

**Sustainability in Education:
An Empirical Assessment of Systemic Integration and
Organisational Practice**

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¹ This list includes shortened captions of all Figures and Tables.

Abbreviations

BMBF	Bundesministerium für Bildung und Forschung (German Federal Ministry of Education and Research)
BMBFSFJ	Bundesministerium für Bildung, Familie, Senioren, Frauen und Jugend (German Federal Ministry for Education, Family Affairs, Senior Citizens, Women and Youth)
ICJ	International Court of Justice
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
ESD	Education for Sustainable Development
EU	European Union
NGO	Non-Governmental Organisation
SD	Sustainable Development
SDGs	Sustainable Development Goals
SOS-UK	Students Organising for Sustainability United Kingdom
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VET	Vocational Education and Training
WIA	Whole Institution Approach

Abstract

Transitioning to a socially just and environmentally safe development pathway necessitates considerable individual, social and societal learning. Education is hence routinely highlighted as a keystone in sustainable development. Yet contemporary education systems often tend to reproduce the very conditions that have led to unsustainability. A reorientation of education and learning towards sustainability has consequently not only been called for by scholars, practitioners and youth, but has also been committed to by various governments and international organisations. To monitor progress, identify challenges and enhance quality on the path towards a sustainable education, it is critical to rigorously assess its systemic integration, practice and outcomes. However, international monitoring to date has mostly relied on self-reporting by countries and educational leaders, which is prone to considerable bias. There is, therefore, a need for the development and large-scale application of meaningful, valid and reliable indicators for sustainability across all levels of education systems. While considerable work has focused on the micro-level of sustainability-related learning processes and outcomes, this dissertation responds to a lack of conceptualisation, operationalisation and large-scale assessments at the macro-level of systemic framework conditions (e.g., policies, curricula, resources) and the meso-level of organisational practice. Taking Germany as an exemplary case, the four individual studies included in this dissertation address these gaps by applying a multi-method approach to the development and application of relevant indicators.

At the macro-level of systemic integration within the political and administrative framework conditions, an input-indicator for Sustainable Development Goal 4.7.1 – the mainstreaming of Education for Sustainable Development (ESD) in policies, curricula, training of educators and assessments – is developed and applied in the first study to over 11,000 documents from Germany (Holst, Singer-Brodowski, et al., 2024). Based on a combination of lexical document analysis and external expert evaluation, the study indicates that sustainability and ESD are mostly an “add-on” in the education system, yet have dynamically been taken up over a timespan of ten years. At the meso-level of educational institutions embedded in their regional contexts, a systematic review of the international literature on the Whole Institution Approach (WIA) offers a first conceptual synthesis to characterise WIAs to sustainability across different areas of education (Holst, 2023). Drawing on an analysis of 104 documents and a validating expert review, the synthesised WIA model includes five core principles (*coherence, continuous learning, participation, responsibility, commitment*), seven interconnected areas of action (*governance, curriculum, campus, community, research, communication, capacity building*), the underlying organisational culture as well as external conditions. The review contributes to a further operationalisation of the WIA for use in practice, policy-making and research. Building

on this conceptual groundwork, the third study included in this dissertation introduces the development, testing, validation and first national-scale application of the WIA-Scale, an instrument to quantify the experience of sustainability as a WIA in organisational practice (Holst, Grund, & Brock, 2024). Based on a survey of 2,985 learners and educators in Germany, the study not only shows the measurability of WIAs, but that the experience of sustainability in line with a WIA appears to be highly effective in empowering learners and educators for sustainable development. The WIA-Scale is consequently suggested as a process-indicator for high-quality sustainability practice within and around educational institutions. Focusing on the largest formal area of education, the fourth study addresses sustainability within schools and the school system (Holst, Brock, et al., 2025). While the third study had examined sustainability through the lenses of learners and educators, the fourth is concerned with the perspectives of leaders. Based on a mixed-method analysis of data from 80 semi-structured interviews and a representative survey of 1,310 principals in Germany, the study shows a stark gap between a strong desire for sustainability in schools, and a considerably lower status quo. Assessing patterns in the descriptions of current practice, challenges and possible drivers, the analysis points to a focus on single and fragmented actions, frequent individualisation and diffusion of responsibility, a perceived lack of resources and a widespread paradigm of approaching sustainability as an addition rather than a core of quality education.

Together, the four studies advance the conceptualisation of the systemic integration and organisational practice of sustainability in education, develop indicators for more valid and reliable assessments, provide national-scale data on the status and effectiveness of sustainability in education, and improve the knowledge base on possible implementation pathways. Linking the individual studies, a picture emerges of a more coherent sustainability integration being highly wished-for, likely effective, yet far from default – both in systemic framework conditions and organisational practice. Asking how to increase effectiveness, four overarching learnings for policy and practice are discussed, focusing on sustainability in education becoming more purposive, experiential, political and structural. Following a reflection on the overall contributions and limitations of the dissertation, implications for future research are derived, emphasising the link between sustainability and general quality education, further conceptual and empirical work on WIAs within and beyond formal education and potentials for transfer to other areas of social and societal learning.

Keywords: Sustainability Transition; Education and Learning; Indicator Development; Whole Institution Approach; Education for Sustainable Development

1. Transitioning towards Sustainability: A Grand Learning Challenge

Contemporary unsustainability, both in terms of humanity transgressing the environmental limits of planet Earth and widespread social injustice (e.g., Rockström et al., 2023), is deeply inscribed not only in present infrastructures, economic systems, and policies (e.g., Biermann et al., 2022; Raworth, 2018; Thacker et al., 2019), but also in human habits and worldviews (e.g., Albarracín et al., 2024; Sterling, 2025). In this light, transitioning towards a socially just and environmentally viable future is not only a matter of shifting technologies, e.g., to replace fossil technologies, but an individual and social (re-)learning challenge at all levels of society (cf. Sterling, 2016). Education and learning are thus recurrently argued to be critical for achieving Sustainable Development (SD; e.g., Pham-Truffert et al., 2020; Vladimirova & Le Blanc, 2016; Xiao et al., 2023) and to constitute a key social tipping element in sustainability transitions (Otto et al., 2020). Consequently, there have been numerous calls and (inter-)national commitments for education systems worldwide to integrate the challenge of sustainability into their structures and practices (e.g., Council of the European Union, 2022; UNECE, 2005; UNESCO, 2021a; United Nations General Assembly, 2017). Yet the status and progress towards this objective have often failed to meet the set ambitions (e.g., Vare, 2014; Wals & Benavot, 2017), or, even more often, have not been systematically measured. One reason for this is that, while the objective of mainstreaming sustainability in education is widely accepted and committed to, it is far less clear what it specifically entails, and how it could meaningfully be measured. With most of the international monitoring on sustainability in education based on self-reporting and many indicators focusing on the micro-level of learning processes and outcomes (details follow in chapter 2), there has been a lack of methodological frameworks to systematically assess sustainability integration at the macro-level of education systems (e.g., in policies, curricula, funding, etc.) and its practice within educational institutions at the meso-level. Adding to the growing body of research on education and learning within and beyond the sustainability sciences, this dissertation makes conceptual, methodological and empirical contributions to such assessments of the systemic integration and organisational practice of sustainability in education. In the following introductory sections, the wider problem frame of a sustainability transition is outlined (1.1) and the relationship between sustainability and education is approached (1.2). Leading on from this, a brief overview is provided of attempts to move towards systemic approaches to sustainability in education, outlining conceptual, methodological and empirical gaps (1.3). On this basis, the research scope and objectives are derived, and a more detailed overview is given of the subsequent main chapters (1.4), in which the conceptual grounds for the assessments are sketched (2), the conducted research is summarised (3), and the findings are jointly discussed (4).

1.1. Human Prosperity and Environmental Integrity: A Reconciliation?

As human population, production, mobility, energy use and other global socio-economic indicators show rapid increases since the mid-20th century, so do associated Earth system trends such as carbon dioxide in the atmosphere, nitrogen in coastal ecosystems or terrestrial biosphere degradation (Steffen et al., 2015). Even from a solely anthropocentric perspective², such a ‘great acceleration’ of the human enterprise on a finite planet poses an existential problem in reconciling prosperous human development with a functioning Earth system (idib.). While biophysical boundaries are being increasingly transgressed, social indicators for human wellbeing are reached at a considerably slower rate (Fanning et al., 2022) and basic human needs are not yet met at a sustainable level of resource use (O’Neill et al., 2018). Also, the benefits of rapid growth have been distributed unequally among members of the human population, and many of those who have contributed the least to the climate and biodiversity crises are among those who are suffering the most from their consequences (Chancel et al., 2022; Lenton et al., 2023). SD, defined by the Brundtland Commission as a *“development that meets the needs of the present without compromising the ability of future generations to meet their own needs”* (United Nations, 1987), is thus not solely a committed-to intergenerational responsibility (United Nations General Assembly, 2015), but a question of distributional justice, human rights and well-being also among the present generation.

While SD characterizes a process of change, the concept of sustainability describes an objective of achieving a combination of collective human well-being *and* environmental integrity, both at a planetary and regional scale (cf. O’Neill et al., 2018; Raworth, 2012; Rockström et al., 2023). At the time of writing, the need to reconcile the objectives of equitable human prosperity and environmental integrity is increasingly being emphasised and specified also in legal proceedings (e.g., Bundesverfassungsgericht, 2021; European Court of Human Rights, 2024; International Court of Justice [ICJ], 2025). As a notable example, the 2025 advisory opinion by the ICJ in response to the UN General Assembly concludes that there is a *“human right to a clean, healthy and sustainable environment”* (ICJ, 2025:19) and that, under international law, states have obligations to ensure the protection of the climate system and of other parts of the environment (ibid.). In this and similar court rulings and advisory opinions, increasing weight is given to the freedoms of others, the freedoms of future generations, and in some cases the legal status (of parts) of the environment. While contemporary unsustainability has been established as a problem diagnosis, the example shows that the concepts of sustainability and SD also represent an invitation for improvement, i.e., beneficial changes towards a (more) just

² For critiques of the dominant anthropocentric approaches to sustainability, see for example Kopnina and Cherniak (2016), Jickling and Wals (2008).

and environmentally safe future (e.g., Karlsson et al., 2020; Moutet et al., 2025). This is also reflected in recent developments towards viewing sustainability and associated policies not only as contributing to individual and collective well-being (e.g., O'Mahony, 2022), but also as a matter of security and resilience in a highly volatile geopolitical environment (e.g., Ginzky & Menger, 2023).

Considering the internationally agreed-upon and legally binding objectives, and that a vast majority of people generally agree with the importance of SD (e.g., Flynn et al., 2024; Ipsos, 2024), it is striking that human development continuously fails to meet the set ambitions (as for the Sustainable Development Goals (SDGs), see for example the mid-term report by Sachs et al., 2023). Reasons for this include the complex coupling of social, environmental and economic systems (Leach et al., 2018), widespread unsustainable habits, beliefs and worldviews (e.g., on the role of neoliberal beliefs: Lepenies, 2022) as well as, as a consequence, conflicting interests that can remain hidden under the integrative notion of sustainability (cf. McKenzie et al., 2015; Wals & Jickling, 2002; Gaudiano & Buenfil Burgos, 2009). On top of this, power asymmetries (e.g., financially, politically, communicative), lock-ins and legacy effects (e.g., Brand et al., 2021) as well as the systemic and structural nature of both problems and solutions (e.g., Niebert, 2019) make sustainability a highly contested objective. This situation has led scholars to call sustainability problems 'wicked' problems (Rittel & Webber, 1973), although the term has been used with a wide range of different connotations (Lönngren & van Poeck, 2021).

Ultimately, it becomes clear that, at core, SD implies complex political, technological and cultural transitions, particularly with a focus on countries that have historically contributed most to environmental degradation and social inequality (e.g., on climate change: Hickel, 2020). In fact, current unsustainability is not only manifested in infrastructures, policies and the economic system, but also pertains to habits, beliefs and worldviews which are, again, linked to the (systemic) environment in which they occur (Lotz-Sisitka et al., 2015; Wals, 2015). If human prosperity is to be reconciled with environmental integrity, such a transition towards sustainability would, as Sterling (2016) among many others has argued, necessarily be associated with a considerable degree of individual, social and societal learning. Consequently, the question arises as to how sustainability, as an inherently normative concept, is related to education and learning. This question is examined and reflected upon in the following section – first from the perspective of sustainability science and subsequently from the perspective of education theory and research.

1.2. Education and Sustainability: Perspectives from Sustainability Science and Education Research

As a relatively new academic field of inquiry, sustainability science unified in the early 2000s as an inherently multi-, often inter- and transdisciplinary, problem-driven field of scholarly inquiry and practice (Bettencourt & Kaur, 2011; Clark & Dickson, 2003; Kates et al., 2001). Combining and expanding theories and methods from various disciplinary backgrounds, it involves integrated analyses of the dynamic and complex nature-society interactions in context of grand Anthropocene challenges, and contributes to transitions towards sustainability (Clark, 2007; Kates, 2011; Spangenberg, 2011). In a synthesising review, Clark and Harley (2020) constructed an integrated framework to highlight key unifying elements within sustainability science. As part of the synthesis, the authors devise core operational capacities needed for SD such as, to name examples, the capacity to “*transform the system onto more sustainable development pathways*”, to “*link knowledge with action*”, or to “*promote equity*” (ibid., p. 331). The development of such (and other) relevant capacities for SD among individuals and institutions is closely linked to what is recurrently called social or, in even wider terms, societal learning (Barth, 2015; Kates et al., 2001; König, 2017; Wals et al., 2009). In fact, (social) learning³ and education have long been highlighted as key factors in a transition towards sustainability in political declarations on SD (e.g., United Nations, 1992) and are frequently pointed to by scholars in the field of sustainability science (e.g., as a social tipping element: Otto et al., 2020; within transition research: cf. van Mierlo & Beers, 2020; on achieving the SDGs: Pham-Truffert et al., 2020; Sachs et al., 2023). In light of the persistent prevalence of unsustainable systems, a transition towards sustainability is argued by various scholars to require not only material and regulatory shifts but, connected to this, shifts in the patterns of and paradigms underlying human thinking and action (e.g., Barth, 2015; Lotz-Sisitka et al., 2015; Sterling, 2001, 2003; Wals & Kieft, 2010). In their analysis of educational contributions to sustainability science, Barth and Michelsen (2013) point out that such substantive (paradigmatic) changes require active and higher-order social learning, i.e., learning in which underlying rules and assumptions are actively questioned and adapted (on double-/triple-loop and higher-order learning, cf. Argyris & Schön, 1978; Barth, 2015; Ison & Russell, 2000; Sterling, 2004; on active social learning, cf. Glasser, 2007). In consideration of the maladaptive resilience of current systemic unsustainability (Sriskandarajah et al., 2010; Sterling, 2010), Lotz-

³ In the debate, the concept of social learning is regularly used as an umbrella term with different meanings and theoretical assumptions (cf. Parson & Clark, 1995). For conceptual clarification, see, for example, Reed et al. (2010), Glasser (2007) and Barth (2015). In this dissertation, I follow the distinction proposed by Barth (2015), who differentiates the dimensions of social interaction (individual learning (in a group), learning as a group, learning transcending group boundaries (e.g., societal)) and forms of learning (single-, double- and triple-loop).

