engaging tools for teaching geography. *International Journal of Learning, Teaching and Educational Research, 23*(10), 522–543. https://doi.org/10.26803/ijlter.23.10.24

Martínez-Hernández, C., & Mínguez, C. (2023). The Anthropocene and the Sustainable Development Goals: Key elements in geography higher education? *International Journal of Sustainability in Higher Education, 24*(7), 1648–1667. https://doi.org/10.1108/IJSHE-09-2022-0316

Martínez-Hernández, C., & Mínguez, C. (2024). Are the UN SDGs being implemented in geography courses at Spanish universities? In W. Leal Filho, T. Dibbern, S. R. de Maya, Md. C. Alarcón-del-Amo, & L. M. Rives (Eds.), *The contribution of universities towards education for sustainable development* (pp. 1–22). Springer. https://doi.org/10.1007/978-3-031-49853-4_1

Martínez-Hernández, C., & Robles-Moral, F. J. (2023). Sustainability education for trainee teachers: Landscape and mirror classes as educational tools. *Sustainability, 15*(24), Article 16624. https://doi.org/10.3390/su152416624

Maude, A. (2016). What might powerful geographical knowledge look like? *Geography, 101*(2), 70–76. https://doi.org/10.1080/00167487.2016.12093987

Maude, A. (2020). The role of geography's concepts and powerful knowledge in a future 3 curriculum. *International Research in Geographical and Environmental Education, 29*(3), 232–243. https://doi.org/10.1080/10382046.2020.1749771

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Maude, A. (2023). Using geography's conceptual ways of thinking to teach about sustainable development. *International Research in Geographical and Environmental Education, 32*(1), 4–19. https://doi.org/10.1080/10382046.2022.2079407

Miao, S., Meadows, M. E., Duan, Y., & Guo, F. (2022). How does the geography curriculum contribute to education for sustainable development? Lessons from China and the USA. *Sustainability, 14*(17), Article 10637. https://doi.org/10.3390/su141710637

Michaeli, E., Madziková, A., Zverková, M., Michalková, J., & Solár, V. (2016). The visualization of geographic objects in education processes and its application in pre-graduate education of future geography teachers. In *International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management (SGEM)* (Vol. 3, pp. 1061–1068). https://doi.org/10.5593/SGEM2016/B53/S22.137

Milson, A. J., Demirci, A., & Kerski, J. J. (2012). The world at their fingertips: A new age for spatial thinking. In A. J. Milson, J. J. Kerski, & A. Demirci (Eds.), *International perspectives on teaching and learning with GIS in secondary schools* (pp. 1–12). Springer. https://doi.org/10.1007/978-94-007-2120-3_1

Mkhongi, F. A., & Musakwa, W. (2020). Perspectives of GIS education in high schools: An evaluation of Umgungundlovu District, KwaZulu-Natal, South Africa. *Education Sciences, 10*(5), Article 131. https://doi.org/10.3390/educsci10050131

Muliaina, T. (2018). In search of meaningful assessment in the university curriculum: The case for culturally relevant pedagogy. *Australian Geographer, 49*(4), 517–535. https://doi.org/10.1080/00049182.2018.1440689

Mulyanie, E., & Setiawan, I. (2024). Enhancing environmental awareness through ecopedagogy and local wisdom: A study of geography education students in Kampung Naga. *E3S Web of Conferences, 600*, Article 05001. https://doi.org/10.1051/e3sconf/202460005001

Navarro, V., Martínez, O., Miranda, J., Rada, D., Bustamante, M. Á., Etaio, I., Lasa, A., Simón, E., & Churruca, I. (2020). Including aspects of sustainability in the degree in human nutrition and dietetics: An evaluation based on student perceptions. *Journal of Cleaner Production, 243*, Article 118545. https://doi.org/10.1016/j.jclepro.2019.118545

Nicholson, D. T., Vargas, V. R., & Skelly, G. (2023). Enquiry-based skills education for sustainable development in a UK geography module as a catalyst for organisational change. *International Journal of Sustainability in Higher Education, 24*(8), 1898–1915. https://doi.org/10.1108/IJSHE-07-2022-0225

Nokelaynen, T. S. (2021). School atlas mapping for education for sustainable development: Topic "world forest resources and biodiversity conservation." *InterCarto. InterGIS, 27*, 31–41. https://doi.org/10.35595/2414-9179-2021-2-27-31-41

Ormand, C. J., Shipley, T. F., Tikoff, B., Dutrow, B., Goodwin, L. B., Hickson, T., Atit, K., Gagnier, K., & Resnick, I. (2017). The spatial thinking workbook: A research-validated spatial skills curriculum for geology majors. *Journal of Geoscience Education, 65*(4), 423–434. https://doi.org/10.5408/16-210.1

Palacios, F. A., Oberle, A., Quezada, X. C., & Ullestad, M. (2017). Geographic education for sustainability: Developing a bi-national geographical thinking curriculum. In C. Brooks, G. Butt, & M. Fargher (Eds.), *The power of geographical thinking: International perspectives on geographical education* (pp. 103–117). Springer. https://doi.org/10.1007/978-3-319-49986-4_8

Papageorgiou, V., Druckman, A., Kioupi, V., & Pinilla-Roncancio, M. (2024). Empowering integration of sustainability in higher education curricula. In A. McNamara, D. Mahon, V. Papageorgiou, & J. Ramdeo (Eds.), *Inspire: Learning for teaching in higher education* (pp. 53–69). Nova Science Publishers.

Paraskevas, A., Lambrinos, N., & Psillos, D. (2010). A study of a blended didactic approach to teacher professional development in geography. *European Journal of Geography, 1*(1), 46–60. https://eurogeojournal.eu/articles/2.%20Paraskevas-final.pdf

Park, H. Y., Licon, C. V., Givens, J., & Sleipness, O. R. (2024). Implementation of sustainability principles in landscape architecture education: An examination of faculty attitudes and course syllabi. *International Journal of Sustainability in Higher Education, 25*(8), 1995–2016. https://doi.org/10.1108/IJSHE-02-2023-0060

Paul, S. A. L., Wilson, A. M. W., Cachimo, R., & Riddell, M. A. (2016). Piloting participatory smartphone mapping of intertidal fishing grounds and resources in northern Mozambique: Opportunities and future directions. *Ocean & Coastal Management, 134*, 79–92. https://doi.org/10.1016/j.ocecoaman.2016.09.018

Perkins, K. M., Munguia, N., Moure-Eraso, R., Delakowitz, B., Giannetti, B. F., Liu, G., Nurunnabi, M., Will, M., & Velazquez, L. (2018). International perspectives on the pedagogy of climate change. *Journal of Cleaner Production, 200*, 1043–1052. https://doi.org/10.1016/j.jclepro.2018.07.296

Pike, S. (2021). Geography education for social and environmental justice education. In A. M. Kavanagh, F. Waldron, & B. Mallon (Eds.), *Teaching for social justice and sustainable development across the primary curriculum* (pp. 37–53). Routledge. https://doi.org/10.4324/9781003003021-3

Pretorius, R., Lombard, A., & Khotoo, A. (2016). Adding value to education for sustainability in Africa with inquiry-based approaches in open and distance learning. *International Journal of Sustainability in Higher Education, 17*(2), 167–187. https://doi.org/10.1108/IJSHE-07-2014-0110

Raath, S., & Hay, A. (2019). Preservice geography students' exposure to systems thinking and cooperative learning in environmental education. *Journal of Geography, 118*(2), 66–76. https://doi.org/10.1080/00221341.2018.1516231

Radulović, B., Džinović, M., Mandić, D., Zukorlić, M., & Starijaš, G. (2023). Outdoor science approach with peer tutoring at university level as an example of implementing sustainable development strategies. *Sustainability, 15*(6), Article 5196. https://doi.org/10.3390/su15065196

Ramirez-Salgado, A., & Wright, E. (2023). Measuring systems thinking using stealth assessment. In *2023 ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--43575

Reid, A. (2005). Environmental change and sustainable development. In M. Smith (Ed.), *Teaching geography in secondary schools* (pp. 224–244). Routledge.

Remington-Doucette, S., & Musgrove, S. (2015). Variation in sustainability competency development according to age, gender, and disciplinary affiliation: Implications for teaching practice and program structure. *International Journal of Sustainability in Higher Education, 16*(4), 537–575. https://doi.org/10.1108/IJSHE-01-2013-0005

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Roberts, M. (2014). Powerful knowledge and geographical education. *Curriculum Journal, 25*(2), 187–209. https://doi.org/10.1080/09585176.2014.894481

Roberts, M. (2023). Powerful pedagogies for the school geography curriculum. *International Research in Geographical and Environmental Education, 32*(1), 69–84. https://doi.org/10.1080/10382046.2022.2146840

Robinson, Z. P. (2015). Are geography students good "environmental citizens"? A comparison between year of study and over time. *Journal of Geography in Higher Education, 39*(2), 245–259. https://doi.org/10.1080/03098265.2014.936312

Rodway-Dyer, S., & Barr, S. (2024). Do we really make a difference? A case study on the value of taught environmental sustainability postgraduate programmes within geography. *International Journal of Sustainability in Higher Education, 25*(6), 1232–1251. https://doi.org/10.1108/IJSHE-06-2023-0243

Rosado-González, E. M., Lourenço, J. M. M., Palacio-Prieto, J. L., & Sá, A. A. (2023). Collaborative mapping on sustainable development goals in Latin America UNESCO global geoparks: A methodological discussion. *International Journal of Geoheritage and Parks, 11*(2), 203–220. https://doi.org/10.1016/j.ijgeop.2023.02.002

Roulston, S. (2013). GIS in Northern Ireland secondary schools: Mapping where we are now. *International Research in Geographical and Environmental Education, 22*(1), 41–56. https://doi.org/10.1080/10382046.2012.759437

Sánchez, J. G. (2010). Research in geography education and sustainable development [La recerca en l'ensenyament de la geografia per al desenvolupament sostenible]. *Documents d'Anàlisi Geogràfica, 56*(2), 339–356. https://doi.org/10.5565/rev/dag.867

Shakhislam, L., Yerlan, I., Duman, A., Ussenov, N., Zhu, K., & Dávid, L. D. (2024). Opportunities and challenges of using geospatial technologies in teaching school geography in Kazakhstan. *International Research in Geographical and Environmental Education, 34*(4), 428–446. https://doi.org/10.1080/10382046.2024.2380173

Shay, E., & Caplow, S. (2017). Integrated traditional and applied education in a public US university: Exploring sustainable cities and regions in classrooms and communities. *Journal of Environmental Studies and Sciences, 7*(1), 121–126. https://doi.org/10.1007/s13412-014-0201-0

Skarstein, F., & Wolff, L.-A. (2020). An issue of scale: The challenge of time, space and multitude in sustainability and geography education. *Education Sciences, 10*(2), Article 28. https://doi.org/10.3390/educsci10020028

Solem, M., Boehm, R. G., & Zadrozny, J. (Eds.). (2024). *Powerful geography: International perspectives and applications*. Springer. https://doi.org/10.1007/978-3-031-54845

Solem, M., & Weiguo, Z. (2018). The role of geography education for global understanding. In A. Demirci, R. de Miguel González, & S. Bednarz (Eds.), *Geography education for global understanding: International perspectives on geographical education* (pp. not provided). Springer. https://doi.org/10.1007/978-3-319-77216-5_5

Stacchiotti, L., Acqua, A., Pennesi, D., Beccaceci, A., & Paris, E. (2019). WASTEBERG: A didactic activity about waste and sustainable use of georesources in relation to Agenda 2030. *Rendiconti Online della Società Geologica Italiana, 49*, 127–133. https://doi.org/10.3301/ROL.2019.62

Suptelo, O., & Niemets, O. (2024). IT, geography and education: Prospects for high-tech industry sectors in the context of sustainable development. In C. Morar, L. Berman, S. Erdal, & L. Niemets (Eds.), *Achieving sustainability in Ukraine through military brownfields redevelopment: NATO ARW 2023* (pp. 443–455). Springer. https://doi.org/10.1007/978-94-024-2278-8_34

Tani, S., Cantell, H., & Hilander, M. (2020). Student exams and relevant knowledge of geography [Ylioppilaskokeet ja maantieteen merkityksellinen tieto]. *Terra, 132*(1), 3–16. https://doi.org/10.30677/terra.82739

Thenga, M., Goldschagg, P., Ferguson, R., & Mandikonza, C. (2020). Teacher professional development and geography teachers' pedagogical practices for climate change education. *Southern African Journal of Environmental Education, 36*, 34–47. https://doi.org/10.4314/sajee.v36i3.17

Trad, S. P. (2019). A framework for mapping sustainability within tertiary curriculum. *International Journal of Sustainability in Higher Education, 20*(2), 288–308. https://doi.org/10.1108/IJSHE-09-2018-0151

Urbańska, M., Charzyński, P., Gadsby, H., Novák, T. J., Şahin, S., & Yilmaz, M. D. (2022). Environmental threats and geographical education: Students' sustainability awareness—evaluation. *Education Sciences, 12*(1), Article 1. https://doi.org/10.3390/educsci12010001

van der Schee, J., & Scholten, H. J. (2009). Geographical information systems and geography teaching. In H. J. Scholten, R. van de Velde, & N. van Manen (Eds.), *Geospatial technology and the role of location in science* (pp. 287–301). Springer. https://doi.org/10.1007/978-90-481-2620-0_15

Varjas, J. (2022). The presence of sustainability in Hungarian geography textbooks. *European Journal of Geography, 13*(1), 22–46. https://doi.org/10.48088/ejg.j.var.13.1.22.46

Vasileva, M. (2020). Opportunities for operationalizing the principle of sustainable development in geography training. In *International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management (SGEM 2020)* (Vol. 5.2, pp. 813–820). https://doi.org/10.5593/sgem2020/5.2/s22.100

Walshe, N. (2017). An interdisciplinary approach to environmental and sustainability education: Developing geography students' understandings of sustainable development using poetry. *Environmental Education Research, 23*(8), 1130–1149. https://doi.org/10.1080/13504622.2016.1221887

Wang, Y., Wu, N., Kunze, C., Long, R., & Perlik, M. (2019). Drivers of change to mountain sustainability in the Hindu Kush Himalaya. In P. Wester, A. Mishra, A. Mukherji, & A. B. Shrestha (Eds.), *The Hindu Kush Himalaya assessment: Mountains, climate change, sustainability and people* (pp. 17–56). Springer Nature. https://doi.org/10.1007/978-3-319-92288-1_2

Westermark, Å., & Jansund, B. (2019). Learning experiences from a time-geographic approach—Commodity chains, globalization, everyday life, and sustainability in context. *Journal of Geography in Higher Education, 43*(4), 486–504. https://doi.org/10.1080/03098265.2019.1661368

Widener, J. M., Gliedt, T., & Tziganuk, A. (2016). Assessing sustainability teaching and learning in geography education. *International Journal of Sustainability in Higher Education, 17*(5), 698–718. https://doi.org/10.1108/IJSHE-03-2015-0050

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Windsor, S., & Kriewaldt, J. (2023). School geography's critical role for a more sustainable future: Powerful knowledge and praxis. *Social Sciences*, *12*(11), Article 585. https://doi.org/10.3390/socsci12110585

Winter, C., Kasuji, S., Poh, C., Robinson, R., & Whittall, D. (2024). Critiquing "powerful knowledge" in school geography through a decolonial lens. *Geography*, *109*(2), 67–78. https://doi.org/10.1080/00167487.2024.2351770

Yli-Panula, E., Jeronen, E., Koskinen, S., & Vesterkvist, S. (2020). Biologian ja maantieteen opetuksessa käytettävät ilmastonmuutoksen opetusmenetelmät. *Ainedidaktiikka, 4*(3), 102–124. https://journal.fi/ainedidaktiikka/article/view/98284/58810

Zhang, J., Yang, S., Dong, C., & Chen, Q. (2010). Apply RS/GIS technology to integrate geography environment education. In *2010 International Conference on E-Product E-Service and E-Entertainment (ICEEE)*.