Sisitka et al. (2015) make the case for transformative, transgressive learning focused on the *“breaking down of the resilience of inherently unsustainable systems/practices/routines and the development of the disruptive capacity and competence needed to do so”* (p. 74). In light of the clear relevance of learning and education for transitions towards sustainability, it is not surprising that there have been and are plenty of calls by youth, practitioners, civil society, political and administrative actors as well as by researchers for a systemic integration of sustainability in formal and non-formal education (e.g., National Platform ESD c/o BMBF, 2017; Sterling, 2024; UNESCO, 2021a, 2024b; Wals & Benavot, 2017). Consequently, the fundamental question arises: Is sustainability, as an inherently normative concept associated with grand societal transitions, at all compatible with foundational ideas and functions of education?

While there is considerable debate over definitions, education may, in a very general sense, be understood as the lifelong formal, non-formal and informal processes through which individuals or groups develop their potentials by acquiring and sharing knowledge, values, and competencies, among others (e.g., UNESCO, 2023a, 2023b). Viewed from a sociological perspective, education systems are, as social institutions, sub-systems of societies (cf. Baraldi & Corsi, 2016, on the work of Luhmann on education). Education is thereby not independent from society and its (other) institutions, but its purpose(s) and functions are to be understood in relation to it. As Biesta (2009) highlights from an educational philosophy perspective, judgements on the objectives, and thus also on the effectiveness or quality of education, are always inherently normative, pointing to what is viewed as desirable, and therefore debatable, at least within democratic societies. To provide an example, Fend (2009) describes four current social functions of school education: (1) integration and legitimation (i.e., reproduction of shared norms and worldviews), (2) enculturation (i.e., reproduction of basic cultural abilities and understandings), (3) allocation and social selection (i.e., distribution on future occupations), and (4) qualification (i.e., gaining of competencies, e.g., for joining the workforce or participation in civil life). In a similar vein, Biesta (2009) highlights (1) qualification, (2) socialisation (i.e., becoming part of social, cultural and political systems), and (3) subjectification. With their minor differences, both heuristics converge in that the functions of education systems are strongly linked to the cultural, social and political systems around them. Following Biesta (2009), this is to highlight the relevance of considering the (often implicit) normative assumptions beneath the functions of education. In other words: What is the purpose of education at a given time? Reflecting on current educational practice, sustainable education scholar Arjen Wals (2020) highlights the observation that contemporary education systems are by no means value-free, but, at least in most western societies, tend to foster competitiveness, employability and continuous economic growth, among others, often with little consideration of equity or the transgression of environmental limits. In other words, not

only the explicitly planned, but also the hidden curriculum of education (Jackson, 1968) is entrenched with normative assumptions, embedded within its cultural, political and social context. The report of the International Commission on the Futures of Education (2021, p. 11) adds to this that *“education systems often reproduce and perpetuate the very conditions that threaten our shared futures (...) limiting education’s potential to be truly transformative”*. On a similar note, Sterling (2017, p. 34) points to the deep paradigmatic embedding of, in particular, neoliberal thought in current education, naming underlying assumptions such as that *“education is key to economic success”*, that the *“prime purpose of education is to make students employable and the economy more productive”*, or that *“quality is assured by competition, metrics and accountability”*. As these observations show, the core question to consider is not as to *whether* there should be normative orientations within education systems – simply, because there always are. Rather, it seems more relevant to ask *what specific* purposes are deemed appropriate for timely education (cf. Biesta, 2002, 2009), and *how* such purposes would unfold in educational practice.

In response to the first question, educational theorist Wolfgang Klafki (1996/2007) emphasises, in line with the observations by Biesta (2009), the intrinsic connection between education and society. On this basis, in his theory of general didactics, he argues that educational theory and practice should not only react to contemporary contexts (e.g., reproduce them), but bear the pedagogic responsibility of enabling present and future generations to evaluate current and possible future social conditions and to participate in shaping them (ibid; p. 50f.)⁴. Consequently, Klafki argues that general education should always be closely linked to the *“key problems that globally interweave our individual and political-societal existence”* (Klafki, 1996/2007, p. 154; translated, cf. also Kvamme, 2021). Already in the 1990s, he exemplarily mentioned the quest for peace, environmental integrity – describing it as *“the question of the destruction or preservation of the natural foundations of human existence”* (p. 58), socially produced inequality within and between societies, or threats and opportunities through technological advances, as epochal key challenges. In such a critical-constructive view on education, the future and future-oriented empowerment of individuals become central reference points for education, linking directly to its very purpose. This also resonates with perspectives of nowadays youth who, as various (inter-)national studies show, are both well-aware of societal key challenges and are calling for a considerably stronger focus on sustainability, both in the political and economic system (Albert et al., 2024; Calmbach et al., 2024; Flynn et al., 2024; Hickman et al., 2021) and within education (e.g., Flynn et al., 2024; Grund & Brock, 2022; SOS United Kingdom, 2024).

⁴ For an English-language examination of Klafki’s educational theory and its implications in the Anthropocene, cf. Kvamme (2021).

In summary, education and, in a broader sense, (social) learning are viewed by scholars within sustainability and education science and in various (inter-)national commitments and declarations as critical to empower individuals and collectives with the capacities and capabilities to contribute to a safe and just future. Further, given the constitutive relation between education (systems) and the social, cultural and political systems around them, the normative orientation of sustainability is considered to be highly compatible with the purposes and functions of adequate education in times of escalating crises of unsustainability. In the following section, a short overview is provided on the commitments to, and the attempts made to move towards integrating sustainability in education systems worldwide, as well as to measure progress on this path. On this basis, methodological and empirical gaps are highlighted, forming the research desideratum to which this thesis responds.

1.3. From Projects towards a Whole-System Approach to Sustainability in Education: Programmatic Trends and Current Evidence

As an educational response to the social and environmental challenges of unsustainability, the concept of Education for Sustainable Development (ESD) emerged in the wake of the Earth Summit in Rio de Janeiro (UN, 1992). Drawing on and linking activities in the fields of environmental education (e.g., Tilbury, 1995), global learning and developmental education (e.g., Scheunpflug & Asbrand, 2006) and global citizenship education (e.g., Davies & Pike, 2009), among others, ESD aims to foundationally (re-)orient education and learning towards sustainability (Sterling, 2001; Wals, 2011)⁵. With its systemic ambition, it aims to empower people of all ages to be able to critically engage with and make meaningful contributions to SD (UNESCO, 2020, 2021a, 2023a). For this, ESD focuses particularly on fostering agency and sustainability-related competencies such as systems and anticipatory thinking, normative reasoning, inter- and intrapersonal competencies and the ability to strategically implement (transformative) actions towards sustainability (Barth et al., 2007; Brundiers et al., 2021; Haan, 2010; Rieckmann, 2018)⁶. In its objective to develop individual and collective capacity to respond adequately to current unsustainability, ESD, as Barth and Michelsen (2013) put it, “*translates research outcomes of sustainability science into educational practice*” (p. 105).

While education, public awareness and training were already highlighted in the Rio Declaration as key drivers for SD (United Nations, 1992), considerable progress towards the

⁵ In this framework paper, the term *sustainable education*, also prominently used by Sterling (2001, 2009), is adopted to refer to a systemic orientation of education towards sustainability at all levels (e.g., of paradigm, purpose, policy and practice; cf. Sterling, 2004). The concept of ESD is used as an umbrella term referring to (educational) concepts, programmes and campaigns (e.g., UNESCO, 2020) that aim to establish a sustainable education.

⁶ Further detailed elaborations on the relevant foundational debates on the objectives of ESD follow in chapter 3.

implementation of ESD within education systems began to take shape throughout the UN Decade on ESD from 2005 to 2014 (cf. Buckler & Creech, 2014)⁷. During this time, various projects contributed to moving ESD from a niche activity towards an innovative approach to recalibrating the purposes and quality of education (Michelsen & Fischer, 2017). At the same time, a large proportion of activities remained project- and case-based actions (Wals, 2012), inconsistent and of an additive rather than a structurally embedded nature (Wals & Benavot, 2017). This is in line with what Vare (2014) described as the rhetoric-reality gap in ESD. The subsequent Global Action Programme (2015-2019; UNESCO, 2014) and the ESD for 2030 framework (UNESCO, 2020) led on from the UN Decade, setting particular focus on a more systemic and, in terms of its transformative ambition, more effective integration of sustainability and ESD. For examples of this systemic emphasis, the final declaration of the World Conference on ESD in 2021 highlights the commitments of member states to ensure *“that ESD is a foundational element of our education systems at all levels”* and to promote *“a whole-institution approach”* (WIA) to sustainability (UNESCO, 2021a, p. 3). In line with this, the roadmap to the current UNESCO ESD framework stresses the importance of structural changes and transformative action (UNESCO, 2020). In Germany, the national context for the empirical parts of this dissertation, this shift was coined as the quest to move *“from projects to structure”* (Deutsche UNESCO-Kommission, 2014, p. 1) and is reflected in the targets set for a deep systemic integration in the National Action Plan on ESD (National Platform ESD c/o BMBF, 2017). Such and other systemic and transformative commitments link to what is also described as a Whole-System Approach to sustainability (Sterling, 2003; UNESCO, 2020; Wals, 2015), emphasising the relevance of integrating sustainability within the paradigm, purpose, policy and practice (Sterling, 2004) and across all levels of education systems (i.e., the micro-, meso- and macro-level; cf. Rode & Michelsen, 2008). Such a systemic perspective is in line with the earlier elaborations on Klafki (1996/2007), viewing sustainability not as *“another issue to be added to an overcrowded curriculum”* (Sterling, 2004, p. 50), but as a critical pillar of contemporary quality education (cf. Didham & Ofei-Manu, 2018; Laurie et al., 2016; UNESCO, 2020).

While considerable ambitions were set, questions remain with respect to the actual degree of sustainability integration within national education systems, its practice and effectiveness. Concerning the former, most international data relies upon countries' self-reporting (e.g., UNESCO, 2019b), which is prone to considerable biases (Benavot & Williams, 2023; Nazir et al., 2011), or focuses on specific sets of topics (e.g., climate change; cf. The MECCE Project,

⁷ A more detailed historical account on the development of ESD as well as associated concepts is provided elsewhere, e.g., by Macintyre et al. (2025), Michelsen and Fischer (2017), Agbedahin (2019) and Webb et al. (2025).

2023). Indeed, large-scale analysis of the degree of systemic implementation based on scientific quality criteria remain rare. In fact, there exist only a handful of large-scale (e.g., national) scientific assessments of the integration of ESD and sustainability into education systems (e.g., Beveridge et al., 2019; Haan, 2021; Singer-Brodowski et al., 2019). One reason for this is that while the objective of mainstreaming sustainability and ESD has been agreed to, the specific operationalisation within valid and reliable indicators has remained a considerable challenge (Brent Edwards et al., 2020; Gallwey, 2016; Giangrande et al., 2019; details follow in chapter 2). With respect to the actual practice and effectiveness of ESD within (and beyond) educational institutions, much of the available research has focused on evaluating specific programmes or interventions (e.g., Aeschbach et al., 2025; Ardoin et al., 2020; Ardoin et al., 2018; van de Wetering et al., 2022) or compared certified and uncertified organisations (e.g., Barratt Hacking et al., 2010; Boeve-de Pauw & van Petegem, 2013; Goldman et al., 2018; Olsson et al., 2019). Though both are relevant for the field, it is difficult to infer systemic effects given their specific foci. At the micro-level of specific learning situations, a range of research further exists that has addressed ESD teaching and competence assessments among learners (e.g., Boeve-de Pauw et al., 2015; Grund & Brock, 2020; Redman et al., 2021).

In summary, while substantial integration of sustainability into the systemic framework conditions (macro-level) and coherent organisational practice (meso-level) have frequently been called for (e.g., UNESCO, 2020, 2021a), there seems to be a lack of large-scale empirical research on the status, quality and effectiveness across these levels of education as well as on pathways for change. One reason for this lies in a lack of conceptual clarity of what a systemic integration and coherent organisational practice of sustainability would concretely imply, and consequently, a lack of operationalisation into meaningful and, at the same time, valid and reliable indicators. Such refined conceptualisation, advanced methodological approaches⁸ and empirical data would be of relevance for the design of effective policies, infrastructures and professional development programmes as well as for identifying paths for future research. Across the individual articles and their joint synthesis, this dissertation attempts to contribute to filling of these gaps. In the following subchapter (1.4), a short synopsis of the preceding considerations is provided to outline the subsequent structure and scope of the dissertation.

⁸ The terms “methodological approach” and “methodological framework” are used in this dissertation to refer to the overall systematic, structured process by which data on a specific research question (or indicator) is collected and analyzed, including the specific methods and procedures used in the analysis and the guiding theoretical and conceptual assumptions beneath.

1.4. Scope and Structure of the Dissertation

As a brief summary of the aforementioned strands of discourse, the following points stand out to form the basis for the development of the research objective and questions:

- 1) The **scale of current social and ecological unsustainability**, along with its implications for both **human wellbeing and environmental integrity**, forms the foundation for a normative argument for a far-reaching transition into a safe and just space for humanity. Through the SDGs, climate accords, biodiversity treaties, and other national and international targets, laws, strategies and agreements, the need for such a transition has been widely recognised, although these commitments are also being challenged and their realisation continues to lag behind the stated ambitions.
- 2) **Individual and collective, social learning** are integral to a transition that contests deeply rooted beliefs and assumptions and involves transformative changes, and thus associated learning processes, in most to all sectors of societies. Such an understanding of societal change as a *“learning challenge at every level”* (Sterling, 2016, p. 212) highlights the possible contributions of education systems and their organisations in empowering individuals and collectives with the capacities and capabilities to contribute to a (more) sustainable future. In this, the normative orientation of sustainability is viewed as **highly compatible with foundational purposes and functions of education**. This was exemplified by Klafki’s (1996) theory on general education, arguing for a close link of timely education to the epochal key challenges, empowering learners to be able to evaluate current and future social conditions, and participate in their shaping.
- 3) In context of 1) and 2), there seems to be a **considerable gap between the set objectives of mainstreaming sustainability** within all levels of education systems, and **available conceptual and methodological frameworks to systematically assess its realisation**. While considerable work has focused on the micro-level of teaching and learning, a systemic integration and coherent organisational practice as a WIA at the macro- and meso-levels of education are frequently called for. Yet there seems to have been a **lack of conceptual clarity and operationalisation within methodological frameworks** at these levels **and consequently, of large-scale empirical data**.

In light of these observations, this dissertation asks: **How can a systemic integration and organisational practice of sustainability in education be conceptualised, operationalised and measured?** And drawing on the exemplary case of the German education system: What can be learned from such measurements about the status and effectiveness of sustainability in education, as well as about relevant conditions and potential transition pathways?

To respond to these questions, the dissertation attempts to explore and thereby concretise the characteristics of a deep systemic integration and organisational practice of sustainability in education, and to operationalise the available conceptual work into meaningful, reliable and valid indicators for scientific assessments. Using and further developing a range of methods – document analysis, systematic literature review, quantitative scale development, large-scale surveys of learners, educators and leaders, and interviews – a multi-method approach is applied. Using large-scale datasets collected as part of the German national monitoring on ESD, the dissertation thereby builds on data for Germany as an exemplary case for a national education system. Under the umbrella of the overall objective, the four research articles focus on the following specific sub-questions:

- Study 1: How can the quality, depth and speed of implementation of sustainability, ESD and related concepts within education systems be operationalised for scientific assessments at the input-level of documents (indicator for SDG 4.7)? Applied to the context of the German education system, what is the status of implementation and what are discernible trends?
- Study 2: At the level of educational institutions in their respective regional contexts, what characterises WIAs to sustainability across the different areas of education? How can these characteristics be synthesised in a joint framework? What are relevant conditions for implementation?
- Study 3: How can the WIA be operationalised for quantitative assessments focusing on the experiences of those within educational institutions (learners, educators)? To what extent is the experience of sustainability at educational institutions (WIAs) related to key aspects of effective sustainability learning (e.g., empowerment, behaviour, knowledge)?
- Study 4: Focusing on school education as the largest area of education and the crucial perspectives of school leaders on their schools and the school system: What preconceptions do principals have regarding sustainability? What do they view as the current status of sustainability at their schools, and how do they envision an ideal state of sustainability in future schools? What challenges and drivers do they describe as being most relevant for sustainability in school development?

Leading on from this introduction to the field of study, the following chapter 2 provides a more nuanced examination of the key concepts of relevance for the conceptualisations, operationalisations and empirical assessments in the four research articles. Specifically, the first section sketches central foundational debates in the field of sustainable education as they

are of relevance to the development of meaningful indicators and the interpretation of the findings in this dissertation (2.1). Subsequently, the second section focuses in more detail on the macro-level of a systemic sustainability integration, highlighting relevant earlier work and further specifying the addressed research gaps at this level (2.2). Zooming in on the meso-level of organisational practice, the third section delves into the conceptual, theoretical and empirical foundations of what is called a WIA to sustainability in education, clarifying the use of key terminologies and sketching the state of research on the concept, status and effectiveness. Through this, the more specific gaps to which this dissertation responds at the meso-level of organisational sustainability practice are further delineated (2.3). Centring on the operationalisation in indicators for assessments, the last sub-chapter provides an overview of the field of indicator development on sustainability in education, outlining conceptual and methodological considerations and types of indicators (2.4).

Based on this conceptual foundation, chapter 3 begins by linking the four research articles to the introduced levels of education systems and types of indicators (3.1). It thereby highlights and connects the specific foci, questions, methods and data of the four research articles in an overarching research design, including a detailed overview in Table 1 (p. 29f.). What follows is a detailed summary of the four studies included in the dissertation, focusing on their conceptual, methodological and empirical contributions to answering the respective (abovementioned) research questions as well as on their specific limitations (3.2).

In the joint discussion, the overarching results and possible implications are reflected upon. After a synthesis and contextualisation of main findings (4.1), implications are discussed for policy and practice, among others (4.2). Overarching methodological contributions and limitations are subsequently reflected upon (4.3) before pathways and questions for further research are considered (4.4). Concluding remarks and personal reflections sum up the dissertation (5).

2. Sustainability in the Education System and its Organisations: Sketching the Grounds for Assessments

2.1. Sustainable Education: But What and How Exactly? Characteristics and Foundational Debates

With the general idea of sustainable, future-oriented education and learning established, more questions arise: What specifically are objectives for sustainability in education? Where do boundaries and tensions lie? And what does the idea of a sustainable education imply for the different layers of (national) education systems? While there are more extensive works on the characteristics of ESD and associated foundational debates elsewhere (e.g., Barth, 2015; Leicht et al., 2018; Michelsen & Fischer, 2017; Scheunpflug & Costa, 2025; Sterling, 2024), the following paragraphs sketch aspects viewed as particularly relevant for the conceptualisation and operationalisation of meaningful indicators and the later contextualisation of the key findings. Specifically, (i) the characteristics of ESD are outlined, (ii) tensions concerning the objectives of a sustainable education and its recipients are discussed and (iii) different qualities of a sustainability integration are considered.

Empowering for Sustainability? Characteristics of ESD

As touched upon in chapter 1, education may be regarded as sustainable if the normative orientation of sustainability is ingrained in the purpose, policies and practice of education, as well as in the underlying paradigms (cf. Sterling, 2004, 2009). In the framework of ESD, such cultural change at all levels of education (systems) would result in an effective empowerment of people of all ages with relevant capacities and competencies to contribute to SD (cf. SDG 4.7, UNESCO, 2020). At the micro-level of teaching and learning, extensive work has been conducted, specifying what such empowerment may entail for individuals of different ages and in different contexts and positions (on contextually differentiated sustainability competencies, e.g., Barth et al., 2007; Brundiers et al., 2021; Eberz et al., 2023; Haan, 2008; Redman & Wiek, 2021; Singer-Brodowski et al., 2025). Depending on assumptions regarding the roles of education in societies and societal change (cf. Jickling & Wals, 2008), empowerment as part of a sustainable education includes more or less focus not only on the *ability* to act, but also on the motivation and capabilities to do so, which links to the concepts of action competence, self-efficacy and agency (Hamann et al., 2024; Kranz et al., 2025; Mogensen & Schnack, 2010; Olsson et al., 2022). In consideration of the path-dependencies of unsustainable systems and deeply held mindsets and worldviews, this is taken further by calls for the development of transgressive capacities to challenge and disrupt current unsustainable paradigms and contribute to systemic change (e.g., Göpel, 2016; Lotz-Sisitka et al., 2015;

Schneidewind, 2013; Ziervogel et al., 2016). Within this breadth of perspectives, an overarching objective of sustainable education may be described as to develop the *“ability of individuals, institutions and organizations to respond sufficiently and appropriately to the pressing realities which affect lives and natural systems globally”* (Sterling, 2024, p. 11). As an educational concept dedicated to this, ESD is, at the level of concrete educational practice, associated with participative, learner-centred, facilitative and real-world oriented learning, action- and efficacy-orientation as well as an integrative perspective on experiential, cognitive and socio-emotional dimensions (e.g., Grund & Brock, 2019; Grund et al., 2024; Haan, 2008; Ojala, 2016; Rieckmann, 2018). It emphasises critical reflection, future-orientation and collaborative learning (e.g., Rieckmann, 2012; Wals, 2011), and its pedagogy is consequently mirrored in new assessment practices (Fischer et al., 2025; King et al., 2024; Redman et al., 2021). Such education requires, as a breadth of literature highlights and specifies, considerable capacity building on the side of educators (e.g., Corres et al., 2020; Fischer et al., 2022; Millican, 2022; Rieckmann & Barth, 2022; Timm & Barth, 2021).

Tensions: What to Aim for? And Whom to Attribute Responsibility to?

Considering the ambitious objectives outlined in the preceding paragraph, questions arise concerning underlying tensions. While the aim to empower learners for sustainability may seem simple at first glance, two of such foundational debates are discussed in the following as they are both closely connected and central to the quest to measure sustainable education in a meaningful way: (i) the navigation between emancipation and indoctrination and (ii) the allocation of responsibility (for an overview, cf. also Fischer, 2014).

Concerning the first, Vare and Scott (2007) have suggested differentiating two forms of sustainability learning: ‘ESD 1’, focused particularly on promoting informed sustainable actions and ways of thinking based on established knowledge about sustainability problems and solutions, and ‘ESD 2’, following a more open process-orientation of empowering learners to reflect upon and deal with sustainability challenges and their dilemmas and contradictions (similarly: Sterling, 2010; an overview and suggestion for ‘ESD 3’: Pettig & Singer-Brodowski, 2024)). While Vare and Scott (2007, p. 192) deliberately conceptualised both as complementary and suggested a *“yes-and approach”* instead of an *“either-or debate”*, the first is sometimes coined an instrumental or deterministic approach (education *for* SD), and the latter is contrasted to the first as more emancipatory and indeterministic (education *as* SD, e.g., Jickling & Spork, 1998; Wals et al., 2008). One of the central questions behind this debate is where to draw the line between timely purposeful, empowering education (cf. Klafki, 1996/2007) on the one hand, and indoctrination on the other (cf. Jickling, 1992). One response to this frequently referred to stems from the field of political education in German-speaking countries, where the so-called

Beutelsbach Consensus (cf. A. S. Christensen & Grammes, 2020; Reinhardt, 2016; Fischer, 2014) outlines principles for education dealing with controversial issues. The consensus includes three key elements: (1) a prohibition on overwhelming learners (e.g., imparting opinions, not allowing for independent judgements), (2) a requirement to present and discuss controversial issues in science and politics as such (e.g., to include different points of view, to not suppress relevant perspectives), and (3) an emphasis of empowering learners to follow their own interests in analysing political situations (i.e., a focus on developing political literacy). One frequent misconception about the Beutelsbach Consensus concerns a need for neutrality among educators. Though teachers often seem to refer to neutrality when teaching controversial issues (Breitenmoser et al., 2024), this is neither directly implied by the imperative for controversy nor by the prohibition on overwhelming learners (cf. A. S. Christensen & Grammes, 2020; Kenner, 2020). In fact, ‘value-free, neutral education’ is not only likely impossible (cf. Sterling, 2009; Wals, 2020 on the normative entrenchment of modern education), but educators are often bound to normative frameworks (e.g., human rights, as inscribed in constitutions and (inter-)national laws). In an attempt to reconcile the sometimes stark separation between the above-mentioned strands (e.g., ESD 1/2), Sterling (2010) argues for them to not only be interrelated and positioned on a spectrum where most educational practice links to both, but that they also address different levels of learning (cf. also Barth, 2015). While he describes behaviourist approaches as first-order learning responses (basic learning), Sterling points to capacity-building approaches as second-order learning, empowering learners to reflexively question assumptions and practice. Building on this lens of learning theory, he highlights third-order social learning as a process of epistemic learning in multi-stakeholder arrangements with the potential for larger-scale paradigmatic shifts.

Closely linked to the preceding, a second foundational tension in the field of sustainable education concerns to whom responsibility for problems and solutions is attributed. While it has been argued with Klafki (1996/2007) that general education is to enable learners to evaluate epochal key challenges and to be able to contribute to solving them, this is, as various scholars highlight, not to imply overburdening individual learners with responsibility (early e.g., Jickling, 1992; Jucker, 2002; Stevenson, 2007). In fact, many current problems of unsustainability are of systemic and structural nature, therefore political and not realistically solvable solely through behavioural changes by individuals (cf. Grunwald, 2010; Niebert, 2019, 2021). Despite this, Kranz et al. (2022, p. 1) found in a systematic review of literature on climate literacy programmes that while *“responsibility for emissions is attributed to the public sphere, the debate about mitigation usually focuses on the private sphere”*. Such a placement of responsibility for solutions at the private level is in line with what Zou (2023) and others criticise as a neoliberal individualisation of responsibility for solutions to problems caused through, at

centre stage, collective (political) decisions and corporate vested interests (e.g., by the fossil industry; cf. Supran & Oreskes, 2021). In this sense, educational institutions are neither in the position to solve the structural and political problems of contemporary societies themselves, nor to offload this responsibility onto learners (on educationalisation and criteria for the (in)appropriateness of dealing with societal problems in education, cf. Bridges, 2008). Yet educational institutions can be in a position to empower learners to be able to critically evaluate the economic and political decisions and systems underlying current crises and to contribute to shaping more sustainable pathways (e.g., Niebert, 2019; Rieckmann, 2026; Schank & Rieckmann, 2019). Looking at ESD, this also implies a critical perspective on underlying assumptions and narratives in ESD policies and practice which may, in fact, even contribute to consolidating a resilient unsustainable system (e.g., Lotz-Sisitka et al., 2015; Kopnina, 2012, 2015 on neoliberalism in context of ESD).

Sustainability Integration: What is Meant?

While there are further relevant foundational debates on the characteristics of sustainable education (e.g., on anthropocentrism or neocolonial narratives in ESD), a detailed elaboration of these debates would be beyond the scope of this thesis. As particularly foundational for the quest to operationalise and assess its systemic integration into policy and practice, I only highlight one last core question in the field here: What would be an adequate breadth and depth of the educational response to current unsustainability? In his early conceptual works on sustainable education, Sterling (2003) proposed differentiating between different ways for education systems and institutions to respond to these challenges: (1) by denial, rejection or minimal response, (2) through a 'bolt-on' of sustainability to an otherwise unchanged system (accommodation, first-order change), (3) through a 'build-in', changing the system by reforming it (second-order change), and (4) through whole-system redesign, reordering central assumptions (epistemic and paradigmatic change). While, as Wals and Benavot (2017) reflected on the 2016 Global Education Monitoring report, international ESD activities had to that point often remained at an additive level, a 'bolt-on' following Sterling's heuristic, it is frequently argued by scholars and within policy documents for sustainability to become an integral part of future-oriented quality education (e.g., Didham & Ofei-Manu, 2018; Laurie et al., 2016; UNESCO, 2020). To better understand what a 'built-in' or 'redesign' in the words of Sterling would imply concretely, it can be useful to consider sustainability in education systems at the micro-, meso- and macro-level (e.g., on indicators: Rode & Michelsen, 2008).