Özgen, N. (2009). The functionality of geographic information system (GIS) technology in geography teaching: Application of a sample lesson. *Kuram ve Uygulamada Eğitim Bilimleri, 9*(4), 1879–1894. https://files.eric.ed.gov/fulltext/EJ867372.pdf

…..

Aboytes, J. G., & Barth, M. (2020). Transformative learning in the field of sustainability: A systematic literature review (1999–2019). *International Journal of Sustainability in Higher Education*, *21*(5), 993–1013. https://doi.org/10.1108/IJSHE-05-2019-0168

Abduganiev, O. I., & Abdurakhmanov, G. Z. (2020). Ecological education for the purposes of sustainable development. *American Journal of Social Science and Education Innovations, 2*, 280–284. Available online: https://www.academia.edu/download/120998510/666.pdf (accessed 18 May 2026).

Abu, A. (2026). International practices of SDG implementation in school geography education: A comparative analysis. In L. Lombardo (Ed.), *Proceedings of the 12th International Scientific Conference "Scientific Results" (January 8–9, 2026), Rome, Italy* (pp. 300–305). https://doi.org/10.5281/zenodo.18218390

Aguado-Moralejo, I., Torres Enjuto, M. C., & Arenaza, O. O. (2020). Place-based learning through field trips in geography. *INTED2020 Proceedings*, 6015–6021. https://doi.org/10.21125/inted.2020.1626

Ai, X., Favier, T., Beneker, T., & Duan, Y. (2025). Orientations of Chinese geography teachers towards climate change education. *Journal of Geography*, *124*(4), 91–103. https://doi.org/10.1080/00221341.2025.2528020

Ajit, G., Lucas, T., & Kanyan, L. (2021). A systematic review of augmented reality in STEM education. *Studies of Applied Economics*, *39*(1), 1–22. https://doi.org/10.25115/eea.v39i1.4280

Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review*, *20*, 1–11. https://doi.org/10.1016/j.edurev.2016.11.002

Aksela, M., Tikkanen, G., & Kärnä, P. (2012). Mielekäs luonnontieteiden opetus: Miten tukea oppilaiden ajattelua ja ymmärtämistä? In P. Kärnä, L. Houtsonen, & T. Tähkä (Eds.), *Luonnontieteiden opetuksen kehittämishaasteita* (pp. 109–128). Opetushallitus.

Al-Barakat, A., AlAli, R., Alotaibi, S., Alrashood, J., Abdullatif, A., & Zaher, A. (2025). Science education as a pathway to sustainable awareness: Teachers' perceptions on fostering understanding of humans and the environment: A qualitative study. *Sustainability*, *17*, Article 7136. https://doi.org/10.3390/su17157136

Albion, P., Redmond, P., Gharineiat, Z., Feldman, J., Shelley, T., Helwig, A., & Burey, P. (2025). Teachers and sustainability education: Exploring the views of Australian preservice and inservice teachers. *The Australian Educational Researcher*, *52*, 3287–3313. https://doi.org/10.1007/s13384-025-00852-2

Ali, L. (2018). The design of curriculum, assessment and evaluation in higher education with constructive alignment. *Journal of Education and e-Learning Research*, *5*, 72–78. https://doi.org/10.20448/journal.509.2018.51.72.78

Alimkulov, J. (2025). Innovative methods in geography education: Strategies for developing project-based competency among future teachers. *Экономика и социум, 3*(2/130), 33–40. Available online: https://cyberleninka.ru/article/n/innovative-methods-in-geography-education-strategies-for-developing-project-based-competency-among-future-teachers (accessed 18 May 2026).

ALLEA (All European Academies). (2013). *Ethics education in science – Statement by the ALLEA Permanent Working Group on Science and Ethics*. Berlin, Germany. https://www.allea.org

Alnagrat, A. J. A., Che Ismail, R., Syed Idrus, S. Z., & Abdulhafith Alfaqi, R. M. (2022). A review of extended reality (XR) technologies in the future of human education: Current trend and future opportunity. *Journal of Human Centered Technology*, *1*(2), 81–96. https://doi.org/10.11113/humentech.v1n2.27

Al-Nofli, M. A., Ibrahim, O. R., & Al Kalbani, K. (2026). Teachers' perceptions of climate change education in Oman. *Asian Journal of Interdisciplinary Research*, *9*(2), 123–139. https://doi.org/10.54392/ajir2627

Al-Sharafi, M. A., Al-Emran, M., Arpaci, I., Iahad, N. A., Al Qudah, A. A., Iranmanesh, M., & Al-Qaysi, N. (2023). Generation Z use of artificial intelligence products and its impact on environmental sustainability: A cross-cultural comparison. *Computers in Human Behavior*, *143*, Article 107708. https://doi.org/10.1016/j.chb.2023.107708

Álvarez-García, O., Sureda-Negre, J., & Comas-Forgas, R. (2015). Environmental education in pre-service teacher training: A literature review of existing evidence. *Journal of Teacher Education for Sustainability, 17*, 72–85. https://doi.org/10.1515/jtes-2015-0006

Amoah Nuamah, J., Mensah, B., Yalley, C. E., Dadson, I. Y., & Okyere, E. Y. (2025). Examining the role of senior high school geography teachers in fostering environmental sustainability: Educational philosophies, challenges, and innovative practices. *Discover Education*, *4*, Article 554. https://doi.org/10.1007/s44217-025-00618-z

Anderson, K. C., & Leinhardt, G. (2002). Maps as representations: Expert–novice comparison of projection understanding. *Cognition and Instruction*, *20*(3), 283–321. https://doi.org/10.1207/S1532690XCI2003_1

Annelin, A., & Boström, G. O. (2023). An assessment of key sustainability competencies: A review of scales and propositions for validation. *International Journal of Sustainability in Higher Education*, *24*(9), 53–69. https://doi.org/10.1108/IJSHE-05-2022-0166

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Anunti, H. (2023). *Geomedia skills for 21st century geography learners: Educational experiments in teaching and learning with geomedia* [Doctoral dissertation, University of Oulu]. Acta Universitatis Ouluensis, A 786. https://urn.fi/URN:ISBN:9789526238326

Ardoin, N. M., Bowers, A. W., Wyman Roth, N., & Holthuis, N. (2018). Environmental education and K–12 student outcomes: A review and analysis of research. *The Journal of Environmental Education, 49*(1), 1–17. https://doi.org/10.1080/00958964.2017.1366155

Asilevi, M. N., Kang, J., Sormunen, K., Karkkainen, S., & Havu-Nuutinen, S. (2026). Primary school students' learning achievement and attitudes towards inquiry-based science fieldwork with socio-demographic information. *Journal of Education in Science, Environment and Health, 12*(1). https://doi.org/10.55549/jeseh.847

Atasoy, E. (2009). Eighth grade students' associations of geographical and environmental concepts. *New Educational Review, 17*(1), 102–124. http://hdl.handle.net/11452/26099

Atjonen, P. (2017). Arviointiosaamisen kehittäminen yleissivistävän koulun opettajien koulutuksessa: Opetussuunnitelmatarkastelun virittämiä näkemyksiä. In V. Britschgi & J. Rautopuro (Eds.), *Kriteerit puntarissa* (pp. 132–169). Suomen Kasvatustieteellinen Seura.

Atjonen, P., Laivamaa, H., Levonen, A., Orell, S., Saari, M., Sulonen, K. T., Tamm, M., Kamppi, P., Rumou, N., Hietala, R., & Immonen, J. (2019). "Että tietää missä on menossa": Oppimisen ja osaamisen arviointi perusopetuksessa ja lukiokoulutuksessa. *Kansallinen koulutuksen arviointikeskus (KARVI), Julkaisut 7*. http://hdl.handle.net/10138/304492

Avelar, A. B. A., da Silva Oliveira, K. D., & Farina, M. C. (2023). The integration of the Sustainable Development Goals into curricula, research and partnerships in higher education. *International Review of Education, 69*, 299–325. https://doi.org/10.1007/s11159-023-10013-1

Backman, M., Pitt, H., Marsden, T., Mehmood, A., & Mathijs, E. (2019). Experiential approaches to sustainability education: Towards learning landscapes. *International Journal of Sustainability in Higher Education, 20*(1), 139–156. https://doi.org/10.1108/IJSHE-06-2018-0109

Bakanov, N. G., Kaimuldinova, K. D., & Shakirova, N. D. (2024). Global competencies in geographic education for sustainable development. *Iasaui Universitetinin Habarshysy, 4*(134), 503–514. https://journals.ayu.edu.kz/index.php/habarshy/article/download/4525/932

Ballang, E., & Ababio, B. T. (2021). Role of fieldwork in the quality of teaching and learning of geography in senior high schools in the Upper West Region, Ghana. *Ghana Journal of Education: Issues and Practices, 7*, 40–61. https://journal.ucc.edu.gh/index.php/gje/article/view/1096/541

Balsiger, J., Förster, R., Mader, C., Nagel, U., Sironi, H., Wilhelm, S., & Zimmermann, A. B. (2017). Transformative learning and education for sustainable development. *GAIA, 26*(4), 357–359. https://doi.org/10.14512/gaia.26.4.15

Barth, P., Dillon, N., Hull, J., & Higgins, B. H. (2016). Fixing the holes in the teacher pipeline: An overview of teacher shortages. Center for Public Education. https://files.eric.ed.gov/fulltext/ED608871.pdf

Baßeng, G., & Budke, A. (2024). Game on, reflection on: Reflection diaries as a tool for promoting reflection skills in geography lessons. *Education Sciences, 14*, Article 316. https://doi.org/10.3390/educsci14030316

Behrendt, M., & Franklin, T. (2014). A review of research on school field trips and their value in education. *International Journal of Environmental & Science Education, 9*(3), 235–245. https://doi.org/10.12973/ijese.2014.213a

Bendl, T., Krajňáková, L., Marada, M., & Řezníčková, D. (2024). Geographical thinking in geography education: A systematic review. *International Research in Geographical and Environmental Education*. https://doi.org/10.1080/10382046.2024.2354097

Bendl, T., & Marada, M. (2021). Kritické myšlení v geografickém vzdělávání: Je geografické myšlení kritické? *Geografie, 126*(4), 371–391. https://doi.org/10.37040/geografie2021126040371

Bengel, P. T. (2023). Modern technologies in geography education—Mobile and virtual approaches for extracurricular environments. *Zeitschrift für Geographiedidaktik, 51*(1), 55–70. https://doi.org/10.17192/z2024.0055

Bentil, S., & Ababio, B. T. (2020). Benefits of adopting problem-based learning in geography education: Standpoint of students and instructors. *International Journal of Education and Evaluation, 6*(3). https://iiardjournals.org/get/IJEE/VOL.%206%20NO.%203%202020/BENEFITS%20OF%20ADOPTING%20PROBLEM.pdf

Benzehaf, B., Razkane, H., & Benzehaf, O. (2025). Exploring university students' perceptions and engagement in environmental awareness and sustainable practices. *Discover Environment, 3*, Article 247. https://doi.org/10.1007/s44274-025-00462-w

Bianchi, G., Pisiotis, U., & Cabrera Giráldez, M. (2022). *GreenComp – The European sustainability competence framework*. JRC Science for Policy Report. Publications Office of the European Union. https://doi.org/10.2760/13286

Biggs, J. B., & Collis, K. F. (1982). *Evaluating the quality of learning: The SOLO taxonomy (Structure of the Observed Learning Outcome)*. Academic Press.

Bijsterbosch, E., van der Schee, J., & Kuiper, W. (2017). Meaningful learning and summative assessment in geography education: An analysis in secondary education in the Netherlands. *International Research in Geographical and Environmental Education, 26*(1), 17–35. https://doi.org/10.1080/10382046.2016.1217076

Black, A. A. (2005). Spatial ability and Earth science conceptual understanding. *Journal of Geoscience Education, 53*(4), 402–414. https://doi.org/10.5408/1089-9995-53.4.402

Blaschke, T., & Merschdorf, H. (2014). Geographic information science as a multidisciplinary and multiparadigmatic field. *Cartography and Geographic Information Science, 41*(3), 196–213. https://doi.org/10.1080/15230406.2014.905755

Bleier, M. (2021). Should we bother to practice ecological responsibility? *Cultural Studies of Science Education, 16*, 783–803. https://doi.org/10.1007/s11422-021-10052-w

Blom, R., & Karrow, D. D. (2024). Environmental and sustainability education in teacher education research: An international scoping review of the literature. *International Journal of Sustainability in Higher Education, 25*(5), 903–926. https://doi.org/10.1108/IJSHE-07-2023-0288

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain.* Longmans, Green and Co.