Since the micro-level (specific learning processes, settings and outcomes) has been discussed extensively with respect to its conceptualisation, operationalisation and assessment in other works (see above), the following sections focus on policy integration at the macro-level (2.2)

and organisational practice (meso-level; 2.3) as the two central lenses adopted in this dissertation, further delineating the specific research gaps to which the articles respond. Subsequently, section 2.4 provides an overview of the debate on indicators for assessments to form the basis for the specification of the overall research design in chapter 3.

2.2. Integration of Sustainability in the Education System: A Policy Transition

To consider the integration of sustainability in education systems, the use of the term *system* in this dissertation requires clarification. While there is no universal definition for systems, in very general terms, they may be understood as sets of interacting and interconnected elements that form a unit or whole, distinct from and sometimes embedded in its environment and other systems, with specific (emergent) properties (e.g., Mele et al., 2010; Nikiforova, 2022). In this sense, social systems, often defined via actors (e.g., Parsons, 1951) or communication (Luhmann, 1998), may be described as social entities with specific rules, (infra-)structures and cultures, mostly linked to a social purpose or function. Drawing on this understanding, the education system would include, as Sterling (2004) puts it, the paradigm, purpose, policy and practice of education. As a sub-system of society, the education system is nested in and in interaction with other societal sub-systems, implying that it is, in the process of a sustainability transition, in correspondence and feedbacks with these (ibid.). In other words: Large-scale societal trends, such as current polycrises (Lawrence et al., 2024), digitisation or political sustainability backlashes (Bosetti et al., 2025) impact education, while education systems can also impact larger-societal trends and discourses (e.g., through empowerment of stakeholders). With respect to paradigm, purpose, policy and practice of education (Sterling, 2004), the empirical parts of this dissertation particularly focus on the levels of policy at the macro-level of education systems – details follow in the remainder of this subchapter – and (organisational) practice (meso-level; section 2.3). Both link in many ways to the paradigm and purpose of education, which are hence discussed in the four articles and their synthesis.

With respect to the policy integration of sustainability at the macro-level of education systems, the term policy is used here in a wide sense, including regulatory, administrative, budgetary and normative frameworks which may be considered conditions for educational practice. As outlined in chapter 1, considerable ambitions have been formulated to integrate sustainability in education policies both internationally (e.g., Council of the European Union, 2022; UNECE, 2005; UNESCO, 2021a) and in national action plans and strategies (e.g., Government of Ireland, 2022; National Platform ESD c/o BMBF, 2017). These ambitions correspond with the introduced notion of a built-in of sustainability or, in some cases, even a systemic redesign (Sterling, 2003). More specifically, mainstreaming ESD and global citizenship education (SDG 4.7.1; UNESCO, 2019b) implies far reaching policy transition equivalent with a regime shift

towards a sustainable education framework (cf. in transition studies; e.g., Geels & Schot, 2007). Such a systemic policy transition would involve a reordering of priorities in the rules (e.g., laws), instruments (e.g., curricula, assessments, funding, goal-setting) and governance (e.g., multi-stakeholder coordination) of education. The indicator for the introduced SDG 4.7.1 refers to a mainstreaming of ESD and global citizenship education in (a) national education policies, (b) curricula, (c) teacher education and (d) student assessment (UNESCO, 2019b). To date, reporting on this indicator is based on countries' self-reporting in line with the UNESCO 1974 Recommendation (revised in 2023; cf. UNESCO, 2023a). While self-reporting by countries, such as within the frameworks of UNESCO or UNECE (cf. chapter 2.4), can foster ownership, provide a governance impetus, and help to highlight and communicate positive examples, there is also considerable critique about inherent biases (cf. Benavot & Williams, 2023). As Nazir et al. (2011, p. 376) put it, self-reporting tends to yield *"uncritical catalogues of successes, which are overtly silent about problems and failures"*. As a built-in or redesign of policies in line with sustainability would, however, imply anything from a deep systemic integration to a paradigmatic shift in assumptions, it is likely that countries' self-reporting on progress is limited in terms of its indicative value. The question therefore is what approaches exist to a more independent, scientific assessment of a systemic integration of sustainability and ESD into the macro-level political and administrative framework conditions.

Looking at the research on the degree of policy integration (on general policy research in the field, cf. Aikens et al., 2016), much research to date has addressed the international programmes associated with ESD (for an overview: Webb et al., 2025). In terms of national implementation, studies have specifically focused on sustainability in curricula, both generally (e.g., Fredriksson et al., 2020; Jóhannesson et al., 2011; Krah et al., 2021; O'Byrne et al., 2015; Weiss & Barth, 2019; Weiss, Barth, & Wehrden, 2021) or with specific foci such as the roles of time or emotions in ESD (Cristóvão et al., 2023; Grauer et al., 2022). Further, research approaching the macro-level of state-wide or (multi-)national policy-setting has addressed sustainability in teacher education programmes (e.g., Ferreira et al., 2007; Goller & Rieckmann, 2022; Gough, 2016), the link between sustainability and quality assurance systems (e.g., Janssens et al., 2021; Mogren & Gericke, 2017; Ryan & Tilbury, 2013), or policy integration in specific areas of education (e.g., Cheeseman et al., 2019). Yet while these approaches each offer valuable insights into specific dimensions of policy transitions towards a sustainable education framework, there has been a gap when it comes to independent and systematic analyses of implementation in full national education systems (for first examples, cf. Beveridge et al., 2019; Haan, 2021; Holst et al., 2020; Singer-Brodowski et al., 2019). Further, Brent Edwards et al. (2020), Giangrande et al. (2019) and Gallwey (2016) all highlight, with different foci, a lack of valid and reliable methodological frameworks to assess the introduced SDG

4.7.1. The first study in this dissertation specifically responds to this by developing and applying an input-indicator for SDG 4.7.1 on the basis of a large-scale document analysis and an external expert review (Holst, Singer-Brodowski, et al., 2024). While study 2 (Holst, 2023) and 3 (Holst, Grund, & Brock, 2024) focus on the meso-level of organisations (cf. chapter 2.3), they also highlight implications at the macro-level of political and administrative framework conditions. Focusing on perspectives of principals on schools and the school system, study four (Holst, Brock, et al., 2025) further includes a focus on macro-level policies and their implications for practice.

2.3. Organisational Sustainability Practice: Towards a Whole Institution Approach?

Providing a structured setting and environment for formal, non-formal and informal learning, educational institutions are a central pillar of education systems. While the term institution in much of social science research refers to sets of rules, norms and practices organising social behaviour (cf. Hodgson, 2006; Ostrom, 1990/2015), educational institution is here used in a narrower sense to focus on organisational manifestations and practice, e.g., in schools, kindergartens or higher education institutions, but also in non-formal settings such as museums, youth centres or as part of adult education. At the meso-level of education systems, educational institutions are embedded in their regional environment, where place-based and real-world relevant learning is often linked to learning in regional educational landscapes (e.g., Fischbach et al., 2015; Kolleck, 2019). In fact, as much of the literature on *“hidden curricula”* highlights (e.g., Jackson, 1968; Wals, 2020; Winter & Cotton, 2012), learning occurs not only through intended instruction and engagement with formally planned content, but permeates everyday experiences within and around educational institutions. Informal learning, i.e., the unstructured, often unintended learning through experience and socialisation, is frequently highlighted as making up a major proportion of human learning (cf. Barth et al., 2012; Conlon, 2004; Gramatakos & Lavau, 2019; Livingstone, 2001).

Consequently, attention to the everyday experiences and practice of (un-)sustainability within and around schools, universities, and other educational institutions has been a central pillar of the discourse on sustainability in education since its early development (e.g., Hargreaves, 2008; Henderson & Tilbury, 2004; Shallcross & Robinson, 1999; Sterling, 2001). In this context, the concept of a WIA is used to broadly refer to a *“mainstreaming sustainability into all aspects of the learning environment”* (Buckler & Creech, 2014, p. 30). As with the systemic integration into macro-level policies (chapter 2.2), various (inter-)national declarations and recommendations have called for the implementation and practice of WIAs across all areas of education (e.g., UNESCO 2020, 2021a, UNECE 2022, Council of the European Union 2022; Southern African Development Community, 2022; for Germany: Standing Conference of the Ministers of

Education and Cultural Affairs, 2024; National Platform ESD c/o BMBF, 2017). But not only political stakeholders, also associations of educational institutions such as the International Association of Universities (cf. Kohl et al., 2022), the German Rectors' Conference (2025) or the German Adult Education Association (Buckbesch & Heinen, 2024) have endorsed WIAs as a being a more consistent and presumably more effective way of integrating sustainability in education. The idea of a WIA is thereby not specific to the narrower sustainability discourse, but is also used in contexts such as health (e.g., Hunt et al., 2015; Wyn et al., 2000), anti-bullying (e.g., Cross et al., 2018) or general organisational development (e.g., Giri et al., 2025; Slavin & Madden, 2013) – many of which are inherently connected to a sustainable education paradigm.

Theoretical and Conceptual Foundations: Why a Whole Institution Approach?

As the notion "*living what we learn*" (Buckler & Creech, 2014, p. 89) has become one of the major concepts in the debate on sustainable education, many references to WIAs are programmatic in nature (for an overview in higher education, cf. Kohl et al., 2022). In contrast, there seems to be a lack of literature that systematically approaches the WIA as an analytical concept and delves into its theoretical and empirical foundations. Before focusing specifically on the conceptualisation and assessment of WIAs, the following paragraphs thus first introduce an exemplary range of (inter-)disciplinary works that may contribute to answering why it seems plausible to many practitioners, scholars and policy stakeholders that a WIA would indeed be a (more) effective way to practice sustainability within and around educational institutions. To approach this question, it may be useful to first take a step back and fundamentally consider ways in which people learn, and what current educational practice often focuses on. As an example, Heron (1992) describes in his seminal work four distinct yet interconnected ways of knowing: (1) experiential knowing, grounded in resonance and embodied presence in the inside- and outside world, (2) presentational knowing, symbolised in visuals, music or other forms of meaningful aesthetic creation, (3) propositional knowing, which is, in essence, conceptual knowledge expressed in statements or theories, and (4) practical knowing, as the ability to actually do something. On this basis, Heron argues that holistic approaches to learning integrate multiple ways of knowing. While there are also other ways to conceptualise learning, this example is to highlight one widely undisputed point: Much of current formal education, particularly in western education systems, focuses strongly on what Heron calls propositional knowing, while more affective, creative and practical forms of learning often seem underrepresented (e.g., Fler & Hammer, 2013; Biesta, 2009 on the effects of focusing on measurability). As an empirical example, we found in a systematic analysis of German school curricula that while the aim of fostering cognitive competencies is ubiquitous, emotional competencies are barely addressed (Grund & Holst, 2023). With its emphasis on experiential and participative learning, linking also to the works of John Dewey (e.g., 1916, 1938), and the

highlighting of informal, socio-emotional dimensions, the notion of a WIAs follows a contrary approach to current practice: It employs a specifically holistic perspective on learning, considering not only conceptual knowledge, but social learning, experience and action.

Linking to experiential and practical learning, conceptualisations of embodied or grounded cognition, i.e. the foundation of cognition in sensory, physical experience and action, have recently gained increasing recognition within and beyond the field of cognitive psychology (cf. Barsalou, 2008; Fugate et al., 2019). Applied to the context of sustainable education, this further highlights the role of material and social environments as critical co-constituents of learning (Brock, 2022), which is a root idea beneath the concept of WIAs. If connected with the abovementioned observations by Wals (2020) that current education systems often embody unsustainable habits and values, a focus on sustainability solely as additional content, neglecting context, could further lead to already observable experiences of dissonance which can result in feelings of hopelessness or disillusion (e.g., Hickman et al., 2021). As was found by Grund and Brock (2019), such disillusion and lack of hope may inhibit action towards sustainability – another reason why the focus on collective and real-world experience and action through a WIA may support agency. Focusing on the key factors that determine human behavioural changes, a recent meta-analysis by Albarracín et al. (2024) further underscores the relevance of experienceable social and structural defaults: Assessing the predicting effects of a wide set of variables, the authors found that habits and access to opportunities for actions stand out as the most impactful (*ibid.*). This links, also within the field of cognitive psychology, to the wealth of research on cognitive biases that affect human action (e.g., conformity bias, consistency bias, availability heuristic, framing effect, status-quo bias, or confirmation bias) (cf. Korteling & Toet, 2022; Tversky & Kahneman, 1974), many of which, again, refer in some way or another to biases towards habitualised and structurally available (standard) ways of thinking and acting (cf. Oeberst & Imhoff, 2023). This is consistent with what Kahneman (2003) called the automatic mode of acting, i.e., the fast and intuitive decisions that we make without considerable conscious effort based on engrained defaults on an everyday basis as compared to the few decisions made on the basis of explicit deliberation. This notion of considering the role of settings for action has also been highlighted in the works on WIAs to health promotion (e.g., Mūkoma & Flisher, 2004 on the Ottawa Charter). In the cultural sciences, Hansen (2011) describes these defaults as the conventions in collectives, which continuously (re-)constitute through different forms of communication and are vital for social cohesion. In organisational contexts, such conventions are manifested in experienceable artefacts (e.g., visible and feelable (infra-)structures, symbols and actions), underlying norms, values and attitudes as well as deeply engrained and often unconscious assumptions (Fischer, 2011; Holst, Fritz, et al., 2025; Schein & Schein, 2017). Focusing on the directly visible and experienceable environment,

scholars in the fields of architecture and design have further highlighted the relevance of the socio-physical environment for learning (e.g., Baars et al., 2023; Baars et al., 2021; Taylor & Enggass, 2009) and the importance of collaborative design involving the relevant stakeholders at and around the educational institution (Bøjer, 2019).