Boeren, E. (2019). Understanding Sustainable Development Goal (SDG) 4 on "quality education" from micro, meso and macro perspectives. *International Review of Education, 65*, 277–294. https://doi.org/10.1007/s11159-019-09772-7

Bos, D., Miller, S., & Bull, E. (2022). Using virtual reality (VR) for teaching and learning in geography: Fieldwork, analytical skills, and employability. *Journal of Geography in Higher Education, 46*(3), 479–488. https://doi.org/10.1080/03098265.2021.1901867

Bourke, T., & Mills, R. (2022). Binaries and silences in geography education assessment research. In T. Bourke, R. Mills, & R. Lane (Eds.), *Assessment in geographical education: An international perspective* (pp. 3–27). Springer. https://doi.org/10.1007/978-3-030-95139-9_1

Boyle, A., Maguire, S., Martin, A., Milsom, C., Nash, R., Rawlinson, S., & Conchie, S. (2007). Fieldwork is good: The student perception and the affective domain. *Journal of Geography in Higher Education, 31*(2), 299–317. https://doi.org/10.1080/03098260601063628

Braun, T., & Dierkes, P. (2017). Connecting students to nature—How intensity of nature experience and student age influence the success of outdoor education programs. *Environmental Education Research, 23*(7), 937–949. https://doi.org/10.1080/13504622.2016.1214866

Brečko, B. N., Ferrari, A., & Punie, Y. (2014). DIGCOMP: A framework for developing and understanding digital competence in Europe. *eLearning Papers, 38*, 1–14. https://publications.jrc.ec.europa.eu/repository/handle/JRC90109

Broncano, F. (2014). Daring to believe: Metacognition, epistemic agency and reflective knowledge. In A. Fairweather (Ed.), *Virtue epistemology naturalized: Bridges between virtue epistemology and philosophy of science* (pp. 1–9). Springer. https://doi.org/10.1007/978-3-319-04672-3_4

Brookfield, K. (2022). Nature-enhanced learning and geography education. *Journal of Geography in Higher Education, 46*(3), 327–342. https://doi.org/10.1080/03098265.2021.1926938

Brundiers, K., & Wiek, A. (2010). Educating students in real-world sustainability research: Vision and implementation. *Innovative Higher Education, 36*, 107–124. https://doi.org/10.1007/s10755-010-9161-9

Brundiers, K., & Wiek, A. (2017). Beyond interpersonal competence: Teaching and learning professional skills in sustainability. *Education Sciences, 7*(1), 39. https://doi.org/10.3390/educsci7010039

Bryan, C., & Clegg, K. (2006). *Innovative assessment in higher education.* Routledge.

Brysch, C. P., Huynh, N. T., & Scholz, M. (2012). Evaluating educational computer games in geography: What is the relationship to curriculum requirements? *Journal of Geography, 111*(3), 102–112. https://doi.org/10.1080/00221341.2011.609998

Butt, G. (2017). Debating the place of knowledge within geography education: Reinstatement, reclamation or recovery? In C. Brooks, G. Butt, & M. Fargher (Eds.), *The power of geographical thinking* (pp. 13–26). Springer.

Caeiro, S., & Simão, J. (2025). Sustainability competences and pedagogical approaches at Universidade Aberta. In R. Lozano, M. Barreiro-Gen, & F. J. Lozano (Eds.), *Developing sustainability competences through pedagogical approaches: Strategies for sustainability* (pp. 43–50). Springer. https://doi.org/10.1007/978-3-031-86035-5_4

Care, E., Griffin, P., & Wilson, M. (Eds.). (2018). *Assessment and teaching of 21st century skills*. Springer. https://doi.org/10.1007/978-3-319-65368-6

Cavadas, B., & Linhares, E. (2023). Using a problem-based learning approach to develop sustainability competencies in higher education students. In W. Leal Filho, A. M. Azul, F. Doni, & A. L. Salvia (Eds.), *Handbook of sustainability science in the future* (pp. 339–366). Springer. https://doi.org/10.1007/978-3-031-04560-8_86

Chang, H.-Y., Binali, T., Liang, J.-C., Chiou, G.-L., Cheng, K.-H., Lee, S. W.-Y., & Tsai, C.-C. (2022). Ten years of augmented reality in education: A meta-analysis of (quasi-)experimental studies to investigate the impact. *Computers & Education, 191*, 104641. https://doi.org/10.1016/j.compedu.2022.104641

Chen, M., Pei, T., Jeronen, E., Wang, Z., & Xu, L. (2022). Teaching and learning methods for promoting sustainability in tourism education. *Sustainability, 14*, 14592. https://doi.org/10.3390/su142114592

Cheng, L., Ritzhaupt, A. D., & Antonenko, P. (2019). Effects of the flipped classroom instructional strategy on students' learning outcomes: A meta-analysis. *Educational Technology Research and Development, 67*(4), 793–824. https://doi.org/10.1007/s11423-018-9633-7

Chernyatin, M. S. (2019). Integration of geography with other disciplines as a methodological condition for the formation of ecocentric consciousness among students. *Modern Problems of Science and Education, 2*, 13. https://vektornaukitech.ru/jour/article/view/800/756

Chiu, T. K. F., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence, 4*, 100118. https://doi.org/10.1016/j.caeai.2022.100118

Chopra, R., Joshi, A., Nagarajan, A., Fomproix, N., & Shashidhara, L. S. (2019). Climate change education across the curriculum. In W. Leal Filho & S. L. Hemstock (Eds.), *Climate change and the role of education* (pp. 53–69). Springer. https://doi.org/10.1007/978-3-030-32898-6_4

Chowdhury, M. (2016). Emphasizing morals, values, ethics, and character education in science education and science teaching. *Malaysian Online Journal of Educational Sciences, 4*(2), 1–16. https://files.eric.ed.gov/fulltext/EJ1095995.pdf

Çifçi, T., & Koybaşı, F. (2017). Geographic consciousness in sustainable education: Students' views. *Journal of Education and Practice, 8*(17), 49–55. https://www.iiste.org/Journals/index.php/JEP/article/view/37466/38547

Clayton, T., & Radcliffe, N. (2018). *Sustainability: A systems approach*. Routledge.

Cochran, K. F., De Ruiter, J. A., & King, R. A. (1993). Pedagogical content knowing: An integrative model for teacher preparation. *Journal of Teacher Education, 44*(4), 263–272. https://doi.org/10.1177/0022487193044004004

Cohen, E. G. (1994). *Designing group work: Strategies for the heterogeneous classroom* (2nd ed.). Teachers College Press.

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Cole, M. J. (2023). Evaluative thinking. *Evaluation Journal of Australasia, 23*(2), 70–90. https://doi.org/10.1177/1035719X231163932
Colomer, J., Serra, T., Cañabate, D., & Bubnys, R. (2020). Reflective learning in higher education: Active methodologies for transformative practices. *Sustainability, 12*(9), 3827. https://doi.org/10.3390/su12093827
Correa, J., López-Díez, A., & Díaz-Pacheco, J. (2025). Teaching geography for a sustainable future: Understanding and analyzing regions in the classroom—A didactic proposal. *Education Sciences, 15*(2), 126. https://doi.org/10.3390/educsci15020126
Corres, A., Ruiz-Mallén, I., & Rieckmann, M. (2024). Educators' competences, motivations and teaching challenges faced in education for sustainable development: What are the interlinkages? *Cogent Education, 11*(1), 2302408. https://doi.org/10.1080/2331186X.2024.2302408
Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute.
Davidson, N., & Major, C. H. (2014). Boundary crossings: Cooperative learning, collaborative learning, and problem-based learning. *Journal on Excellence in College Teaching, 25*(3–4), 7–55. https://files.su.ac.za/public/documents/2025-09/davidson-n-major-c-h-2014-boundary-crossings-cooperative-learning-collaborative-learning-and-problem.pdf
Dem, K., & Seden, K. (2025). Pedagogical and content knowledge: Geography teachers' and students' perceptions. *Educational Innovation and Practice, 10*(1), 23–47. https://doi.org/10.17102/eip.10.2025.02
Demssie, Y. N., Wesselink, R., Biemans, H. J. A., & Mulder, M. (2019). Think outside the European box: Identifying sustainability competencies for a base of the pyramid context. *Journal of Cleaner Production, 221*, 828–838. https://doi.org/10.1016/j.jclepro.2019.02.255
Deringer, S. A., & Hanley, A. (2021). Virtual reality of nature can be as effective as actual nature in promoting ecological behavior. *Ecopsychology, 13*(3), 219–226. https://doi.org/10.1089/eco.2020.0044
DGfG (Deutsche Gesellschaft für Geographie). (2014). *Educational standards in geography for the Intermediate School Certificate with sample assignments*. https://edumedia-depot.gei.de/server/api/core/bitstreams/48a9b39a-23bf-443f-a945-16ef95c4f11d/content
Dikmen, M. (2021). Does gamification affect academic achievement? A meta-analysis of studies conducted in Turkey. *International Journal of Curriculum and Instruction, 13*(3), 3001–3020. https://ijci.net/index.php/IJCI/article/view/797
Di Wilmot, S., Witham, B., Fomproix, M., García de la Vega, A., Grob, R., Mäsgen, J., & Wilson, S. (2025). Transformative learning in geography education: International perspectives and practices. *International Research in Geographical and Environmental Education*. https://doi.org/10.1080/10382046.2025.2473104
Djordjevic, I., Jovanovic, S., Markovic, M., Andjelkovic, S., Prnjat, Z., Matović, S., & Valjarević, A. (2026). Project-based learning in geography and its impact on developing students' values, attitudes and pro-environmental behavior. *Sustainability, 18*, 725. https://doi.org/10.3390/su18020725
Donthu, N., Kumar, S., & Pattnaik, D. (2020). Forty-five years of Journal of Business Research: A bibliometric analysis. *Journal of Business Research, 109*, 1–14. https://doi.org/10.1016/j.jbusres.2019.10.034
European Commission (EC). (2024). *Learning for sustainability in Europe: Building competences and supporting teachers and schools* (Eurydice report). European Education and Culture Executive Agency. https://doi.org/10.2797/81397
Edelson, D. C., Shavelson, R. J., & Wertheim, J. A. (Eds.). (2013). *A road map for 21st century geography education: Assessment* (Report from the Assessment Committee of the Road Map for 21st Century Geography Education Project). National Geographic Society.
Efe, H., & Umdu Topsakal, Ü. (2025). Let's take the pulse of the classroom on sustainability! An exploratory study on student views and teacher solution suggestions regarding sustainable development goals. *Sustainability, 17*, 5095. https://doi.org/10.3390/su17115095
El Batri, B., Alami, A., Zaki, M., & Nafidi, Y. (2020). Environmental education in Moroccan primary schools: Promotion of representations, knowledge, and environmental activities. *Elementary Education Online, 19*, 219–239. https://doi.org/10.17051/ilkonline.2020.653790
Elkington, J. (2007). Partnerships from cannibals with forks: The triple bottom line of 21st century business. *Environmental Quality Management, 8*(1), 37–51. (Original work published 1998).
Ellis, A. K., & Stuen, C. J. (1998). *The interdisciplinary curriculum*. Eye On Education.
Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing, 62*(1), 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x
Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K., & Kyngäs, H. (2014). Qualitative content analysis. *SAGE Open, 4*(1). https://doi.org/10.1177/2158244014522633
ElSayary, A. (2024). An introduction to interdisciplinary approach on global issues for educational reform. In A. ElSayary & R. Olowoselu (Eds.), *Interdisciplinary approaches for educators' and learners' well-being* (pp. 3–12). Springer. https://doi.org/10.1007/978-3-031-65215-8_1
Erduran, S., & Dagher, Z. R. (2014). Reconceptualizing the nature of science for science education: Scientific knowledge, practices and other family categories. Springer. https://doi.org/10.1007/978-1-4020-6670-2_1
Espinoza Freire, E. E. (2022). El trabajo colaborativo en la enseñanza-aprendizaje de la geografía – Collaborative classroom work in the teaching-learning process of geography. *Revista Universidad y Sociedad, 14*(2), 101–109. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2218-36202022000200101&lng=es
Espinosa-Gutiérrez, P.-T., Gavari-Starkie, E., Lucini-Baquero, C., & Pastrana-Huguet, J. (2025). STEAM education using natural resources in rural areas: Case study of a grouped rural school in Ávila, Spain. *Sustainability, 17*(6), 2736. https://doi.org/10.3390/su17062736
European Union. (2018). *Council recommendation of 22 May 2018 on key competences for lifelong learning*. Official Journal of the European Union, C 189. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Fadjarajani, S., As'ari, R., & Eka Putri, A. (2024). Model of problem-based learning in geography: Focusing on societal dynamics to enhance spatial thinking skills. *E3S Web of Conferences, 600*, 02011. https://doi.org/10.1051/e3sconf/202460002011
Fernández Álvarez, R., & Fernández, J. (2021). Design and initial validation of a questionnaire on prospective teachers' perceptions of the landscape. *Education Sciences, 11*(3), 112. https://doi.org/10.3390/educsci11030112
Fien, J. (2001). *Education and sustainability: Reorienting Australian schools for a sustainable future*. Australian Conservation Foundation.
Finnish National Agency for Education. (2016). *National core curriculum for basic education 2014*. Next Print Oy.
Finnish National Agency for Education. (2019). *National core curriculum for general upper secondary education*. Punamusta Oy.
Firinci Orman, T. (2024). Exploring youth eco-literacy through lived experiences. *Journal of Environmental Education, 55*(5), 363–377. https://doi.org/10.1080/00958964.2024.2345354
Fisher, C., & Binns, T. (Eds.). (2016). *Issues in geography teaching*. Routledge.
Friman, H., Banner, I., Sitbon, Y., Sahar-Inbar, L., & Shaked, N. (2024). Experiential learning for sustainability: A catalyst for global change. *The Educational Administration: Theory and Practice, 30*(5), 8508–8514. https://doi.org/10.53555/kuey.v30i5.4404
Fu, B. J., & Li, Y. (2016). Bidirectional coupling between the Earth and human systems is essential for modeling sustainability. *National Science Review, 3*(4), 397–398. https://doi.org/10.1093/nsr/nww094
Fu, J., Hutson, B., Thierer, K., Zhang, X., & Taylor, J. (2025). Experiential learning assessment: A dive into the literature. *Intersection: A Journal at the Intersection of Assessment and Learning, 6*(1), 3–20. https://doi.org/10.61669/001c.131785
Fuchs, H., Benkova, E., Fishbein, A., & Fuchs, A. (2024). The importance of psychological and cognitive flexibility in educational processes to prepare and acquire 21st century skills. In S. Kot, B. Khalid, & A. ul Haque (Eds.), *Corporate practices: Policies, methodologies, and insights in organizational management* (pp. 91–114). Springer. https://doi.org/10.1007/978-981-97-0996-0_6
Fögele, J. (2016). *Entwicklung basiskonzeptionellen Verständnisses in geographischen Lehrerfortbildungen: Rekonstruktive Typenbildung | Relationale Prozessanalyse | Responsive Evaluation*. Monsenstein und Vannerdat.
Ghafar, Z. N., Raheem, B. R., & Mahmood, H. M. A. (2023). Teaching and learning through storyboarding: A new approach via critical reflection. *Research Journal of Humanities and Social Sciences, 3*(4), 94–100. https://doi.org/10.36348/merjhss.2023.v03i04.005
Ganguly, R. (2023). Mobile learning for geography education in K–12 curriculum projects. *International Journal of Current Research, 15*(2), 23886–23890. https://doi.org/10.24941/ijcr.44830.02.2023
García de la Vega, A. A. (2022). Proposal for geography competence assessment in geography fieldtrips for sustainable education. *Sustainability, 14*, 1429. https://doi.org/10.3390/su14031429
García-Fortes, M. Á., Banos-González, I., & Esteve-Guirao, P. (2024). ESD action competencies of future teachers: Self-perception and competence profile analysis. *International Journal of Sustainability in Higher Education, 25*(8), 1558–1580. https://doi.org/10.1108/IJSHE-07-2023-0323
Garzón, J., Pavón, J., & Baldiris, S. (2019). Systematic review and meta-analysis of augmented reality in educational settings. *Virtual Reality, 23*(4), 447–459. https://doi.org/10.1007/s10055-019-00379-9
Gericke, N. (2022). Teaching for the Anthropocene: Bildung-oriented education for sustainable development in a subject-specific curriculum. In E. Krogh, A. Qvartrup, & S. T. Graf (Eds.), *Bildung, knowledge, and global challenges in education* (pp. 53–69). Routledge. https://doi.org/10.4324/9781003279365
Gericke, N., Hudson, B., Olin-Scheller, C., & Stolare, M. (2018). Powerful knowledge, transformations and the need for empirical studies across school subjects. *London Review of Education, 16*(3), 428–444. https://doi.org/10.18546/LRE.16.3.06
Gericke, N., Tani, S., Newall, E., & Deng, Z. (2025). A framework for curricular analysis of powerful knowledge: Comparing school biology in England, Finland and Sweden. *Journal of Curriculum Studies, 57*(4), 441–465. https://doi.org/10.1080/00220272.2025.2512323
Ghafar, Z. N. (2023). The teacher-centered and the student-centered: A comparison of two approaches. *International Journal of Arts and Humanities, 1*(1), 18–23. https://doi.org/10.61424/ijah.v1i1.7
Giannakou, O., & Klonari, A. (2019). Digital storytelling in education using WEBGIS. *European Journal of Geography, 10*, 154–172. https://www.eurogeojournal.eu/index.php/egj/article/view/190
Gilissen, M. G. R., Knippels, M.-C. P. J., & van Joolingen, W. R. (2020). Bringing systems thinking into the classroom. *International Journal of Science Education, 42*(8), 1253–1280. https://doi.org/10.1080/09500693.2020.1755741
Goga, M., & Roşu, D. (2021). The integration of new technologies in geography lessons. *Revista Românească pentru Educaţie Multidimensională, 13*(1), 234–246. https://doi.org/10.18662/rrem/13.1/370
Golledge, R., Marsh, M., & Battersby, S. (2008). A conceptual framework for facilitating geospatial thinking. *Annals of the American Association of Geographers, 98*, 285–308. http://www.jstor.org/stable/25515122
Greaves, R., & Vlachopoulos, D. (2022). The use of gamification as a vehicle for pedagogic sharing and teachers' professional development. *Revista Iberoamericana de Educación a Distancia, 26*(1), 245–264. https://doi.org/10.5944/ried.26.1.34026
Green, S., Higgins, J. P. T., Alderson, P., Clarke, M., Mulrow, C. D., & Oxman, A. D. (2011). Introduction. In J. P. T. Higgins & S. Green (Eds.), *Cochrane handbook for systematic reviews of interventions* (Version 5.1.0, pp. 3–9). University of Oxford.
Grindsted, T. S. (2015). The matter of geography in education for sustainable development: The case of Danish university geography. In W. L. Filho (Ed.), *Transformative approaches to sustainable development at universities* (pp. 13–24). Springer. https://doi.org/10.1007/978-3-319-08837-2_2
Grmuša, M., Drobac-Pavićević, M., & Kovačević, B. (2024). Improving the geography curriculum: Analysis of learning outcomes and the possibility of application of powerful knowledge principle. *International Research in Geographical and Environmental Education*, 1–16. https://doi.org/10.1080/10382046.2024.2432475
Gudmundsdottir, S., & Shulman, L. S. (1987). Pedagogical content knowledge in social studies. *Scandinavian Journal of Educational Research, 31*(2), 59–70. https://doi.org/10.1080/0031383870310201