Concept, Status, Effectiveness and Transition Pathways: Research Gaps

As these solely exemplary contributions from different disciplines serve to highlight, there is a considerable theoretical foundation that can support calls by practitioners, scholars and policy stakeholders for more integrative approaches to sustainability in education. Specifically, WIA concepts address the different and connected ways of experiential and participative (social) learning, recognise the influence of the socio-physical environment and focus on the structural and behavioural defaults at and around educational institutions. If, as the previous sections suggest, a WIA seems theoretically well-founded and is frequently called for, further questions arise: What are the specific characteristics of WIAs to sustainability in education across different areas of education (conceptualisation)? And what is the available evidence on the status and effectiveness of WIAs as well as on associated transition pathways?

Concerning the first, existing models to conceptualise a WIA to sustainability have either been specific to certain areas of education (e.g., Barth et al., 2012; Henderson & Tilbury, 2004; McMillin & Dyball, 2009; Shallcross et al., 2006; Tilbury & Galvin, 2022; Wals et al., 2024; Wals & Mathie, 2022), have addressed specific sub-components (e.g., areas of action; cf. Djordjevic & Cotton, 2011; Niedlich, Bauer, et al., 2020) or have set focus on relevant, yet specific thematic or pedagogical approaches (e.g., on consumption cultures, cf. Fischer, 2011). Further, a range of guidelines are available that focus on specific contexts of educational practice (e.g., Breiting et al., 2005; Forssten Seiser et al., 2023; Gibb, 2016; UNESCO, 2017a; WWF, 2011). Yet there has been a gap when it comes to a systematic conceptual synthesis to structure key characteristics of WIAs across different areas of education in one coherent model. As part of the second study (Holst, 2023), such conceptual synthesis is developed on the basis of a systematic review of the international grey and scientific literature on WIAs and refined through an expert review.

As to the status and potential effectiveness of WIAs, research to date has mostly focused on

- (i) individual or comparative case-studies (e.g., Bosevska & Kriewaldt, 2020; Evans et al., 2012; Ramísio et al., 2019; Schopp et al., 2020; on moving beyond: Barth & Thomas, 2012) and interviews and/or surveys at a limited number of organisations (e.g., Mogren & Gericke, 2019; Mogren et al., 2019; Torsdottir et al., 2023);

- (ii) the development and application of assessment tools to analyse real-world indicators and (mostly self-reported) actions on sustainability (e.g., Caeiro et al., 2020; Fischer et al., 2015; Urbanski & Filho, 2015; Warner & Elser, 2015); and
- (iii) comparisons between certified and uncertified organisations in terms of their practice and associated outcomes particularly among learners (e.g., Barratt Hacking et al., 2010; Boeve-de Pauw & van Petegem, 2013; Goldman et al., 2018; Olsson et al., 2019; Spínola, 2015).

While the three main strands of research have led to considerable insight into organisational development, highlighted good practices and barriers and provided tools for research and practice, neither allows for large-scale perspectives on the current (and desired) degree of WIA implementation and associated framework conditions within full education systems. In terms of effectiveness, the studies that have compared certified and uncertified organisations have often yielded mixed or no results (e.g., Cincera & Krajhanzl, 2013; Olsson et al., 2019; Spínola, 2015; for an overview: Niebert, 2019). Also, while some of the available assessments allow for a perspective on specific real-world indicators and potentially biased self-reports, few studies have systematically and quantitatively assessed the perspectives of the, from an educational perspective, key stakeholders in education: learners and educators. In reflecting on progress in the field of higher education, Kohl and colleagues summarised in 2022 (p. 229) that there was still a lack of systematic data on the “*effectiveness and efficiency*” of WIAs. Also, while there have been various case-studies and few larger analyses of drivers and barriers (cf. Evans et al., 2012; Verhulst & Lambrechts, 2015; Weiss, Barth, Wiek, & Wehrden, 2021; Zachariou & Kadji-Beltran, 2009), the same seems to be the case for large-scale (e.g., national-scale) data on the current status and possible transition pathways. There is thus not only a lack of systematic data on the views of learners and educators, but also of leaders in educational institutions (e.g., school principals⁹; Cebrián et al., 2022; Müller et al., 2022). Based on the conceptual synthesis of WIAs, the third study in this dissertation (Holst, Grund, & Brock, 2024) responds to the gaps concerning instruments to systematically assess experienced WIA implementation and large-scale data on its status and effectiveness. For this, it introduces the development, validation and first national-scale application of the WIA-Scale. Focusing on school education and the perspective of principals, the fourth study (Holst, Brock, et al., 2025) adds to this by addressing the current and desired status of whole-school sustainability as well as challenges and drivers.

⁹ The term principal is used here synonymously to other terms describing the role of a school leader (e.g., director, headmaster).

2.4. Indicators and Assessments: How to Measure Sustainable Education?

As discussed in the previous sections, numerous studies have assessed specific elements of systemic sustainability integration and organisational practice. Yet they have also pointed to a lack of large-scale empirical data on the current and desired status, effectiveness as well as barriers of and drivers to sustainable education. In a time where public discourse and policy-making are highly attentive to what is measured, it is key to consider the conceptual, methodological and normative foundations of such measurements. As Biesta (2009) has highlighted, what is measured, e.g., as an educational process or outcome, is not necessarily what is relevant and purposeful, but often what is easy to measure and compare. In this light, the development of meaningful indicators is critical not only as a scientific endeavour, but also as a supportive contribution to SD (cf. Biermann et al., 2017; Hák et al., 2016). Building on a strand of discourse on indicators for sustainable education, the following paragraphs provide an overview of purposes, functions and levels of indicators and associated methods to set the ground for the subsequent positioning of the four research articles as part of this dissertation.

Fundamentally, a differentiation is to be made between the *indicandum*, i.e., what is to be measured, as compared to *indicators*, which are simplified representations of reality based on specific measurement procedures (Brock, Waltner, & Rabinowitz, 2025). Indicators are, as approximations, used to systematically assess and monitor quantitative and qualitative characteristics of what is to be measured (on the use in educational monitoring, cf. Ioannidou, 2010). Indicators thereby not only help to provide data, but also channel attention and facilitate further action (cf. Tilbury & Janousek, 2006). In the context of sustainable education, important groundwork on indicator development was conducted by the UNECE expert group on indicators for tracing the implementation of the UNECE ESD strategy (UNECE, 2009) and in the context of Australia and the UNESCO-IUCN in the Asia-Pacific (Tilbury & Janousek, 2006; Tilbury et al., 2007). In Germany, early work on indicators was done during the UN Decade on ESD (Michelsen et al., 2011; Nickel & Müller, 2008; Rode & Michelsen, 2008) and continued as part of the national ESD monitoring (e.g., Brock et al., 2018; Singer-Brodowski et al., 2019) and several projects on indicator development (e.g., Günther et al., 2022; Hemmer et al., 2024). Indicators across these and later efforts draw on both qualitative (observational) and quantitative data. While quantitative indicators are widely used in educational reporting and policy-making, they are at times criticised for a bias towards measuring the easily quantifiable instead of the meaningful (Biesta, 2009). Qualitative indicators, on the other hand, can support the analysis of specific characteristics – similar to descriptors (e.g., Council of Europe, 2018) – and offer opportunities for social learning and co-creation among stakeholders (e.g., Tilbury, 2007). Yet they fall less into the logics of the “*age of measurability*” (Biesta, 2009, p. 33).

In terms of functions of indicators, Tilbury and Janousek (2006) and Tilbury et al. (2007) suggest differentiating four functional types, whereby specific indicators may contribute to more than one: (1) status indicators (i.e., the current overall picture on a specific question), (2) facilitative indicators (e.g., describing context conditions, process characteristics and learning), (3) result or effect indicators (e.g., outputs, outcomes, impacts and performances) as well as (4) communicative indicators, which focus specifically on accessible communication and dialogue with relevant stakeholders. Across the four, indicators not only provide information, but can also support the process of implementation (for an overview, cf. Brock, Waltner, & Rabinowitz, 2025). Focusing on different stages in the education system, indicators may address inputs (e.g., conditions for implementation), processes (e.g., activities, experienced practice), outputs (e.g., results of activities) as well as outcomes and impacts (e.g., on competencies, actions) (Brock, Waltner, & Rabinowitz, 2025; Tilbury & Janousek, 2006; Tilbury et al., 2007; UNECE, 2009). At these different stages, indicators may allow for measurements of the status, developments and effects (see above), not only for scientific assessments and educational reporting, but also as tools for self-analyses within specific educational institutions (Rode & Michelsen, 2008).

Depending on the subject at focus, what constitutes an input or output/outcome may differ (e.g., empowerment of teachers as an outcome of teacher education, but as an input for school practice; cf. Brock, Waltner, & Rabinowitz, 2025). Also, links between these different stages are frequently assumed; yet this assumption requires close consideration and is often flawed due to, to name just examples, a lack of linear relationships between inputs and practices, context specificity of actions and results, relevant factors outside the locus of control, inclusion only of what is currently measurable, attribution problems and time lags. Another problem that is frequently criticised in the practical use of indicators within policy-making on sustainable education concerns reliance on self-reported data (cf. Benavot & Williams, 2023). As part of the mentioned efforts by UNECE and UNESCO, indicators were designed mostly for national reporting, using dichotomous (yes/no) schemes and sharing of good practice examples based on self-assessments. While this procedure was motivated by the objective of fostering participation and increasing legitimacy among member states, the data yielded is frequently criticised within the academic discourse as unreliable and misleading due to, among others, inherent conflicts of interest (e.g., Brockwell et al., 2022; Nazir et al., 2011). Reviewing characteristics of ideal indicators, Brock, Waltner, and Rabinowitz (2025) therefore suggest taking a set of key considerations into account, ranging from indicators being valid, reliable and assessable at reasonable cost with adequate samples to them also being highly accepted, credible and relevant, of communicative value and with the ability to foster effective solutions.

Having in mind the need to attend to the purposes underlying indicators (cf. Biesta, 2009), their different functions (cf. Tilbury & Janousek, 2006; Tilbury et al., 2007), different stages (input, process, output, outcome) as well as for them not only to be valid and reliable, but also feasible, facilitative and effective (Brock, Waltner, & Rabinowitz, 2025), a last consideration to be highlighted here concerns different layers in a multi-level system. As a heuristic to cluster different groups of indicators, Rode and Michelsen (2008) differentiate between the already introduced (1) macro-level, including the (inter-)national or regional systemic conditions and initiatives (e.g., policies, resource provision, governance processes), (2) meso-level, where educational institutions are situated within regional environments and (3) micro-level, which involves specific learning situations and outcomes. If focused on learners as key recipients, indicators at the macro-level mostly include inputs (e.g., framework conditions such as laws, curricula and funding), while indicators at the meso- and micro-level are often (not always¹⁰) focused on processes, outputs and outcomes (e.g., experienced educational practice, learning environments, networks, development of competencies, agency and real-world change).

Within the sketched overall framework for indicators, conceptual, methodological and empirical contributions are made within this dissertation across different layers (macro, meso; the latter linked micro), stages (inputs, processes; the latter linked to outcomes) and indicator types (status, facilitative, effects, communication) (details are provided in chapter 3.1). Within the four articles, an independent scientific perspective is deliberately applied, distanced from, for other reasons in some instances valuable, self-reporting by political or administrative representatives. In this, leaning on the words by Brock, Waltner, and Rabinowitz (2025), the four articles attempt to contribute to the development of ‘more ideal indicators’ for sustainable education. As highlighted in sections 2.1-2.3, the works in the dissertation thereby specifically focus, in the heuristic by Sterling (2004), on policies and practices where purpose and paradigm manifest and become visible.

After this chapter has sketched relevant foundations for conceptualising, operationalising and empirically assessing the systemic integration and organisational practice of sustainability in education, the following third chapter begins by providing an overview of the overall research design. Subsequently, the four research articles are summarised to lay the conceptual, methodological and empirical foundations for the joint discussion in chapter 4.

¹⁰ As an example of the complex allocation, the infrastructure provided at an educational institution may be considered an input to educational practice, as much as it may be viewed as part of the learning process itself (cf. chapter 2.3).

3. Assessing the Integration of Sustainability in Education Systems and Organisational Practice: Overall Research Design and Key Findings

3.1. Overall Research Design

The four individual articles as part of the dissertation each offer specific contributions to the conceptualisation, operationalisation and assessment of the systemic integration and organisational practice of sustainability in education. The work applies an interdisciplinary, multi-method approach, addressing multiple data sources, and pertaining to different system layers, stages and indicator types (Table 1). Before the key insights from the four articles are summarised (chapter 3.2), the following lines briefly introduce the focus of the four studies and highlight the core considerations of the research design based on the foundations introduced in chapter 2. Accompanying this, Figure 1 illustrates the relationship of the four studies to the different layers of education systems as they are embedded in a wider societal landscape. Further, Table 1 provides an overview of the objectives of the studies, addressed layers, stages and indicator types as well as research question(s), applied method(s) and data.

Using the introduced system layers (Rode & Michelsen, 2008; Figure 1) as a structuring heuristic, a considerable emphasis of available large-scale studies was described in chapter 2 to focus on the micro-level of, among others, empowerment of learners (e.g., competence development) and specific learning situations. Responding to a lack of large-scale assessments and appropriately valid and reliable methodological approaches at the macro-level, study 1 (Holst, Singer-Brodowski, et al., 2024) focuses on the policy integration of sustainability by developing and applying an input-indicator to assess the status and diffusion of ESD and sustainability within documents of education systems. The multi-method design includes knowledge integration with relevant key stakeholders as well as an external expert evaluation based on a lexical analysis of over 11,000 documents from the exemplary German education system. At the meso-level of educational institutions, study 2 (Holst, 2023) responds to the lack of a conceptual synthesis concerning the core characteristics of WIAs across different areas of education. For this, it combines a systematic review of the international literature on WIAs ($n = 104$ documents) with a multi-stakeholder expert review to synthesise and validate central characteristics of WIAs in a joint framework. It further highlights systemic enabling conditions at the macro-level of education systems as well as gaps within the debate. Study 3 (Holst, Grund, & Brock, 2024) builds on this conceptual groundwork to develop, validate and apply the WIA-Scale as a process indicator to systematically assess sustainability experience in line with a WIA at and around educational institutions from the perspective of learners and educators (application in Germany, $n = 2,985$). Linking the meso-level of organisational

practice with the micro-level of individual experience and learning, it further assesses the effectiveness of WIAs in terms of its association with central sustainability-related outcomes (e.g., empowerment, behaviour, knowledge). Focusing on the largest area of education, school education, study 4 (Holst, Brock, et al., 2025) addresses the critical perspectives of leaders in educational institutions. Based on 80 qualitative interviews and a representative survey of 1,310 principals, the mixed-method study provides information on the current and desired status of sustainability in school practice (meso-level) as well as on barriers and drivers across the micro-, meso- and macro-level of school education.