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Gunderson, P. (2024). Exploring the interdisciplinary dimensions of geography: A comprehensive analysis. *Journal of International Social Research, 17*(111), 1–3. https://doi.org/10.17719/jisr.2024.135358

Ha, C., Huang, G., Zhang, J., & Dong, S. (2022). Assessing ecological literacy and its application based on linguistic ecology: A case study of Guiyang City, China. *Environmental Science and Pollution Research, 29*, 18741–18754. https://doi.org/10.1007/s11356-021-16753-7

Hagevik, R. A. (2003). *The effects of online science instruction using geographic information systems to foster inquiry learning of teachers and middle school science students* (Doctoral dissertation, North Carolina State University). https://repository.lib.ncsu.edu/server/api/core/bitstreams/65c6bce0-1b83-4078-b448-eeca640c9dc3/content

Hajek, K. M., Paul, H., & ten Hagen, S. (2024). Objectivity, honesty, and integrity: How American scientists talked about their virtues, 1945–2000. *History of Science, 62*(3), 442–469. https://doi.org/10.1177/00732753231206773

Hamid, J. S. (2023). Utilization of modern methods of teaching geography curriculum in Iraq. *International Journal of Research in Social Sciences and Humanities, 13*(2), 657–667. https://doi.org/10.37648/ijrssh.v13i02.054

Hammond, L., Healy, G., Bladh, G., & Tani, S. (2025). Reflecting on the powers, possibilities and constraints of geography curricula in England, Finland and Sweden. *Journal of Curriculum Studies, 57*(4), 382–401. https://doi.org/10.1080/00220272.2024.2420366

Hamutoğlu, N. B., Savaşçı, M., & Sezen-Gültekin, G. (2019). Digital literacy skills and attitudes towards e-learning. *Journal of Education and Future, 16*, 93–107. https://dergipark.org.tr/en/download/article-file/770802

Hartono, R. (2020). Evaluating sustainable education using eco-literacy. *Habitat, 31*(2), 78–85. https://doi.org/10.21776/ub.habitat.2020.031.2.9

Harwood, D., & Rawlings, K. (2001). Assessing young children's freehand sketch maps of the world. *International Research in Geographical and Environmental Education, 10*(1), 20–45. https://doi.org/10.1080/10382040108667422

Haubrich, H. (2007). Geography education for sustainable development. In S. Reinfried, S. Schleicher, & A. Rempfler (Eds.), *Geographical views on education for sustainable development* (pp. 27–38). HGD.

Hazen, H. D., & Alberts, H. C. (2021). Innovative approaches to teaching in geography. *Geography Teacher, 18*(1), 1–2. https://doi.org/10.1080/19338341.2020.1861549

Hilander, M. (2017). *Kuvatulkinta ja maantieteellinen tarkkaavaisuus* (Doctoral dissertation, University of Helsinki). https://urn.fi/URN:ISBN:978-951-51-3102-7

Hilander, M., & Tani, S. (2026). Maantieteen opetus tutkimuskohteena. In A. Kallioniemi et al. (Eds.), *Suomalainen ainedidaktinen tutkimus: Näkymiä alan kehitykseen ja haasteisiin* (pp. 326–350). https://doi.org/10.23988/sats.1898

Holbrook, J., Rannikmäe, M., & Soobard, R. (2020). STEAM education—A transdisciplinary teaching and learning approach. In B. Akpan & T. J. Kennedy (Eds.), *Science education in theory and practice* (pp. 465–477). Springer. https://doi.org/10.1007/978-3-030-43620-9_31

Holton, M. (2017). "It was amazing to see our projects come to life!" Developing affective learning during geography fieldwork through tropophilia. *Journal of Geography in Higher Education, 41*(2), 1–15. https://doi.org/10.1080/03098265.2017.1290592

Howlett, C., Ferreira, J., & Blomfield, J. (2016). Teaching sustainable development in higher education: Building critical, reflective thinkers through an interdisciplinary approach. *International Journal of Sustainability in Higher Education, 17*(3), 305–321. https://doi.org/10.1108/IJSHE-07-2014-0102

Hudson, B., Gericke, N., Olin-Scheller, C., & Stolare, M. (2023). Trajectories of powerful knowledge and epistemic quality: Analysing transformations across school subjects. *Journal of Curriculum Studies, 55*(2), 119–137. https://doi.org/10.1080/00220272.2023.2182164

Huoponen, A. (2025). *Pathways toward pro-environmental education: Synthesis of three voices from the school context* (Doctoral dissertation, University of Eastern Finland). https://urn.fi/URN:ISBN:978-952-61-5693-4

IGU Commission on Geographical Education. (2016). *International charter on geographical education*. https://www.igu-cge.org/wp-content/uploads/2019/03/IGU_2016_eng_ver25Feb2019.pdf

Jackson, P. (2006). Thinking geographically. *Geography, 91*(3), 199–204. https://doi.org/10.1080/00167487.2006.12094167

Jahnke, I. (2012). Socio-technical learning. In N. M. Seel (Ed.), *Encyclopedia of the sciences of learning* (pp. 3141–3143). Springer.

James, P., & Magee, L. (2016). Domains of sustainability. In A. Farazmand (Ed.), *Global encyclopedia of public administration, public policy, and governance* (pp. 1–17). Springer. https://doi.org/10.1007/978-3-319-31816-5_2760-1

Jantsch, E. (1972). Towards interdisciplinarity and transdisciplinarity in education and innovation. In L. Apostel (Ed.), *Interdisciplinarity: Problems of teaching and research in universities* (pp. 97–121). OECD/CERI.

Jekel, T., Sanchez, E., Gryl, I., Juneau-Sion, C., & Lyon, J. (Eds.). (2014). *Learning and teaching with geomedia*. Cambridge Scholars Publishing.

Jasim, N. I., Gunasekaran, S. S., Al-Sharafi, M. A., Ibrahim, M., Hassan, A., Mahmoud, M. A., & Bakather, A. (2025). Exploring a nexus among green behavior and environmental sustainability: A systematic literature review and avenues for future research. *Resources, Conservation & Recycling Advances, 25*, 200249. https://doi.org/10.1016/j.rcradv.2025.200249

Jeronen, E. (2025). Sustainability. In B. Warf (Ed.), *The encyclopedia of human geography*. Springer. https://doi.org/10.1007/978-3-031-92524-5_309

Jeronen, E., & Jeronen, J. (2026). Bibliometric and content analysis of sustainable education in biology. *Education Sciences, 16*, 201. https://doi.org/10.3390/educsci16020201

Jeronen, J. (2024). Raven—Absorb scientific literature. https://github.com/Technologicat/raven

Jeronen, E., Ahonen, P., & Korkeamäki, R.-L. (2022). Connections of transformative education with Bhutan's pedagogical ideas. *Sustainability, 14*, 163. https://doi.org/10.3390/su14010163

Jeronen, E., Keinonen, T., & Kärkkäinen, S. (2024). Visioning transformative science education for sustainability. *Discourse and Communication for Sustainable Education, 15*(1), 19–38. https://doi.org/10.2478/dcse-2024-0003