In terms of indicator types (Tilbury & Janousek, 2006), the three empirical studies (1, 3, 4) provide systemic, national-scale information on the status of sustainability at specific levels of education (e.g., study 1 at the macro-level, study 3 and 4 at the meso-level). Though not inherently designed as transdisciplinary approaches (cf. Jahn et al., 2012; Lang et al., 2012), they contain communicative and facilitative elements, e.g., by including relevant stakeholders in the study design (study 1; choice of documents), validation of instruments (study 3) or data collection and communication (study 4). Further, study 3 includes a focus on effects at the micro-level, assessing relations between sustainability experience in line with a WIA and outcomes among learners and educators. Regarding stages of education, the proposed indicators focus on the input-level (study 1 and 4) as well as the process-level (study 2, 3 and 4), the latter of which is further linked to the level of outcomes (study 3).

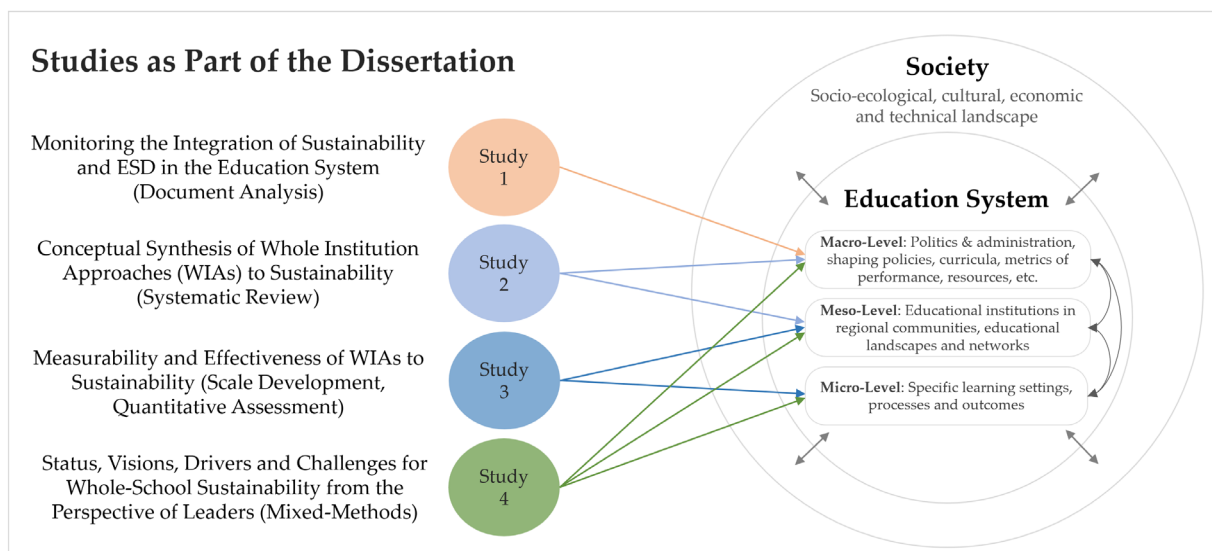


Figure 1: Overview of the four studies as part of the cumulative dissertation and their relation to different levels of the education system (Michelsen & Rode, 2008).

Table 1: Overview of the focus and objectives of the four articles, addressed system layers (micro, meso, macro; Rode & Michelsen, 2008), stages (input, process, output, outcome) and indicator types (status, facilitative, effect, communication) (cf. Brock, Waltner, & Rabinowitz, 2025; Tilbury & Janousek, 2006; UNECE, 2009) as well as research question(s), applied method(s) and data.

Article	Focus / Objectives	System Layers	Stages	Indicator Types	Research Question(s)	Method(s)	Data
Holst, Singer-Brodowski, et al. (2024)	Operationalisation and application of an input-indicator to assess the systemic integration of Education for Sustainable Development (ESD) and sustainability in education systems	Education system (macro)	Inputs (baseline and developments over time)	Status, facilitative, communication	How can the quality, depth and speed of implementation of sustainability, ESD and related concepts within education systems be operationalised for scientific assessments at the input-level of documents (indicator for SDG 4.7)? Applied to the context of the German education system, what is the status of implementation and what are discernible trends?	Lexical document analysis, qualitative content analysis, external expert evaluation	Documents (policies, curricula, training of educators, student assessment) in the four formal areas of the German education system ($n = 11,061$ documents, 6,553 new), six experts involved in the expert evaluation
Holst (2023)	Conceptualisation and operationalisation of the characteristics of Whole Institution Approaches (WIAs) to sustainability in education	Educational institutions (meso), linked to systemic framework conditions (macro)	Processes (conceptual basis), linked to inputs (external conditions)	-	At the level of educational institutions in their respective regional contexts, what characterises WIAs to sustainability across the different areas of education? How can these characteristics be synthesised in a joint framework? What are relevant conditions for implementation?	Systematic literature analysis, written expert review (qualitative and quantitative)	International peer-reviewed literature, grey literature ($n = 104$ documents), nine experts participated in the written expert review

Holst, Grund, and Brock (2024)	Operationalisation and empirical assessment of WIAs to sustainability at and around educational institutions from the perspective of those directly involved in everyday practice (learners, educators)	Educational institutions (meso), linked to learning outcomes (micro)	Processes, linked to outcomes	Status, facilitative, effect, communication	How can the WIA be operationalised for quantitative assessments focusing on the experiences of those within educational institutions (learners, educators)? To what extent is the experience of sustainability at educational institutions (WIAs) related to key aspects of effective sustainability learning (e.g., empowerment, behaviour, knowledge)?	Scale development, pretesting and validation, survey with learners and educators	Expert workshop ($n = 12$), qualitative pretest ($n = 10$), quantitative pretest ($n = 77$), quantitative survey ($n = 2,481$ learners and 504 educators)
Holst, Brock, et al. (2025)	Perspectives of school leaders (principles) on sustainability in schools and the school system	Educational institutions (meso) in a systemic environment (macro) and patterns in perspectives of leaders (micro)	Inputs, processes, outputs	Status, facilitative, communication	What preconceptions do principals have regarding sustainability? What do they view as the current status of sustainability at their schools, and how do they envision an ideal state of sustainability in future schools? What challenges and drivers do they describe as being most relevant for sustainability in school development?	Qualitative content analysis, statistical analysis of quantitative survey data	Mixed-method interviews ($n = 80$) and subsequent representative quantitative survey ($n = 1,310$) of school principals

3.2. Key Findings: Summary of Research Articles

3.2.1. Monitoring the Integration of Sustainability and ESD in the Education

System (Document Analysis, Study 1: Holst, Singer-Brodowski, et al., 2024)¹¹

SDG 4.7 sets the ambition for education systems to “ensure [by 2030] that all learners acquire the knowledge and skills needed to promote sustainable development” and highlights the central role of ESD to achieve this objective (United Nations General Assembly, 2015, p. 21). Consequently, the UNESCO member states have committed themselves to “[e]nsure that ESD is a foundational element of our education systems at all levels” (UNESCO, 2021a, p. 3). To trace status and progress of such integration of sustainability and ESD, it is crucial to reliably assess and monitor the degree of implementation within education systems (Brent Edwards et al., 2020; Kioupi & Voulvoulis, 2019; Stepanek Lockhart, 2018).

As was highlighted in chapter 2, the global indicator for SDG 4.7 is currently described as the “extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment” (UNESCO, 2017b, 2019a, 2019b). However, monitoring of this indicator is based on self-assessments by member states using a dichotomous scheme and highlighting of best-practices examples (idib.), leading to positively biased self-reporting (cf. Benavot & Williams, 2023; Nazir et al., 2011). Also, the indicator had not been operationalised for independent scientific assessments at the level of national education systems, and questions remained as to its concreteness (Brent Edwards et al., 2020; Gallwey, 2016; Giangrande et al., 2019). In this light, the first article in this dissertation proposes a framework for a valid, reliable and comparable input-indicator to assess the depth and quality as well as speed of sustainability and ESD integration in education systems. While several previous studies had conducted document analyses on ESD in specific regional contexts (e.g., Beveridge et al., 2019; Fredriksson et al., 2020; Haan, 2021; Holst et al., 2020; Krah et al., 2021), evaluating the results had been difficult due to the lack of standardised criteria for the degree of ‘mainstreaming’ and speed of implementation. In response, the proposed indicator offers a conceptual and methodological operationalisation usable both for scientific assessments and more valid and reliable reporting. For this purpose, it combines document analysis with standardised external expert evaluation on the quality and depth of implementation as well as on speed of change.

¹¹ The research article summarised here was originally published in *Sustainable Development* (© 2024 The Authors. Published by ERP Environment and John Wiley & Sons Ltd.). The full text is included in the Appendix (8.1.1).

Conceptually, the evaluation builds on the implementation heuristic developed by Sterling (2003), who described four different modes of sustainability uptake: denial, bolt-on, built-in and redesign (cf. chapter 2.1). The heuristic was adapted into a 6-category assessment framework for evaluating the mainstreaming of ESD and sustainability within documents of education systems as an indicator for systemic implementation in line with SDG 4.7.1 (No Mentioning, Isolated Mentioning, Add-On, Partial Integration, Substantial Integration, Redesign). Speed of change was operationalised as document-group specific in relation to the usual publication dates and revision cycles in five categories (Strong Increase, Medium Increase, Small Increase, No Change, Decrease). Detailed descriptions of each category and its operationalisation as well as the specific methodological approach to lexical document analysis and the standardised external expert evaluation along the operationalised categories can be found in the manuscript and supplementary information.

As a concrete application case, the indicator framework is applied in the article to analyse longitudinal 10-year data from the German education system, specifically a total of 11,061 documents collected as part of the German national monitoring of ESD. For the assessment, 6,553 new documents were collected, and analysed in longitudinal comparison with 4,508 documents from previous studies (Brock et al., 2018; Holst et al., 2020; Singer-Brodowski et al., 2019). The data includes all domains of SDG 4.7.1 (education policy, curricula, training of educators, student assessment) and stems from all formal areas of education (early childhood education, school education, vocational education and training, higher education). For the external expert evaluation, six high-profile experts were chosen on the basis of the context of their expertise, working on the different areas of education as well as on indicator development. In the results, the descriptive findings from the document analysis are first outlined for each area of education. This includes, for example, information on the quantity and quality of the current and past implementation of sustainability, ESD and related concepts in laws, documents from conferences of ministers, educational reports, curricula, training regulations, course handbooks for educational practice and training of educators, study regulations, assessments, and others (34 document groups). Subsequently, the ratings (mean, modus) by the six experts on the predominant patterns of implementation (quality/depth, speed of change) are reported for each sub-indicator of SDG 4.7.1. Across the sub-indicators and different areas of education, the mean evaluations were found to be concentrated on and to range around the “add-on”-pattern of systemic implementation, as is illustrated in Figure 2. Based on the work of Sterling (2003), this pattern is operationalised as a *“medium to low overall quality of integration, where implementation usually involves adding ESD to a mostly unchanged main body of content”* (Holst, Singer-Brodowski, et al., 2024, p. 3917). While the evaluation of the sub-indicators ranged from “Isolated Mentioning” via “Add-On” to “Partial Integration”, none of

the sub-indicators was evaluated in the lowest or the highest two categories (No Mentioning, Substantial Integration, Redesign). Of the four sub-indicators, education of educators was found to be the lowest ranking sub-indicator in Germany at the time of the study, with two fields of education evaluated in the category “Isolated Mentioning” and two pertaining to the “Add-On” pattern. Concerning the speed of change, most sub-indicators were found to have increased to a small degree, with implementation in curricula and education of educators in early childhood education as well as curricula in vocational education and training having increased considerably. Also, specificities regarding the areas of education are highlighted, such as the highest score for an individual document group for the standard training elements (“Standardberufsbildpositionen”) in vocational education and training, where sustainability was set in 2020 as a standard theme for all training programmes, or higher ratings for state policy documents in higher education than for policy documents issued by higher education institutions and their representative bodies (e.g., rectors conferences).

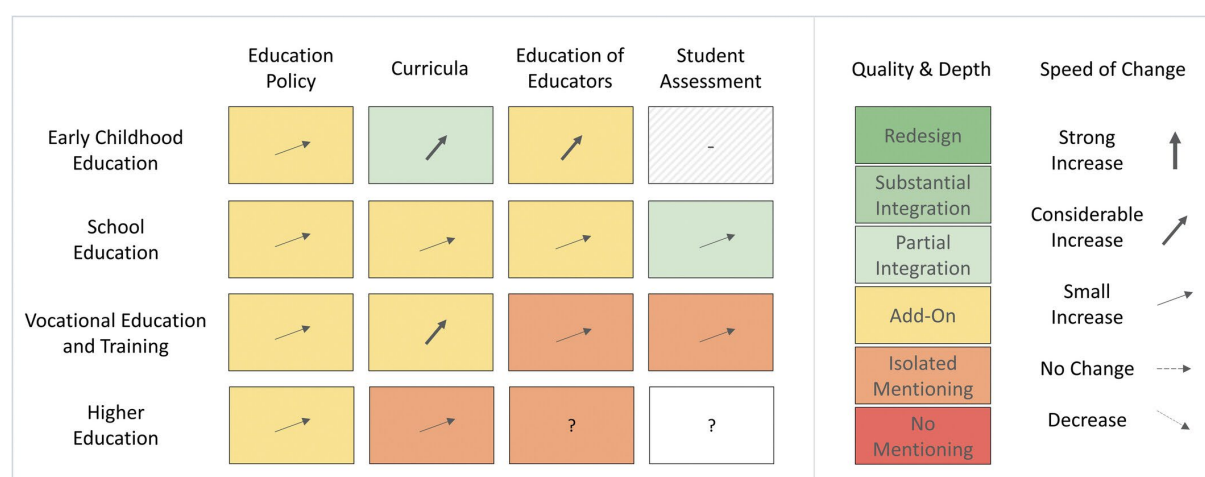


Figure 2 (Figure 3 in Holst, Singer-Brodowski, et al., 2024): The current status as well as developments in the implementation of ESD in documents of the German education system. Colours refer to mean values from the external expert evaluation on quality and depth of implementation. Arrows refer to mean values concerning speed of change. As student assessment does not exist in Early Childhood Education, no data could be assessed for this sub-indicator. Further, no data could be included for student assessments in Higher Education. Speed of change could further not be evaluated for education of educators in higher education as no longitudinal data was available.