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Jickling, B., & Spork, H. (1998). Education for the environment: A critique. *Environmental Education Research, 4*(3), 309–327. https://doi.org/10.1080/1350462980040306
Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher, 38*(5), 365–379. https://doi.org/10.3102/0013189X09339057
Kadhim, A. J., & Cochrane, T. (2025). Exploring the real impact of ICT tools on secondary school students' learning of geography. *Pacific Journal of Technology Enhanced Learning, 7*(1). https://doi.org/10.24135/pjtel.v7i1.202
Kagoda, A. M. (2009). Teaching and learning geography through small group discussions. *Current Research Journal of Social Sciences, 1*(2), 27–32. https://maxwellsci.com/print/crjss/(2)27-32.pdf
Kakungulu, S. J. (2024). The importance of environmental education: Teaching sustainability in the classroom. *Eurasian Experiment Journal of Humanities and Social Sciences, 5*(2), 22–25. https://kiu.ac.ug/assets/publications/2376_the-importance-of-environmental-education-teaching-sustainability-in-the-classroom.pdf
Kampourakis, K. (2022). Reconsidering the goals of evolution education: Defining evolution and evolutionary literacy. *Evolution: Education and Outreach, 15*, 21. https://doi.org/10.1186/s12052-022-00180-4
Kausar, F. M. (2025). Effect of collaborative learning on students' communication skills and reasoning skills. *Social Science Review Archives, 3*(3), 2228–2244. https://doi.org/10.70670/sra.v3i3.1065
Kemmis, S., & Mutton, R. (2012). Education for sustainability (EfS): Practice and practice architectures. *Environmental Education Research, 18*, 187–207. https://doi.org/10.1080/13504622.2011.596929
Kesler, M. (2020). *Opettaja luovan ongelmanratkaisun prosessin ohjaajana* (Doctoral dissertation, University of Helsinki). Yliopistopaino Unigrafia. http://hdl.handle.net/10138/322029
Kesler, M., Havu-Nuutinen, S., & Kärkkäinen, S. (2024). Ongelmanratkaisutaitojen kehittäminen biologian opetuksessa. In A. Uitto, E. Jeronen, & E. Yli-Panula (Eds.), *Biologian opetus ja tiedekasvatus kestävän tulevaisuuden edistäjinä* (pp. 172–201). Suomen ainedidaktisen tutkimusseuran julkaisuja. https://doi.org/10.23988/sats.1066
Kiewra, L., Powell, R. B., Stern, M. J., Hemby, T., & Browning, M. H. (2023). Is naturalness associated with positive learning outcomes during environmental education field trips? *Journal of Environmental Education, 54*(2), 148–162. https://doi.org/10.1080/00958964.2022.2157369
Kim, M., & Bednarz, R. (2013). Development of critical spatial thinking through GIS learning. *Journal of Geography in Higher Education, 37*(3), 350–366. https://doi.org/10.1080/03098265.2013.769091
Kim, M., & Shin, J. (2015). The pedagogical benefits of SimCity in urban geography education. *Journal of Geography, 115*, 1–12. https://doi.org/10.1080/00221341.2015.1061585
King, C., Gorfinkiel, D., & Frick, M. (2021). International comparisons of school-level geoscience education: The UNESCO/IGEO expert opinion survey. *International Journal of Science Education, 43*(1), 56–78. https://doi.org/10.1080/09500693.2020.1854894
Klein, J. T. (2017). Typologies of interdisciplinarity: The boundary work of definition. In R. Frodeman (Ed.), *The Oxford handbook of interdisciplinarity* (2nd ed., pp. 21–34). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198733522.013.3
Kmeť, A., Mázorová, L., Frolo, J., & Šmida, D. (2024). Do Slovak teachers teach outside? An insight into geography and biology teachers' opinions on outdoor education and place-based learning. *Geographia Cassoviensis, 18*(1), 66–77. https://doi.org/10.33542/GC2024-1-04
Knight, S., Buckingham Shum, S., & Littleton, K. (2014). Epistemology, assessment, pedagogy: Where learning meets analytics in the middle space. *Journal of Learning Analytics, 1*(2), 23–47. https://doi.org/10.18608/jla.2014.12.3
Kocalar, A. O., & Demirkaya, H. (2017). Geography teachers' views on effective geography teaching. *Review of International Geographical Education Online, 7*(3), 332–346. https://files.eric.ed.gov/fulltext/EJ1165612.pdf
Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.
Kotsis, K. T. (2024). The significance of experiments in inquiry-based science teaching. *European Journal of Education and Pedagogy, 5*(2), 86–92. http://doi.org/10.24018/ejedu.2024.5.2.815
Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice, 41*(4), 212–218. http://www.jstor.org/stable/1477405
Kubisch, S., Parth, S., Deisenrieder, V., Oberauer, K., Stötter, J., & Keller, L. (2021). From transdisciplinary research to transdisciplinary education—the role of schools in contributing to community well-being and sustainable development. *Sustainability, 13*(1), 306. https://doi.org/10.3390/su13010306
Kumar, V., & Kumar Choudhary, S. (2025). Reimagining scientific literacy: A textbook framework for future-focused science education. *Research in Science Education, 55*, 1109–1127. https://doi.org/10.1007/s11165-025-10269-7
Laato, S., Pietarinen, T., Rauti, S., & Sutinen, E. (2020). Potential benefits of playing location-based games: An analysis of game mechanics. In H. C. Lane, S. Zvacek, & J. Uhomoibhi (Eds.), *Computer supported education. CSEDU 2019. Communications in Computer and Information Science* (Vol. 1220). Springer. https://doi.org/10.1007/978-3-030-58459-7_27
Lambert, D. (1996). Issues in assessment. In P. Bailey & P. Fox (Eds.), *Geography teacher's handbook* (pp. 187–201). Geographical Association.
Lambert, D. (2011). The lie of the land (revisited). *Teaching Geography, 36*(1), 24–25. https://www.jstor.org/stable/23756956
Lambert, D. (2016). Geography. In D. Wyse, L. Hayward, & J. Pandya (Eds.), *The handbook of curriculum, pedagogy and assessment* (pp. 391–407). SAGE.
Lambert, D., Solem, M., & Tani, S. (2015). Achieving human potential through geography education: A capabilities approach to curriculum making in schools. *Annals of the Association of American Geographers, 105*(4), 723–735. https://doi.org/10.1080/00045608.2015.1022128

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Lan, D., Dalyot, S., & Baram-Tsabari, A. (2024). Expressions of geographic literacy in the context of the COVID-19 pandemic: The role of geographic education among adults. *Journal of Geoscience Education, 72*(4), 472–484. https://doi.org/10.1080/10899995.2023.2289092

Landøy, A., Popa, D., & Repanovici, A. (2020). Teaching learning methods. In A. Landøy, D. Popa, & A. Repanovici (Eds.), *Collaboration in designing a pedagogical approach in information literacy* (pp. 137–161). Springer. https://doi.org/10.1007/978-3-030-34258-6_10

Lane, R., & Bourke, T. (2017). Assessment in geography education: A systematic review. *International Research in Geographical and Environmental Education, 28*(1), 22–36. https://doi.org/10.1080/10382046.2017.1385348

Lankenau, G. R. (2018). Fostering connectedness to nature in higher education. *Environmental Education Research, 24*(2), 230–244. https://doi.org/10.1080/13504622.2016.1225674

Laupichler, M. C., Aster, A., Schirch, J., & Raupach, T. (2022). Artificial intelligence literacy in higher and adult education: A scoping literature review. *Computers and Education: Artificial Intelligence, 3*, 100101. https://doi.org/10.1016/j.caeai.2022.100101

Lawrence, J., Morrell, L. J., & Scott, G. W. (2023). Building a competence-based model for the academic development of programme leaders. *International Journal for Academic Development, 29*(3), 379–392. https://doi.org/10.1080/1360144X.2023.2166942

Leal Filho, W., Viera Trevisan, L., Sivapalan, S., Mazhar, M., Kounani, A., Mbah, M. F., Abubakar, I. R., Matandirotya, N. R., Pimenta Dinis, M. A., Borsari, B., & Abzug, R. (2025). Assessing the impacts of sustainability teaching at higher education institutions. *Discover Sustainability, 6*(1), 227. https://doi.org/10.1007/s43621-025-01024-z

Lewinsohn, T. M., Attayde, J. L., Fonseca, C. R., Ganade, G., Jorge, L. R., Kollmann, J., Overbeck, G. E., Prado, P. I., Pillar, V. D., Popp, D., da Rocha, P. L., Silva, W. R., Spiekermann, A., & Weisser, W. W. (2015). Ecological literacy and beyond: Problem-based learning for future professionals. *Ambio, 44*(2), 154–162. https://doi.org/10.1007/s13280-014-0539-2

Li, M., Ma, S., & Shi, Y. (2023). Examining the effectiveness of gamification as a tool promoting teaching and learning in educational settings: A meta-analysis. *Frontiers in Psychology, 14*, 1253549. https://doi.org/10.3389/fpsyg.2023.1253549

Liefländer, A. K., & Bogner, F. X. (2018). Educational impact on the relationship of environmental knowledge and attitudes. *Environmental Education Research, 24*(4), 611–624. https://doi.org/10.1080/13504622.2016.1188265

Liefländer, A. K., Fröhlich, G., Bogner, F. X., & Schultz, P. W. (2013). Promoting connectedness with nature through environmental education. *Environmental Education Research, 19*(3), 370–384. https://doi.org/10.1080/13504622.2012.697545

Lindström, N. (2024). Controversial issues in social studies subjects: Conveying values and facilitating critical thinking. *Ethics and Education, 19*(4), 593–611. https://doi.org/10.1080/17449642.2024.2418764

Liodaki, D., Rekhviashvili, L., Lang, T., & Apostolopoulou, E. (2024). Theorizing multiple geographies: Interrelations of space and multiplicity in geographical research. *Geography Compass, 18*, e12766. https://doi.org/10.1111/gec3.12766

Lisberg Jensen, E. (2025). "The name of things": Lexical ecological literacy as Bildung in environmental and sustainability education. *The Journal of Environmental Education*, 1–14. https://doi.org/10.1080/00958964.2025.2541885

Lisowski, A. (2012). Geography and social sciences in transdisciplinary science. *Miscellanea Geographica, 15*, 9–40. https://doi.org/10.2478/v10288-012-0001-x

Liu, Y., & Pásztor, A. (2022). Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis. *Thinking Skills and Creativity, 45*, 101069. https://doi.org/10.1016/j.tsc.2022.101069

Lotz-Sisitka, H. (2024). Towards a politics of transgression in environmental education research: Meta-review of a T-learning research archive. *Australian Journal of Environmental Education, 40*(3), 549–573. https://doi.org/10.1017/aee.2024.62

Lovren, V. O., & Jablanovic, M. M. (2023). Bridging the gap: The affective dimension of learning outcomes in environmental primary and secondary education. *Sustainability, 15*(8), 6370. https://doi.org/10.3390/su15086370

Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017). Connecting competences and pedagogical approaches for sustainable development in higher education: A literature review and framework proposal. *Sustainability, 9*, 1889. https://doi.org/10.3390/su9101889

Lynch, R., McCormack, O., & Hennessy, J. (2025). Exploring teachers' and students' views and experiences of field trips. *Journal of Adventure Education and Outdoor Learning*, 1–19. https://doi.org/10.1080/14729679.2025.2530091

Lyon, E. G. (2013). Learning to assess science in linguistically diverse classrooms: Tracking growth in secondary science preservice teachers' assessment expertise. *Science Education, 97*, 442–467. https://doi.org/10.1002/sce.21059

Macrine, S. L., & Fugate, J. M. B. (2021). Translating embodied cognition for embodied learning in the classroom. *Frontiers in Education, 6*, 712626. https://doi.org/10.3389/feduc.2021.712626

Maddrell, A. M. C. (1994). A scheme for the effective use of role plays for an emancipatory geography. *Journal of Geography in Higher Education, 18*(2), 155–162. https://doi.org/10.1080/03098269408709251

Massey, D. (2014). Taking on the world. *Geography, 99*(1), 36–39. https://doi.org/10.1080/00167487.2014.12094389

Maude, A. (2017). Geography and powerful knowledge: A contribution to the debate. *International Research in Geographical and Environmental Education, 27*(2), 179–190. https://doi.org/10.1080/10382046.2017.1320899

McKeown, R., & Hopkins, C. (2007). Moving beyond the EE and ESD disciplinary debate in formal education. *Journal of Education for Sustainable Development, 1*(1), 17–26. https://doi.org/10.1177/097340820700100107

Meadows, M. E. (2020). Geography education for sustainable development. *Geography Education for Sustainable Development, 1*, 88–92. https://doi.org/10.1016/j.geosus.2020.02.001

Mensah, B., Poku, A. A., & Quashigah, A. Y. (2022). Technology integration into the teaching and learning of geography in senior high schools in Ghana: A TPACK assessment. *Social Education Research, 3*(1), 80–90. https://doi.org/10.37256/ser.3120221218

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education, 70*, 29–40. https://doi.org/10.1016/j.compedu.2013.07.033

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Miles, H. J. (2023). Practising difference across geography: A transdisciplinary and Deleuzian approach to intradisciplinary thinking. *Environment and Planning, 2*(4), 495–514. https://doi.org/10.1177/26349825231200607
Mishra, R. K. (2015). Mapping the knowledge topography: A critical appraisal of geography textbook questions. *International Research in Geographical and Environmental Education, 24*(2), 118–130. https://doi.org/10.1080/10382046.2014.993170
Molthan-Hill, P., Blaj-Ward, L., Mbah, M. F., & Ledley, T. S. (2022). Climate change education at universities: Relevance and strategies for every discipline. In M. Lackner, B. Sajjadi, & W. Y. Chen (Eds.), *Handbook of climate change mitigation and adaptation* (pp. 3395–3457). Springer.
Mondal, A. (2024). Promoting interdisciplinary learning in geography education. *International Journal of Novel Research and Development, 9*(6), 808–812. https://ijnrd.org/papers/IJNRD2306653.pdf
Montani, I., Honnibal, M., Boyd, A., Van Landeghem, S., & Peters, H. (2023). spaCy: Industrial-strength natural language processing in Python. https://doi.org/10.5281/zenodo.1212303
Morris, R., Perry, T., & Wardle, L. (2021). Formative assessment and feedback for learning in higher education: A systematic review. *Review of Education, 9*, e3292. https://doi.org/10.1002/rev3.3292
Msengi, C., & Growe, L. (2025). Fostering global awareness through university, school, and community partnerships. *International Research and Review: Journal of Phi Beta Delta Honor Society for International Scholars, 14*(2). https://files.eric.ed.gov/fulltext/EJ1484769.pdf
Muller, J., & Young, M. (2019). Knowledge, power and powerful knowledge revisited. *The Curriculum Journal, 30*(2), 196–214. https://doi.org/10.1080/09585176.2019.1570292
Mulvik, I., Pribuišis, K., Siarova, H., Vežikauskaitė, J., Sabaliauskas, E., Tasiopoulou, E., Gras-Velazquez, A., Bajorinaitė, M., Billon, N., Fronza, V., Disterheft, A., & Finlayson, A. (2021). *Education for environmental sustainability: Policies and approaches in European Union Member States*. Publications Office of the European Union. https://doi.org/10.2766/391
Munowenyu, E. (2007). Assessing the quality of essays using the SOLO taxonomy: Effects of field and classroom-based experiences by 'A' level geography students. *International Research in Geographical & Environmental Education, 16*(1), 21–43. https://doi.org/10.2167/irg204.0
Murti, W., Rohman, F., Sari, M. S., & Ibrohim. (2025). Ecoliteracy competencies: A systematic literature review of domains, approaches, and impacts in education. *EURASIA Journal of Mathematics, Science and Technology Education, 21*(8), em2677. https://doi.org/10.29333/ejmste/16658
Muukkonen, H., & Kajamaa, A. (2024). Knowledge objects and knowledge practices in interdisciplinary learning: Example of an organization simulation in higher education. *Journal of the Learning Sciences, 33*(2), 365–404. https://doi.org/10.1080/10508406.2024.2344794
Mwaluko, F. Z., Kemboi, M. J., & Tarmo, A. P. (2023). Integration of information and communication technology in instruction of geography: A study of public secondary schools in Manyoni District, Tanzania. *The Educator: A Journal of the School of Education, Moi University, 3*(1), 65–80. https://journals.mu.ac.ke/index.php/edj/article/view/109
Naeem, S., Chazdon, R., Duffy, J. E., Prager, C., & Worm, B. (2016). Biodiversity and human well-being: An essential link for sustainable development. *Proceedings of the Royal Society B, 283*, 20162091. https://doi.org/10.1098/rspb.2016.2091
Nagel, P. (2008). Geography: The essential skill for the 21st century. *Social Education, 72*(7), 354–358. https://www.socialstudies.org/system/files/publications/articles/se_7207354.pdf
Nazir, J., & Pedretti, E. (2016). Educators' perceptions of bringing students to environmental consciousness through engaging outdoor experiences. *Environmental Education Research, 22*(2), 288–304. https://doi.org/10.1080/13504622.2014.996208
Nilsson Dahlström, Å. (2025). Challenges and opportunities for social sustainability in education: A scoping review. *Cogent Social Sciences, 11*(1), 2491706. https://doi.org/10.1080/23311886.2025.2491706
Nkuna, W. R., & Mawela, A. S. (2025). Challenges faced by grade 12 geography teachers in implementing geomorphology fieldwork in Tshwane districts. *International Journal of Learning, Teaching and Educational Research, 24*(5), 136–154. https://doi.org/10.26803/ijlter.24.5.7
Novak, J. D. (2010). *Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations*. Routledge.
Obi, J. N., & Ojo, E. (2026). Mainstreaming climate change in school curricula: Critical review of pedagogy, policy and Global South perspectives. *Cogent Education, 13*(1), 2613489. https://doi.org/10.1080/2331186X.2026.2613489
Odell, V., Molthan-Hill, P., Martin, S., & Sterling, S. (2019). Transformative education to address all sustainable development goals. In W. Leal Filho, A. Azul, L. Brandli, P. Özuyar, & T. Wall (Eds.), *Quality education* (pp. 1–12). Springer. https://doi.org/10.1007/978-3-319-69902-8_106-1
OECD. (2017). *PISA 2015 assessment and analytical framework: Science, reading, mathematics, financial literacy and collaborative problem solving (Rev. ed.)*. OECD Publishing. https://doi.org/10.1787/9789264281820-en
OECD. (2019). *PISA 2018 assessment and analytical framework*. OECD Publishing. https://doi.org/10.1787/b25efab8-en
OECD. (2023). *PISA 2025 science framework (draft)*. https://pisa-framework.oecd.org/science-2025/assets/docs/PISA_2025_Science_Framework.pdf
Olsson, D., Gericke, N., & Boeve-de Pauw, J. (2022). The effectiveness of education for sustainable development revisited: A longitudinal study on secondary students' action competence for sustainability. *Environmental Education Research, 28*(3), 405–429. https://doi.org/10.1080/13504622.2022.2033170
Ongek, M., Ajowi, J., & Otienoh, R. (2025). Influence of use of discussion teaching strategy on learning and performance of learners in geography in public secondary schools in Nyakach Sub-County, Kenya. *GAS Journal of Arts Humanities and Social Sciences, 3*(5), 32–38. https://doi.org/10.5281/zenodo.16417098
Oraby, G. A. E. M. (2026). The role of geography education in achieving education for sustainable development. *Journal of Geographical Sciences and Education, 4*(1), 72–84. https://doi.org/10.69606/geography.v4i1.443
Orion, N., & Libarkin, J. C. (2023). *Earth science education*. Routledge. https://doi.org/10.4324/9780367855758-26

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Osborne, J., Rafanelli, S., & Kind, P. (2018). Toward a more coherent model for science education than the crosscutting concepts of the Next Generation Science Standards: The affordances of styles of reasoning. *Journal of Research in Science Teaching, 55*(7), 962–981. https://doi.org/10.1002/tea.21460

Ottander, K., & Simon, S. (2021). Learning democratic participation? Meaning-making in discussion of socioscientific issues in science education. *International Journal of Science Education, 43*(12), 1895–1925. https://doi.org/10.1080/09500693.2021.1946200

Ouariachi, T., Li, C.-Y., & Elving, W. J. L. (2020). Gamification approaches for education and engagement on pro-environmental behaviors: Searching for best practices. *Sustainability, 12*(11), 4565. https://doi.org/10.3390/su12114565

Painho, M., Santos, M. Y., & Pundt, H. (2010). *Geospatial thinking*. Springer. https://doi.org/10.1007/978-3-642-12326-9

Panjaitan, B. R., Ningrum, E., & Waluya, B. (2023). Digital learning tools in geography education: A systematic literature review. *Eurasia Proceedings of Educational & Social Sciences, 33*, 135–143. https://doi.org/10.55549/epess.1413355

Parker, R., & Thomsen, B. S. (2019). Learning through play at school: A study of playful integrated pedagogies that foster children's holistic skills development in the primary school classroom. *Student Learning Processes*. https://research.acer.edu.au/learning_processes/22/

Passon, J., & Schlesinger, J. (2019). Inquiry-based learning in geography. In H. A. Mieg (Ed.), *Inquiry-based learning – Undergraduate research, the German multidisciplinary experience* (pp. 281–290). Springer. https://doi.org/10.1007/978-3-030-14223-0_26

Patashnik, O., & Lamport, L. (1985). *BibTeX: A program for formatting bibliographies*. https://www.ctan.org/pkg/bibtex

Pauw, I. (2015). Educating for the future: The position of school geography. *International Research in Geographical and Environmental Education, 24*(4), 307–324. https://doi.org/10.1080/10382046.2015.1086103

Persano Adorno, D., Birsan, E. A., Stoica, S. F., Capatina, M., Cojocaru, C., Tzortzaki, A., Štanfelj, Z., Dinçer, Y. S., & Pizzolato, N. (2025). Sustainability as a cross-curricular link: Creative European strategies for eco-conscious environmental education. *Sustainability, 17*, 5193. https://doi.org/10.3390/su17115193

Polo-Martín, B. (2026). StoryMapping as a geotechnological tool to explain urban landscape change: A case study from Madrid. *Urban Science, 10*, 272. https://doi.org/10.3390/urbansci10050272

Potter, N. N. (2022). The virtue of epistemic humility. *Philosophy, Psychiatry, & Psychology, 29*(2), 121–123. https://doi.org/10.1353/ppp.2022.0022

Prabakaran, M. (2020). Historical appropriation of epistemological values: A goal ahead for higher education. *Higher Education for the Future, 7*(1), 67–81. https://doi.org/10.1177/23476311198864

Prasetya, S. P., Prasetyo, K., Budiyanto, E., Rindawati, Murtini, S., Fadirubun, F. F., & Dock, C. (2024). Development of virtual geography laboratory to improve cognitive learning outcomes and spatial capabilities in social sciences education. *International Journal of Social Learning, 4*(3), 369–386. https://doi.org/10.47134/ijsl.v4i3.285

Prince, M. J., & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons and research basis. *Journal of Engineering Education, 95*, 123–138. https://doi.org/10.1002/j.2168-9830.2006.tb00884.x

Rakuasa, H., & Latue, P. C. (2024). Role of geography education in raising environmental awareness: A literature review. *Journal of Education Method and Learning Strategy, 2*(01), 1–7. https://doi.org/10.59653/jemls.v2i01.293

Renshaw, S. (2011). Creative thinking and geographical investigation. *Teaching Geography, 36*(2), 64–66. https://portal.geography.org.uk/downloads/journals/TG_SUM_2011_RENSHAW.pdf

Resnik, D. B. (2018). *The ethics of research with human subjects: Protecting people, advancing science, promoting trust*. Springer.

Ribeiro, V., Monteiro, I., & Quinta e Costa, M. (2016). Geography, history and natural sciences: An interdisciplinary teaching approach with GIS. In *EDULEARN16 Proceedings* (pp. 1–8). https://doi.org/10.21125/edulearn.2016.1729

Roberts, D. A. (2007). Scientific literacy/science literacy. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 729–780). Lawrence Erlbaum Associates.

Roberts, D. A., & Bybee, R. W. (2014). Scientific literacy, science literacy, and science education. In N. G. Lederman & S. K. Abell (Eds.), *Handbook of research on science education* (Vol. 2, pp. 545–558). Routledge.

Roberts, M. (2023). *Learning through enquiry* (2nd ed.). The Geographical Association.

Robinson, Z. (2011). Teaching climate change in higher education: Barriers and opportunities. In S. Haslett, D. France, & S. Gedye (Eds.), *Pedagogy of climate change: An introduction* (pp. 36–50). Higher Education Academy.

Robinson, G. M., Hardman, M., & Matley, R. J. (2021). Using games in geographical and planning-related teaching: Serious games, edutainment, board games and role-play. *Social Sciences & Humanities Open, 4*(1), 100208. https://doi.org/10.1016/j.ssaho.2021.100208

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., … Foley, J. A. (2009). A safe operating space for humanity. *Nature, 461*, 472–475. https://doi.org/10.1038/461472a

Rockström, J., & Sukhdev, P. (2016). The SDGs wedding cake. Stockholm Resilience Centre. https://www.stockholmresilience.org/research/research-news/2016-06-14-how-food-connects-all-the-sdgs.html

Rodgers, C. (2002). Defining reflection: Another look at John Dewey and reflective thinking. *Teachers College Record, 104*, 842–866. https://doi.org/10.1111/1467-9620.00181

Rodriguez, M. C., & Albano, A. D. (2017). *The college instructor's guide to writing test items: Measuring student learning*. Routledge.

Saal, F. E., Downey, R. G., & Lahey, M. A. (1980). Rating the ratings: Assessing the psychometric quality of rating data. *Psychological Bulletin, 88*(2), 413–428. https://doi.org/10.1037/0033-2909.88.2.413

Saar, M., & Palang, H. (2009). The dimensions of place meanings. *Living Reviews in Landscape Research, 3*(3), 1–24. http://www.livingreviews.org/lrlr-2009-3