In the discussion, the findings from the case of Germany are contextualised and the conceptual and methodological advances for assessing systemic sustainability integration are reviewed. Concerning the former, both the dominant ‘add-on’-pattern of implementation and the dynamically increasing, albeit overall continuously slow speed of change are argued to not sufficiently match the ambitions stated by the UNESCO member states to “[e]nsure that ESD is a foundational element of our education systems at all levels” (UNESCO, 2021a, p. 3). Focused on the sub-indicators, the deficient status of education of educators is discussed as in line with previous research from Germany (Grund & Brock, 2020; Holst et al., 2020) and internationally

(Fischer et al., 2022; Gough, 2016; Haan, 2021), which highlights it as a key field of action. With respect to federal and state policies, it was found that ESD and sustainability have been taken up in all areas of education, but that the existing policies are mostly not binding and tend to approach sustainability as another additional aspect, not a guiding principle for quality education. Synthesising the key findings, the study points out that *“it is not yet apparent that ESD has been comprehensively integrated (in a cross-cutting way) into documents of the German education system”* (Holst, Singer-Brodowski, et al., 2024, p. 3919). With respect to methodological contributions, the proposed and applied indicator framework offers advances to increase the validity, reliability and comparability of both self-assessments and independent scientific assessments. Specifically, the literature-based conceptual framework operationalises different degrees of quality and speed of implementation, contributing to an increased validity of assessments. By specifying and delineating categories for evaluation and by proposing a process for an external expert assessment, the framework further allows for higher reliability and comparability across different contexts. Reflecting on methodological challenges, the heterogenous and large-scale datasets as well as availability of suitable experts and sufficient resources are discussed. While these aspects are important to consider, opportunity lies in the scalability of the approach (e.g., for regional assessments or focused on specific groups of documents), its flexible use in different contexts (e.g., national, international) and for a range of relevant key concepts (e.g., ESD, global citizenship education).

Finally, while the article develops and applies an input-indicator for assessing sustainability and ESD within documents as a proxy for implementation at the macro-level of education systems, it further argues for integrative approaches to assessments and monitoring across inputs, processes and outcomes at all levels of education systems (cf. also Marron & Naughton, 2019; Unterhalter, 2019). The article further highlights with respect to the connection between educational practice and its systemic environment that *“individuals cannot be expected to act consistently in a sustainable manner if the norms around them – as formalized in documents – treat sustainability as an isolated issue or “add-on””* (Holst, Singer-Brodowski, et al., 2024, p. 3920). Referring to the fundamental objective of education to empower learners with the abilities to confront epochal key challenges (Klafki, 1996/2007), the study thereby underscores the critical role of a substantial integration of sustainability into the macro-level framework conditions.

3.2.2. Conceptual Synthesis of Whole Institution Approaches to Sustainability (Systematic Review, Study 2: Holst, 2023)¹²

Considering the importance of the socio-physical environment for learning, there have been calls by scholars, policy-makers, practitioners and UN organisations for a more coherent practice of sustainability within and around educational institutions for decades (e.g., Henderson & Tilbury, 2004; Sterling, 2003; UNESCO, 2014). Yet while the notion of WIAs is widely used in guidelines, reports and scientific articles, there has been a gap when it comes to a systematic conceptual synthesis of the core objectives and characteristics of the approaches in use across different contexts (cf. chapter 2.3). The second research article responds to this gap: in systematically reviewing the international scientific and grey literature on WIAs, it provides a synopsis of the conceptions in use and synthesises core characteristics and conditions for an efficacious implementation of WIAs within a joint framework. It thereby contributes to a refined operationalisation of the WIA for both educational practice and future scientific assessments (e.g., in study 3).

To address the question what specifically characterises a WIA to sustainability across different areas of education, the article combines a systematic literature review ($n = 104$ international documents from scientific and grey literature) with a written expert review. The data were systematically collected via two complementary academic search engines (Web of Science, Education Resources Information Center), a standardised online search (Google) to screen for missing scientific and grey literature as well as through in-text citations¹³. The retrieved data was filtered using two mutually-inclusive, content-related criteria: a focus on sustainability and on the design or development of educational institutions. The data was analysed by applying the approach of qualitative content analysis (Kuckartz, 2014, 2019) to the literature analysis. All data was inductively coded in thematic categories, pooling segments that refer to similar concepts, and clustered at different abstraction levels. In a subsequent consolidating step, the categories and text segments at different levels (components, facets, sub-facets) were reviewed and definitions were developed for each category. As part of an expert review (Artino et al., 2014; Olson, 2010), nine experts on ESD and WIAs from different sectors of an exemplary education system (Germany) participated in a written online survey. For this, the literature-based concepts were translated into 53 statements starting with “*At our educational institution, ...*” and assessed by the experts on their representativeness, relevance and

¹² The research article summarised here was originally published in *Sustainability Science* (© 2022 The Authors. Published by Springer Nature). The full text is included in the Appendix (8.1.2).

¹³ For further methodological details on the literature search (e.g., the search strings), see the manuscript in the Appendix (8.1.2).

comprehensiveness, yielding high mean scores and few conceptual additions at the level of sub-facets (for further details, see the original manuscript and supplementary material).

Before introducing the synthesised WIA-framework, the review provides a short description of the international debate on WIAs. The review highlights that most available literature on WIAs to date focuses on school education and higher education. While references were made (e.g., for cooperation), few articles set the primary focus on early childhood, non-formal or vocational education and training. Also, the majority of articles (range: 1999-2020) were published after the beginning of the ESD Global Action Programme (2015), suggesting high interest and rapid developments in the field in recent years. Within the following main sections of the results, the synthesised WIA-framework is outlined, providing exemplary references to the international literature. In a synthesising section, the article summarises:

“In a nutshell, WIAs are described in the international literature as continuous individual and institutional learning processes to coherently mainstream sustainability as a fundamental principle within all activities of an educational organization. Through WIAs, all formal and informal learning as and for sustainability is embedded within its socio-physical surrounding, implying that both social processes (e.g. governance, communication) and physical contexts (built and natural environment) consistently practice sustainability. Such an orientation of both the visible and the hidden curriculum towards sustainability aims to link formal and informal learning, ideally creating an authentic sustainable learning environment in which everyone involved is empowered with the abilities to design and create sustainable futures.” (Holst, 2023, p. 1024)

Specifically, the synthesised WIA model consists of five core principles (*coherence, continuous learning, participation, responsibility, long-term commitment*), seven highly interconnected areas of action (*governance, curriculum and learning, operations and campus management, communities and networks, research, capacity building and communication*), the underlying organisational culture as well as relevant external conditions (cf. Figure 3). Highlighting the relevance of context specific approaches, the review outlines characteristics of each of the core principles, areas of action, organisational culture and external conditions in a WIA.

Whole Institution Approaches to Sustainability in Education

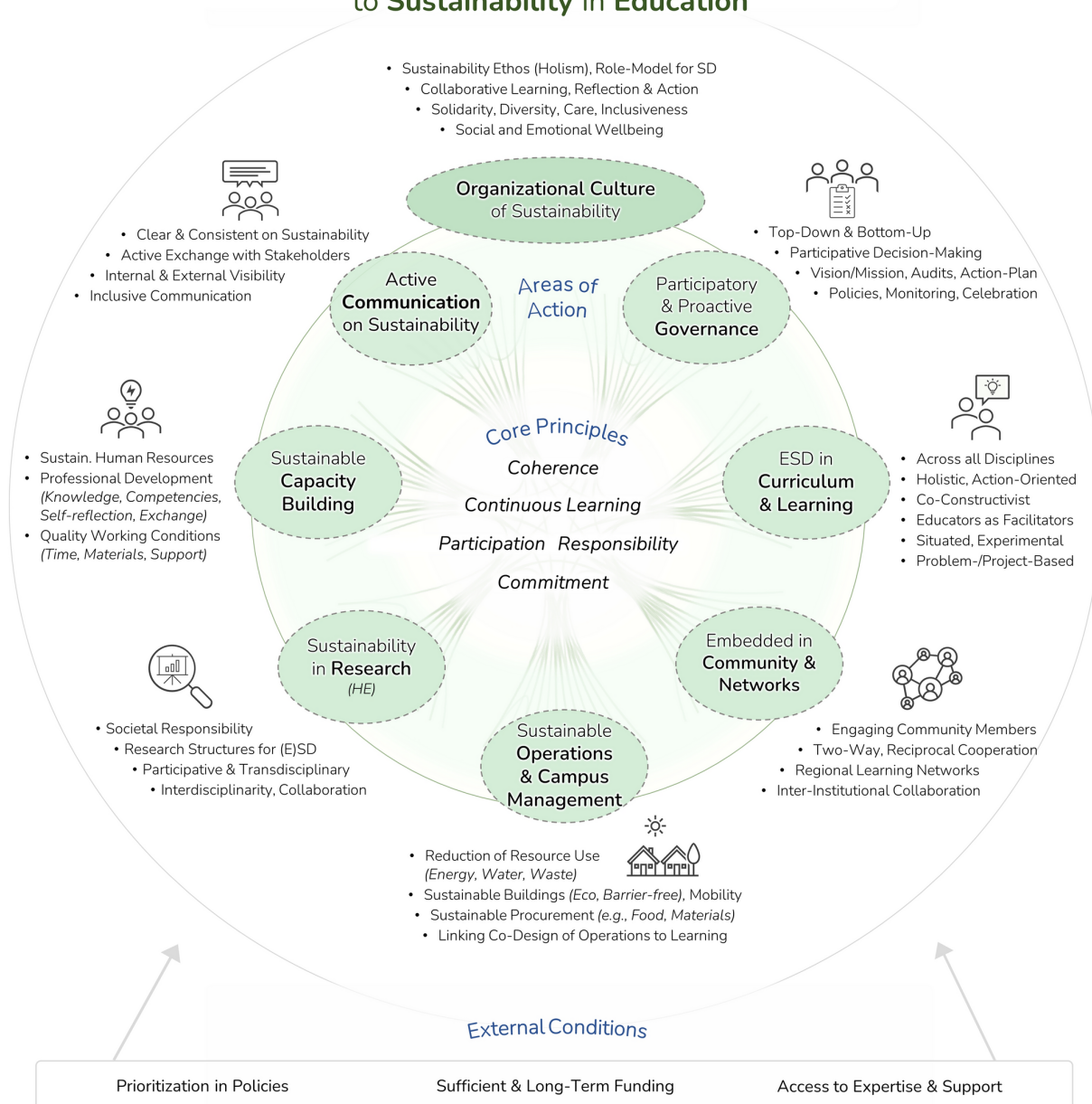


Figure 3 (Figure 2 in Holst, 2023): Synthesised framework for Whole Institution Approaches (WIAs), including five core principles (coherence, continuous learning, participation, responsibility, long-term commitment), seven highly interconnected areas of action (governance, curriculum, community and networks, operations and campus management, research (in higher education), capacity building, communication), organisational culture as well as relevant external conditions for the realisation of WIAs. Central concepts identified in the literature review are displayed in the outer circle. ESD: Education for Sustainable Development, SD: Sustainable Development, HE: higher education.

As the analysis shows, key characteristics of the approaches in use converge across different authors and areas of education. In terms of learning, the idea of WIAs links the informal, “hidden” and “living” curriculum (Shallcross et al., 2006; Winter & Cotton, 2012) to formal learning, thereby connecting processes with relevant outcomes and impacts. In approaching sustainability as a core element of quality education at the organisational level, the concept

adopts a holistic approach to sustainability (e.g., Mogren et al., 2019) and attempts to move beyond a fragmented and additive implementation of sustainability (e.g., Lozano et al., 2015; McMillin & Dyball, 2009). In the discussion, the essence of the approach is in this light argued not to be limited to educational institutions, but to be applicable also to various other organisational arrangements (e.g., businesses, non-governmental organisations).

In terms of the conceptual and methodological contributions, the synthesised WIA framework provides systematic, literature-based groundwork for its operationalisation in further research (e.g., study 3), policy-making and practice. In describing key characteristics and gaps in the debate, the study may allow for a more analytic perspective on WIAs as compared to the various programmatic approaches. With respect to the methods used, the article points to the focus on English-language literature and the need for further context-sensitive studies on WIAs across the globe. Further, the article highlights the means taken to mitigate potential biases in a qualitative analysis conducted by a single researcher (e.g., the systematic and rule-bound procedure, cross-sectoral expert review). In terms of future research, it is emphasised that the debate has mostly focused on school and higher education, which is why further emphasis on the wide array of other contexts is suggested. Also, few studies to date have offered analyses of the specific learning processes in contact with what is called the hidden curriculum as well as research specifying the frequently highlighted roles of organisational culture and communication (for examples, cf. Adams et al., 2018; Djordjevic & Cotton, 2011; Fischer, 2011). The study further highlights that while there is a wealth of programmatic calls as well as conceptual and practical work on WIAs (e.g., guidelines, self-assessment tools), little systematic (e.g., large-scale, non-self-reporting biased) data is available on its implementation and effectiveness.

In a concluding remark, the article summarises the collaborative process described with a WIA as a process to collaboratively set the default modes at and around educational institutions on sustainability. This way, the concept of WIAs is argued to function both as an instrument for more coherent organisational development in times of (un-)sustainability, and as a potential keystone for quality sustainability learning.