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Sabornido, E. B., Niepes, G. L., & Cabria, F. M. N. (2022). Key challenges and barriers in gamification: A systematic review. *Asia Pacific Journal of Advanced Education and Technology, 1*(1), 13–19.
Safitri, S., Juhadi, J., & Aji, A. (2024). Ecoliteracy learning design with augmented reality-based SETS approach for flood disaster education. *International Journal of Recent Educational Research, 5*(3), 779–795. https://doi.org/10.46245/ijorer.v5i3.610
Said, M. Z., Ahmad, M. Z., & Shaari. (2021). Pedagogy for sustainable development among geography teachers towards implementing sustainable development goals (SDGs). *Jurnal Pendidikan Geosfer, 6*(2), 134–142. https://doi.org/10.24815/jpg.v6i2.23651
Saira, Z. N., & Hafeez, M. (2021). A critical review on discussion and traditional teaching methods. *Psychology and Education, 58*(1), 1871–1886. https://doi.org/10.17762/pae.v58i1.1042
Sánchez-García, R., & Reyes-de-Cózar, S. (2025). Enhancing project-based learning: A framework for optimizing structural design and implementation—A systematic review with a sustainable focus. *Sustainability, 17*(11), 4978. https://doi.org/10.3390/su17114978
Santos, A. V., da Silva, R. S., de Souza, A. C., Vaz Rocha, E. A., da Costa Santos, L., Araújo, J. E., de Paula, M. S., Silva Pereira, N. A., & de Sousa-Baracho, I. P. (2025). Didactics and environmental education: Pedagogical workshops as a strategy for sustainability-oriented learning. *Revista Caderno Pedagógico, 22*(9), e18184. https://doi.org/10.54033/cadpedv22n9-196
Šašinka, Č., Stachoň, Z., Sedlák, M., Chmelík, J., Herman, L., Kubíček, P., Šašinková, A., Doležal, M., Tejkl, H., Urbánek, T., Svatoňová, H., Ugwitz, P., & Juřík, V. (2019). Collaborative immersive virtual environments for education in geography. *ISPRS International Journal of Geo-Information, 8*(3), 1–25. https://doi.org/10.3390/ijgi8010003
Sass, W., Boeve-de Pauw, J., Olsson, D., Gericke, N., De Maeyer, S., & Van Petegem, P. (2020). Redefining action competence: The case of sustainable development. *The Journal of Environmental Education, 51*(4), 292–305. https://doi.org/10.1080/00958964.2020.1765132
Savage, E., Tapics, T., Evarts, J., Wilson, J., & Tirone, S. (2015). Experiential learning for sustainability leadership in higher education. *International Journal of Sustainability in Higher Education, 16*(5), 692–705. https://doi.org/10.1108/IJSHE-10-2013-0132
Sawyer, J., & Obeid, R. (2017). Cooperative and collaborative learning: Getting the best of both worlds. In R. Obeid, A. Schwartz, C. Shane-Simpson, & P. J. Brooks (Eds.), *How we teach now: The GSTA guide to student-centered teaching* (pp. 163–177). Society for the Teaching of Psychology.
Schellekens, L. H., Bok, H. G. J., de Jong, L. H., van der Schaaf, M. F., Kremer, W. D. J., & van der Vleuten, C. P. M. (2021). A scoping review on the notions of assessment as learning (AaL), assessment for learning (AfL), and assessment of learning (AoL). *Studies in Educational Evaluation, 71*, 101094. https://doi.org/10.1016/j.stueduc.2021.101094
Schmäing, T., & Grotjohann, N. (2021). Students' word associations with different terms related to the Wadden Sea: Does the place of residence (coast or inland) have an influence? *Education Sciences, 11*, 284. https://doi.org/10.3390/educsci11060284
Scholten, N., Bienert, N., & Mehren, R. (2025). How can scientific literacy be enhanced in geography education? Two ways forward: Geoboxes and digital experiments. In D. Piróg & A. Świętek (Eds.), *Future-ready geography: Key challenges in geography* (pp. 85–100). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-81268-2_5
Schön, D. (1992). *The reflective practitioner*. Routledge. https://doi.org/10.4324/9781315237473
Scoffham, S. (2013). Geography and creativity: Developing joyful and imaginative learners. *Education, 41*(4), 368–381. https://doi.org/10.1080/03004279.2013.819625
Semetsky, I. R. (2003a). The problematics of human subjectivity: Gilles Deleuze and the Deweyan legacy. *Studies in Philosophy and Education, 22*, 211–225. https://doi.org/10.1023/A:1022877506539
Semetsky, I. R. (2003b). Deleuze's new image of thought, or Dewey revisited. *Educational Philosophy and Theory, 35*(1), 17–29. https://doi.org/10.1111/1469-5812.00003
Semken, S., Geraghty Ward, E., Moosavi, S., & Chinn, P. W. U. (2017). Place-based education in geoscience: Theory, research, practice, and assessment. *Journal of Geoscience Education, 65*(4), 542–562. https://doi.org/10.5408/17-276.1
Sharma, A., Kapoor, D. S., Thakur, K., & Singh, K. J. (2023). Promoting deeper, meaningful learning in the contemporary educational landscape. In C. F. Calhoun (Ed.), *The impact and importance of instructional design in the educational landscape* (pp. 112–152). IGI Global. https://doi.org/10.4018/978-1-6684-8208-7.ch005
Sharma, D. (2021). Understanding processes and strategies for integrating sustainable development in curriculum. In E. Sengupta, P. Blessinger, & M. Makhanya (Eds.), *Humanizing higher education through innovative approaches for teaching and learning* (Vol. 35). Springer. https://doi.org/10.1108/S2055-364120200000035005
Shea, D. L., Lubinski, D., & Benbow, C. P. (2001). Importance of assessing spatial ability in intellectually talented young adolescents: A 20-year longitudinal study. *Journal of Educational Psychology, 93*(3), 604–614. https://doi.org/10.1037/0022-0663.93.3.604
Shen, Y., Wang, Z., Li, M., Yuan, J., & Gu, Y. (2022). An empirical study of geography learning on students' emotions and motivation in immersive virtual reality. *Frontiers in Education, 7*, 831619. https://doi.org/10.3389/feduc.2022.831619
Shephard, K. (2022). On the educational difference between being able and being willing. In P. Vare, N. Lausselet, & M. Rieckmann (Eds.), *Competences in education for sustainable development* (pp. 45–52). Springer. https://doi.org/10.1007/978-3-030-91055-6_6
Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14. https://doi.org/10.3102/0013189X015002004
Shrivastava, P., Stafford Smith, M., O'Brien, K., & Zsolnai, L. (2020). Transforming sustainability science to generate positive social and environmental change globally. *One Earth, 2*(4), 329–340. https://doi.org/10.1016/j.oneear.2020.04.010
Siarova, H., Sternadel, D., & Szőnyi, E. (2019). *Research for CULT committee: Science and scientific literacy as an educational challenge*. European Parliamentary Research Service. https://policycommons.net/artifacts/1335164/research-for-cult-committee/1941452/

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Silfver, M., Helkama, K., Lönnqvist, J.-E., & Verkasalo, M. (2008). The relation between value priorities and proneness to guilt, shame and empathy. *Motivation and Emotion, 32*(2), 69–80. https://doi.org/10.1007/s11031-008-9084-2

Simon, G. L., & Graybill, J. K. (2010). Geography in interdisciplinarity: Towards a third conversation. *Geoforum, 41*, 356–363. https://doi.org/10.1016/j.geoforum.2009.11.012

Simonyi, S. R., & Homoki, E. (2020). Comparative analysis of the methods of teaching geography in different types of schools. *Journal of Applied Technical and Educational Sciences, 10*(3), 104–114. https://doi.org/10.24368/jates.v10i3.187

Singh, Y., & Suri, P. K. (2022). An empirical analysis of mobile learning app usage experience. *Technology in Society, 68*, 101929. https://doi.org/10.1016/j.techsoc.2022.101929

Sipos, Y., Battisti, B., & Grimm, K. (2008). Achieving transformative sustainability learning: Engaging heads, hands and heart. *International Journal of Sustainability in Higher Education, 9*(1), 68–86. https://doi.org/10.1108/14676370810842193

Sırakaya, M., & Alsancak Sırakaya, D. (2022). Augmented reality in STEM education: A systematic review. *Interactive Learning Environments, 30*(8), 1556–1569. https://doi.org/10.1080/10494820.2020.1722713

Sjöström, J., & Eilks, I. (2018). Reconsidering different visions of scientific literacy and science education based on the concept of bildung. In Y. J. Dori, Z. R. Mevarech, & D. R. Baker (Eds.), *Cognition, metacognition, and culture in STEM education* (pp. 65–88). Springer. https://doi.org/10.1007/978-3-319-66659-4_4

Sjöström, J., Economou, C., Edström, A.-M., Ekberg, J.-E., Svensson Källberg, P., Larneby, M., Liljefors Persson, B., Ryan, U., Schubert, P., Wangen, B., & Örbring, D. (2024). Knowledge contributions from different school subjects to cross-curricular didactics for bildung and sustainability. In C. Hilli & N. Mård (Eds.), *Crossing over subject boundaries towards new horizons: Recent trends in research on cross-curricular teaching from the NOFA 9 Conference* (pp. 66–91). Ainedidaktisia tutkimuksia, 25. https://doi.org/10.23988/sats.1009

Slavin, R. E., Hurley, E. A., & Chamberlain, A. M. (2022). Cooperative learning and achievement: Theory and research. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, & G. M. Sinatra (Eds.), *APA educational psychology handbook* (Vol. 1, pp. 253–275). American Psychological Association.

Soini, K., & Birkeland, I. (2014). Exploring the scientific discourse on cultural sustainability. *Geoforum, 51*, 213–223. https://doi.org/10.1016/j.geoforum.2013.12.001

Song, H., & Cai, L. (2024). Interactive learning environment as a source of critical thinking skills for college students. *BMC Medical Education, 24*, 270. https://doi.org/10.1186/s12909-024-05247-y

Sourgiadaki, M., & Karkalakos, S. (2023). "GreenComp" as a tool for examining motivation of vocational teachers to create learning opportunities for the green transition. *SN Social Sciences, 3*, 114. https://doi.org/10.1007/s43545-023-00699-3

Spaiser, V., Ranganathan, S., Bali Swain, R., & Sumpter, D. (2016). The sustainable development oxymoron: Quantifying and modelling the incompatibility of sustainable development goals. *International Journal of Sustainable Development & World Ecology, 24*(6), 457–470. https://doi.org/10.1080/13504509.2016.1235624

Sposab, K., & Rieckmann, M. (2024). Development of sustainability competencies in secondary school education: A scoping literature review. *Sustainability, 16*(23), 10228. https://doi.org/10.3390/su162310228

Springer, L., Stanne, M. E., & Donovan, S. S. (2022). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of Educational Research, 69*(1), 21–51. https://doi.org/10.3102/00346543069001021

Stanny, C. (2016). Reevaluating Bloom's taxonomy: What measurable verbs can and cannot say about student learning. *Education Sciences, 6*(4), 37. https://doi.org/10.3390/educsci6040037

Steingrübl, S., & Budke, A. (2022). Writing in geography lessons—An unreflected routine? *Education Sciences, 12*, 587. https://doi.org/10.3390/educsci12090587

Sterling, S. (2001). *Sustainable education: Re-visioning learning and change*. Schumacher Society/Green Books.

Sterling, S. (2004). An analysis of the development of sustainability education internationally: Evolution, interpretation and transformative potential. In C. Cullingford & J. Blewitt (Eds.), *The sustainability curriculum: The challenge for higher education* (pp. 43–62). Routledge.

Sterling, S. (2008). Sustainable education – Towards a deep learning response to unsustainability. *Policy & Practice: A Development Education Review, 6*, 63–68.

Sterling, S., Dawson, J., & Warwick, P. (2018). Transforming sustainability education at the creative edge of the mainstream: A case study of Schumacher College. *Journal of Transformative Education, 16*(4), 323–343. https://doi.org/10.1177/1541344618784375

Stevens, S. Y., Shin, N., & Peek-Brown, D. (2013). Learning progressions as a guide for developing meaningful science learning: A new framework for old ideas. *Educación Química, 24*(4), 381–390. https://doi.org/10.1016/S0187-893X(13)72491-1

Strobel, J., & van Barneveld, A. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdisciplinary Journal of Problem-Based Learning, 3*(1), 44–58. https://doi.org/10.7771/1541-5015.1046

Sumleth, E., & Walpuski, M. (2012). Experimental learning environments. In N. M. Seel (Ed.), *Encyclopedia of the sciences of learning* (pp. 1229–1233). Springer.

Suwarno, Sholeh, M., Kurniawan, E., & Benardi, A. I. (2026). Enhancing students' critical thinking and ecoliteracy through geo-outdoor contextual problem-based learning. *Innovations in Pedagogy and Technology, 2*(2), 59–75. https://doi.org/10.63385/ipt.v2i2.331

Swain, R. B. (2018). A critical analysis of the sustainable development goals. In W. Leal Filho (Ed.), *Handbook of sustainability science and research* (pp. 341–355). Springer. https://doi.org/10.1007/978-3-319-63007-6_20

Swift, D., & Rawlings Smith, E. (2025). Leading professional learning for sustainability in geography education through curriculum design. *Journal of Professional Capital and Community, 10*(1), 35–47. https://doi.org/10.1108/JPCC-12-2023-0092

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Szczytko, R., Carrier, S. J., & Stevenson, K. T. (2018). Impacts of outdoor environmental education on teacher reports of attention, behavior, and learning outcomes for students with emotional, cognitive, and behavioral disabilities. *Frontiers in Education, 3*, 46. https://doi.org/10.3389/feduc.2018.00046

Södervik, I., Tuononen, T., Ratvio, R., Laisi, T., & Pietikäinen, J. (2026). Educating agents of change: Investigating curricula to foster sustainability competencies in university. *The Curriculum Journal*. Advance online publication. https://doi.org/10.1002/curj.70050

Tal, T., Levin-Peled, R., & Levy, K. S. (2019). Teacher views on inquiry-based learning: The contribution of diverse experiences in the outdoor environment. *Frontiers in Education, 3*, 46.

Tani, S. (2017a). Geography and sustainability education in Finnish schools. In Y. Ida (Ed.), *ESD in Geography, History, Civics and Social Studies* (pp. 248–258). Kokoin Shoin Publishers.

Tani, S. (2017b). Maantieteen opetuksen haasteita: Digitalisaatio, opetuksen eheyttäminen ja opettajan roolin murros. *Terra*, *129*(4), 211–222. https://terra.journal.fi/article/view/107192/62680

Tani, S., Cantell, H., & Hilander, M. (2018). Powerful disciplinary knowledge and the status of geography in Finnish upper secondary schools: Teachers' views on recent changes. *Journal of Research and Didactics in Geography, 7*(1), 5–16. https://doi.org/10.4458/0623-01

Tani, S., Cantell, H., Hilander, M., & Jutila, H. (2023). *Maantiede – maailmantiede: Ympäristö ja ihminen vuorovaikutuksessa*. Gaudeamus.

Taylor, N., Quinn, F., Jenkins, K., Miller-Brown, H., Rizk, N., Prodromou, D., Serow, P., & Taylor, S. (2019). Education for sustainability in the secondary sector—A review. *Journal of Education for Sustainable Development, 13*(1), 102–122. https://doi.org/10.1177/0973408219846675

TENK. (2019). *Human sciences in Finland: Ethical review guidelines*. Finnish National Board on Research Integrity. https://tenk.fi/sites/default/files/2021-01/Ethical_review_in_human_sciences_2020.pdf

Tilbury, D. (2006). Environmental education for sustainability: Defining the new focus of environmental education in the 1990s. *Environmental Education Research, 1*(2), 195–212. https://doi.org/10.1080/1350462950010206

Trahorsch, P., & Bláha, J. D. (2022). The influence of textbook visual quality of geographical phenomena on children's conceptions. *Journal of Geography, 121*(3), 100–114. https://doi.org/10.1080/00221341.2022.2088828

Uhlenwinkel, A., Béneker, T., Bladh, G., Tani, S., & Lambert, D. (2017). GeoCapabilities and curriculum leadership: Balancing the priorities of aim-based and knowledge-led curriculum thinking in schools. *International Research in Geographical and Environmental Education, 26*(4), 327–341. https://doi.org/10.1080/10382046.2016.1262603

Uitto, A., Jeronen, E., & Yli-Panula, E. (2024a). Luonnontiedekasvatus ja kestävän kehityksen kasvatus biologian opetuksessa. In A. Uitto, E. Jeronen, & E. Yli-Panula (Eds.), *Biologian opetus ja tiedekasvatus kestävän tulevaisuuden edistäjinä* (pp. 30–79). Suomen ainedidaktinen tutkimusseura ry. https://doi.org/10.23988/sats.1066

Uitto, A., & Saloranta, S. (2017). Subject teachers as educators for sustainability: Survey study. *Education Sciences, 7*(1), 8. https://doi.org/10.3390/educsci7010008

Uitto, A., Yli-Panula, E., & Jeronen, E. (2024b). Näkökulmia kestävyyttä korostavan biologian opetukseen ja arviointiin. In A. Uitto, E. Jeronen, & E. Yli-Panula (Eds.), *Biologian opetus ja tiedekasvatus kestävän tulevaisuuden edistäjinä* (pp. 80–96). Suomen ainedidaktinen tutkimusseura ry. https://doi.org/10.23988/sats.1066

UN (United Nations). (2003). *Activities undertaken in implementation of Agenda 21, the programme for the implementation of Agenda 21*. https://digitallibrary.un.org/record/501841?v=pdf

UN (United Nations). (2020). *Resolution adopted by the General Assembly on 19 December 2019 (A/RES/74/233): Follow-up to the second United Nations conference on landlocked developing countries*. United Nations. https://docs.un.org/en/A/RES/74/233

UN (United Nations). (2021). *Transforming our world: The 2030 Agenda for sustainable development*. Department of Economic and Social Affairs, Sustainable Development. https://sdgs.un.org/2030agenda

UNESCO (United Nations Educational, Scientific and Cultural Organization). (2016). *Education 2030: Incheon declaration and framework for action for the implementation of Sustainable Development Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*. https://unesdoc.unesco.org/ark:/48223/pf0000245656

UNESCO (United Nations Educational, Scientific and Cultural Organization). (2017a). *Education for sustainable development goals: Learning objectives*. https://doi.org/10.54675/cgba9153

UNESCO (United Nations Educational, Scientific and Cultural Organization). (2017b). *Roadmap for implementing the global action programme on education for sustainable development*. https://unesdoc.unesco.org/ark:/48223/pf0000230514

Vahed, A., Walters, M. M., & Ross, A. H. A. (2023). Continuous assessment fit for purpose? Analysing experiences of academics from a South African university of technology. *Education Inquiry, 14*, 267–283. https://doi.org/10.1080/20004508.2021.1994687

Valladares, L. (2021). Scientific literacy and social transformation. *Science & Education, 30*(3), 557–587. https://doi.org/10.1007/s11191-021-00205-2

Vallance, S., Perkins, H. C., & Dixon, J. E. (2011). What is social sustainability? A clarification of concepts. *Geoforum, 42*(3), 342–348. https://doi.org/10.1016/j.geoforum.2011.01.002

van de Wetering, J., Leijten, P., Spitzer, J., & Thomaes, S. (2022). Does environmental education benefit environmental outcomes in children and adolescents? A meta-analysis. *Journal of Environmental Psychology, 81*, 101782. https://doi.org/10.1016/j.jenvp.2022.101782

Verma, A., & Dhaigude, A. S. (2026). Quality education – Sustainable development goal 4: A bibliometric analysis through a management and policy lens. *Integration of Education, 30*(1), 10–28. https://doi.org/10.15507/1991-9468.030.202601.010-028

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Verma, K., & Estaville, L. (2018). Role of geography courses in improving geospatial thinking of undergraduates in the United States. *International Journal of Geospatial and Environmental Research, 5*(3/2). https://www.academia.edu/download/60349929/Geography_Courses_and_Geospatial_Thinking20190820-13187-3g4pcc.pdf

Veugen, M., Gulikers, J., & Den Brok, P. (2021). We agree on what we see: Teacher and student perceptions of formative assessment practice. *Studies in Educational Evaluation, 70*, 101027. https://doi.org/10.1016/j.stueduc.2021.101027

Villarosa, M. A. (2025). Eco-literacy awareness of pre-service science teachers: Assessment of knowledge, awareness, ethics, emotion, and behaviour. *Journal of Interdisciplinary Perspectives, 3*(7), 537–547. https://doi.org/10.69569/jip.2025.088

Virranmäki, E., Valta-Hulkkonen, K., & Pellikka, A. (2021). Geography curricula objectives and students' performance: Enhancing students' higher-order thinking skills? *Journal of Geography, 120*(3), 97–107. https://doi.org/10.1080/00221341.2021.1877330

Vogelstein, J. T., Verstynen, T., Kording, K. P., Isik, L., Krakauer, J. W., Etienne-Cummings, R., Ogburn, E. L., Priebe, C. E., Burns, R., Kutten, K., Knierim, J. J., Potash, J. B., Hartung, T., Smirnova, L., Worley, P., Savonenko, A., Phillips, I., Miller, M. I., Vidal, R., … Yang, W. (2022). Prospective learning: Back to the future. *arXiv*. https://doi.org/10.48550/arXiv.2201.07372

Vronski, O., & Vronska, N. (2015). Using information technologies to improve the spatial understanding of students. In *Environment. Technology. Resources: Proceedings of the International Scientific and Practical Conference*. Rezekne Academy of Technologies. https://doi.org/10.17770/ETR2011VOL2.1009

Wadson, D., Mulenga, I. M., & Milupi, I. (2023). Teacher preparedness and strategies used in teaching of climate change education in the Southern region of Malawi. *East African Journal of Education and Social Sciences, 4*(5), 62–71. https://doi.org/10.46606/eajess2023v04i05.0320

Wahelo, T. T., Mengistu, D. A., & Merawi, T. M. (2025). Geography teachers' implementation of problem-based learning for deforestation and climate change education in Metekel Zone Secondary Schools, Northwest Ethiopia. *International Journal of Educational Development, 117*, 103314. https://doi.org/10.1016/j.ijedudev.2025.103314

Walker, A., & Leary, H. A. (2009). Problem-based learning meta-analysis: Differences across problem types, implementation types, disciplines, and assessment levels. *Interdisciplinary Journal of Problem-Based Learning, 3*(1), 6–28. https://doi.org/10.7771/1541-5015.1061

Wang, C.-C. (2021). The process of implementing problem-based learning in a teacher education programme: An exploratory case study. *Cogent Education, 8*(1), 1996870. https://doi.org/10.1080/2331186X.2021.1996870

Wang, S., Fu, B., Zhao, W., Liu, Y., & Wei, F. (2018). Structure, function, and dynamic mechanisms of coupled human–natural systems. *Current Opinion in Environmental Sustainability, 33*, 87–91. https://doi.org/10.1016/j.cosust.2018.05.002

Wangdi, N., Wangmo, Y., Penjor, & Tshering, K. (2024). Enhancing Class X students' learning in geography through collaborative approach. *Asian Journal of Advanced Research and Reports, 18*(12), 460–472. https://doi.org/10.9734/ajarr/2024/v18i12843

Weeden, P. (2013). How do we link assessment to making progress in geography? In D. Lambert & M. Jones (Eds.), *Debates in geography education* (pp. 143–154). Routledge. https://doi.org/10.4324/9780203136614-19

Wehry, S., Monroe-Ossi, H., Cobb, S., & Fountain, C. (2012). Concept mapping strategies: Content, tools and assessment for human geography. *Journal of Geography, 111*(3), 83–92. https://doi.org/10.1080/00221341.2011.604094

Whalen, K., & Paez, A. (2021). Student perceptions of reflection and the acquisition of higher-order thinking skills in a university sustainability course. *Journal of Geography in Higher Education, 45*(2), 108–127. https://doi.org/10.1080/03098265.2020.1804843

White, P. J., Ardoin, N. M., Eames, C., & Monroe, M. C. (2024). Agency in the Anthropocene: Education for planetary health. *The Lancet Planetary Health*.

Wiek, A., Bernstein, M. J., Foley, R. W., Cohen, M., Forrest, N., Kuzdas, C., Kay, B., & Withycombe Keeler, L. (2016). Operationalising competencies in higher education for sustainable development. In M. Barth, G. Michelsen, M. Rieckmann, & I. Thomas (Eds.), *Handbook of higher education for sustainable development* (pp. 241–260). Routledge.

Wiek, A., & Redman, A. (2022). What do key competencies in sustainability offer and how to use them. In P. Vare, N. Lausselet, & M. Rieckmann (Eds.), *Competences in education for sustainable development*. Springer. https://doi.org/10.1007/978-3-030-91055-6_4

Wiek, A., Withycombe, L., & Redman, C. (2011c). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science, 6*(2), 203–218. https://doi.org/10.1007/s11625-011-0132-6

Wiek, A., Withycombe, L., Redman, C. L., & Banas Mills, S. (2011a). Moving forward on competence in sustainability research and problem solving. *Environment: Science and Policy for Sustainable Development, 53*(2), 3–12. https://doi.org/10.1080/00139157.2011.554496

Wiek, A., Withycombe, L., Redman, C., & Banas Mills, S. (2011b). On competence in moving forward sustainability research and problem solving. *Environment, 53*(2), 3–12. https://doi.org/10.1080/00139157.2011.554496

Wiggan, G., Smith, D., & Watson-Vandiver, M. J. (2021). The national teacher shortage, urban education and the cognitive sociology of labor. *The Urban Review, 53*, 43–75. https://doi.org/10.1007/s11256-020-00565-z

Wijnia, L., Loyens, S. M. M., & Derous, E. (2011). Investigating effects of problem-based versus lecture-based learning environments on student motivation. *Contemporary Educational Psychology, 36*(2), 101–113. https://doi.org/10.1016/j.cedpsych.2010.11.003

Woods, C. T., Davids, K., & Araújo, D. (2024). On ecological literacy through implicated participation. *New Ideas in Psychology, 73*, 101079. https://doi.org/10.1016/j.newideapsych.2024.101079

Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y., & Liang, J.-C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education, 62*, 41–49. https://doi.org/10.1016/j.compedu.2012.10.024

Yeon, Y.-K., Lee, B. Y., Park, S., Kim, D., Shin, Y. H., Koh, H. J., & Kim, S. W. (2025). Digital competence in geoscience fieldwork: A case study of the KMapper application. *Journal of Geography in Higher Education, 50*(1), 100–117. https://doi.org/10.1080/03098265.2025.2560328

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
♣*Corresponding Author: Eila Jeronen*

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Yli-Panula, E., Banos-Conzales, I., Jeronen, E., & Matikainen, E. (2025). Student teachers' views on content knowledge of environmental issues in biological and geoscience subject matters. *Interdisciplinary Journal of Environmental and Science Education, 21*(4), e2520. https://doi.org/10.29333/ijese/17442

Yli-Panula, E., Jeronen, E., & Lemmetty, P. (2020). Teaching and learning methods in geography promoting sustainability. *Education Sciences, 10*(1), 5. https://doi.org/10.3390/educsci10010005

Yli-Panula, E., Jeronen, E., & Mäki, S. (2022). School culture promoting sustainability in student teachers' views. *Sustainability, 14*(12), 7440. https://doi.org/10.3390/su14127440

Yli-Panula, E., Södervik, I., Jeronen, E., & Rantala, H. (2024). Finnish primary school student teachers' systems thinking regarding sustainability in connection with reproduction, biodiversity and sustainable development. *Nordic Studies in Science Education, 20*(2), 191–205. https://doi.org/10.5617/nordina.10385

Yli-Panula, E., Jeronen, E., Vesterkvist, S., & Tolonen, P. (2021). Finnish subject student teachers' views on their social competencies at the end of their educational studies. In E. Jeronen (Ed.), *Transitioning to quality education* (pp. 63–87). MDPI.

Young, M. (2009). Education, globalization and the 'voice of knowledge'. *Journal of Education and Work, 22*(3), 193–204. https://doi.org/10.1080/13639080902957848

Young, M. (2013). Overcoming the crisis in curriculum theory: A knowledge-based approach. *Journal of Curriculum Studies, 45*(2), 101–118. https://doi.org/10.1080/00220272.2013.764505

Young, M., & Muller, J. (2013). On the powers of powerful knowledge. *Review of Education, 1*(3), 229–250. https://doi.org/10.1002/rev3.3017

Yücel, D., & Çalışkan, İ. (2025). A comparative investigation of environmental literacy dimensions in science curricula of several countries. *Participatory Educational Research, 12*(4), 210–228. https://doi.org/10.17275/per.25.57.12.4

Zeidler, D. L., Herman, B. C., & Sadler, T. D. (2019). New directions in socioscientific issues research. *Disciplinary and Interdisciplinary Science Education Research, 1*(1), 11. https://doi.org/10.1186/s43031-019-0008-7

Zhan, Z., He, L., & Zhong, X. (2024). How does problem-solving pedagogy affect creativity? A meta-analysis of empirical studies. *Frontiers in Psychology, 15*, 1287082. https://doi.org/10.3389/fpsyg.2024.1287082

Zhang, X., Jung, W., & Asari, M. (2025). Systematic review of environmental education teaching practices in schools: Trends and gaps (2015–2024). *Sustainability, 17*, 8561. https://doi.org/10.3390/su17198561

Zhao, Y., Liu, X., & Han, X. (2024). Enhancing pro-environmental behavior through nature-contact environmental education: An empirical analysis based on randomized controlled experiment design. *Frontiers in Environmental Science, 12*, 1491780. https://doi.org/10.3389/fenvs.2024.1491780

Zhou, T., Cañabate, D., Bubnys, R., Stanikūnienė, B., & Colomer, J. (2025). Collaborative learning, cooperative learning and reflective learning to foster sustainable development: A scoping review. *Review of Education, 13*, e70065. https://doi.org/10.1002/rev3.70065

Ölçer-Çevik, C., & Kozaner, Ç. (2025). Building a sustainable future: Perspectives on primary school sustainability projects from teachers and pre-service teachers. *International Journal of Evaluation and Research in Education, 14*(5), 3403–3417. https://doi.org/10.11591/ijere.v14i5.33362

International Journal of Educational Studies
Vol. 9, No. 2, pp. 1-71
2026
DOI: *10.53935/2641-533x.v9i2.1156*
Corresponding Author: Eila Jeronen

Copyright:
© 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).