3.2.3. Measurability and Effectiveness of WIAs to Sustainability (Scale Development, Quantitative Assessment, Study 3: Holst, Grund, & Brock, 2024)¹⁴

Although a strong link between the everyday experience of (un-)sustainability at educational institutions and related learning outcomes has long been suspected (e.g., Buckler & Creech, 2014; McMillin & Dyball, 2009; Tilbury & Galvin, 2022), systematic assessments of WIAs and their effectiveness are scarce in the international literature. While there have been case studies and analyses at a small number of organisations, mostly self-reporting based applications of assessment tools on real-world indicators and comparisons between certified and uncertified organisations (for details, cf. chapter 2.3), there has not been a validated quantitative scale to systematically assess experienced WIAs at and around educational institutions. Consequently, there has been a lack of large-scale data on its implementation and effectiveness. In this light, the third article asks how the WIA can be operationalised for quantitative assessments, and to what extent the experience of WIAs is related to sustainability-related learning outcomes. In response to these questions, it introduces a systematically tested and validated assessment instrument, the WIA-Scale, as a process indicator for sustainable education, and presents data from a first large-scale assessment in Germany on the implementation and effectiveness of WIAs ($n = 2,985$ learners and educators from school education, vocational education and higher education). Through this, it provides both a methodological framework for assessing WIAs and evidence on the relationship between the experience of sustainability at educational institutions (meso-level) and learning outcomes.

To ensure high content validity of the operationalisation, the developed WIA-Scale builds on the systematic literature review on WIAs (cf. 4.2.2, Figure 4 for a summarising overview). As part of the literature analysis, the facets and sub-facets of WIAs were translated into 53 items. To integrate comprehensiveness, high relevance and representativeness for WIAs as well as practical usability, i.e., number of items, the items were prioritised based on a written expert review and a cross-sectoral expert workshop, and refined and consolidated in two rounds of qualitative pretesting and a quantitative pretest with 77 learners and educators in one federal state of Germany (e.g., Campanelli, 2008; Collins, 2003; Willis, 1999; for details on the pretesting, see the manuscript in Appendix 8.1.3). The final WIA-Scale consists of 15 items for

¹⁴ The research article summarised here was originally published in *Sustainability Science* (© 2024 The Authors. Published by Springer Nature). The full text is included in the Appendix (8.1.3).

educators as well as 13 items for learners, corresponding to two items for each area of action as well as for organisational culture and one item for the overarching key principle of participation. Also, two complementary items were developed, an outcome-indicator on institution-evoked motivation to act for sustainability (WIA-Sust-Motivation), and a possible one-item indicator for the WIA-Scale (WIA-Coherence).

Whole Institution Approaches to Sustainability in Education

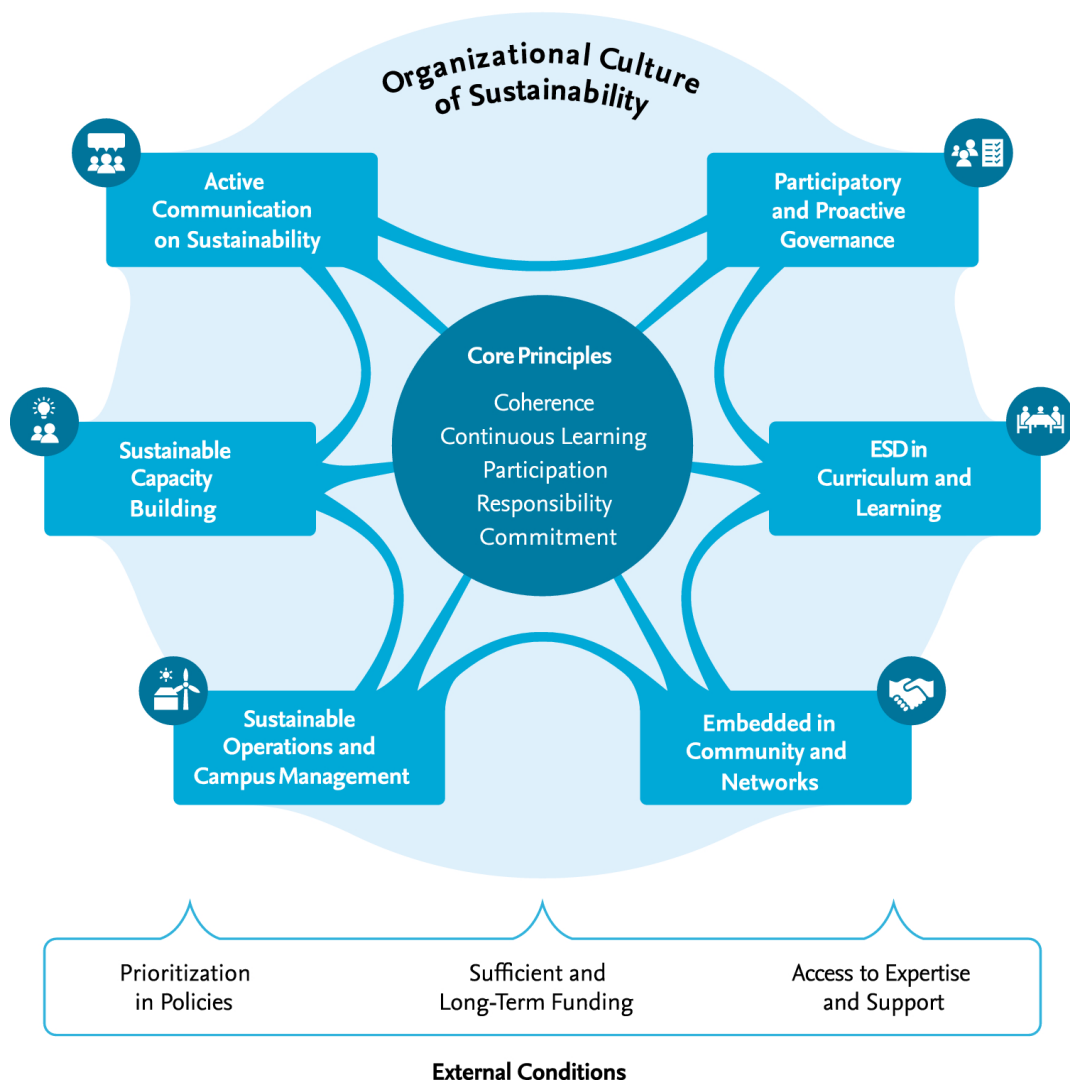


Figure 4 (Figure 1 in Holst, Grund, & Brock, 2024): Overview of the Whole Institution Approach (adapted from Holst, 2023).

In a first large-scale assessment, a total of 2,481 learners (14–24 years, $M = 19.2$ years; $SD = 2.7$ years) and 504 educators ($M = 43.2$ years, $SD = 11.7$ years) were subsequently surveyed with the WIA-Scale (all federal states) via an online-access-panel. The data was used to assess the quality criteria of the WIA-Scale (e.g., distributional characteristics, discriminatory power of individual items, reliability, convergent validity, criterion validity, factorial validity) and to exploratively analyse possible correlations with the abovementioned complementary items as

well as with a diverse set of variables relevant for sustainability-related learning processes and outcomes (e.g., perceived empowerment evoked by one's educational institution to solve SD issues, subjective knowledge on SD, sustainable behaviours, general well-being, problem awareness, relevance of ESD for educators and their participation in relevant trainings). Also, regression modelling was used to replicate the analysis of Grund and Brock (2020) on the prediction of sustainable behaviour of learners, including ecological problem awareness, emotions and attitudes regarding sustainability, connectedness with nature and humanity, age, gender and available money as other possible predictors. Further details on the statistical procedures and limitations can be found in the manuscript (8.1.3).

Concerning the testing of the WIA-Scale, the findings indicate appropriate item difficulty and good differentiation among individuals, excellent internal consistency (as a measure for reliability) as well as good convergent, criterion and factorial validity (for details, see the full manuscript). Based on the first one-time large-scale application (no assessment of test-retest reliability), high overall scale quality could be assumed. Interestingly, only small or no correlations were found between the response behaviour on the WIA-Scale and respondents' sustainability-related problem awareness, indicating that the scale seems to function independently from prior problem perception. Based on the findings, the scale is suggested to function as a valid and reliable process indicator for coherent sustainability integration in and around educational institutions. With respect to current WIA practice in Germany, it was found that few learners and educators agree or strongly agree on average across the WIA-Scale that sustainability is currently lived in their educational institution (3.9% and 8.9% respectively). The significantly right-skewed distribution of responses among learners signals that, at present, the systemic implementation of WIAs may be aspired to (e.g., Council of the European Union, 2022; National Platform ESD c/o BMBF, 2017; UNESCO, 2020, 2021a), but is not close to being realised. Yet the data also shows that WIAs are experienced to different degrees in different contexts, highlighting the relevance of specific pathways and development processes (Birney & Reed, 2009; Bohunovsky et al., 2020; Bosevska & Kriewaldt, 2020). In terms of the sampling, the data used is cross-organisational, which allows for aggregated analysis across regions, nations (as in this case) or even at the international level.

Regarding the effectiveness of WIAs, the relationship between the experience of sustainability (WIA-Scale) and key measures related to sustainability learning processes and outcomes were assessed. The results indicate a strong relationship between how sustainable the educational institution was perceived, and how motivated and empowered individuals felt through their educational institution to act for sustainability. Also, both learners and educators who responded higher on the WIA-Scale viewed themselves as more knowledgeable on SD and described higher overall wellbeing (for an overview of statistically significant correlations, see

Figure 5). For educators, experiencing more sustainability in line with a WIA was further correlated with a higher attributed relevance of ESD, better knowledge of sustainability and ESD, greater participation in trainings and fewer perceived barriers to its implementation.

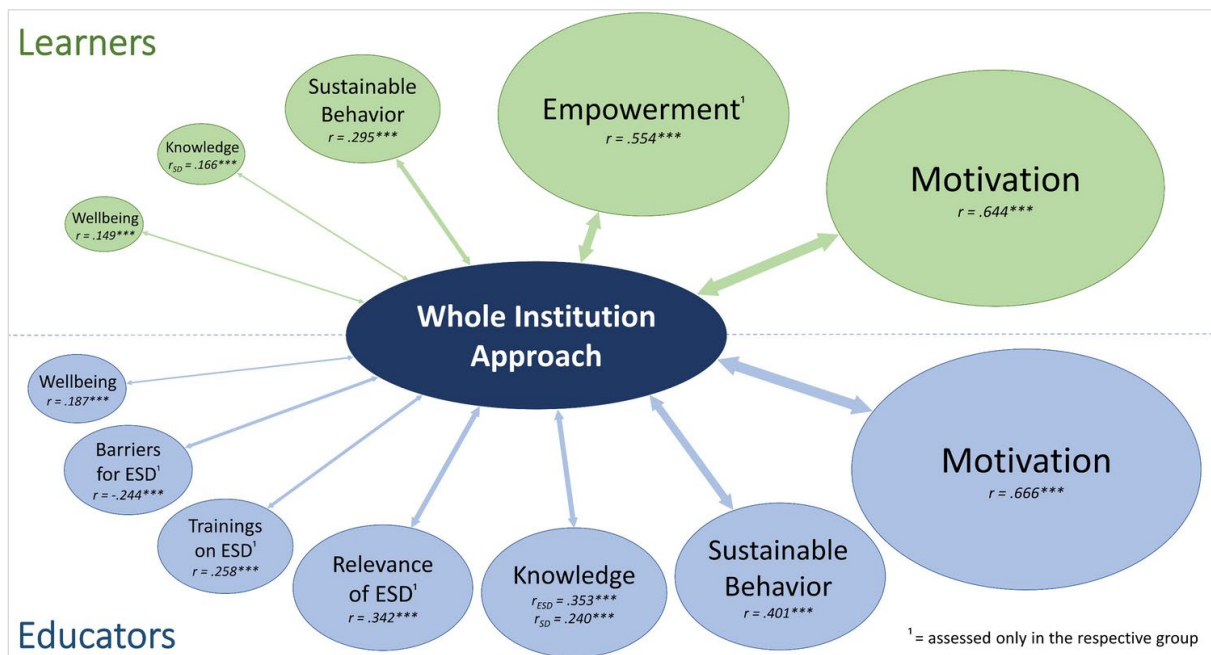


Figure 5 (Figure 3 in Holst, Grund, & Brock, 2024): Overview of correlations between the WIA-Scale and variables relevant for sustainability learning as exploratively assessed. Displayed are significant correlations with $r > 0.1^{***}$. Superscript (1) indicates those constructs that were assessed with one of the groups only. SD = Sustainable Development, ESD = Education for Sustainable Development.

Multiple regression modelling further revealed that experienced sustainability (WIA) was the strongest predictor of self-reported sustainable acting by learners (cf. Figure 6; replication of Grund & Brock, 2020). Using the WIA-Scale in the model instead of the ESD holism and pluralism scale (Boeve-de Pauw et al., 2015) increased the overall predictive power of the model from 23.8 to 28.7%. To test for potential spillover effects, the model was additionally calculated only with items specifically focused on activities outside the educational context, i.e. handprint activities such as informing others via social media, or engaging in a group or organisation for SD (e.g., Spliesgart et al., 2025), with similar results.

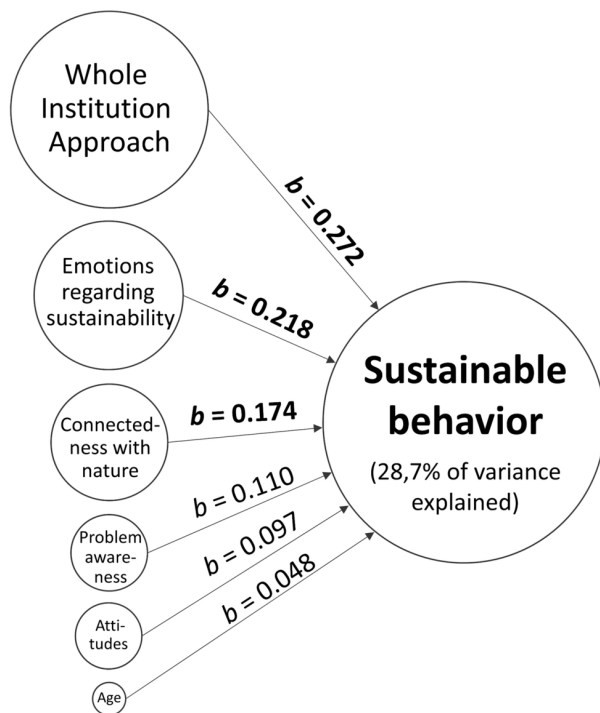


Figure 6 (Figure 4 in Holst, Grund, & Brock, 2024): Predictive power of individual predictors of young people's reports of how sustainable they act (multiple-regression analysis, replicating the study setup by Grund and Brock (2020) with the WIA-Scale as a predictor instead of the ESD holism and pluralism scale (Boeve-de Pauw et al., 2015); $n = 2,385$, 14-24 years).

In synthesis, the findings suggest high overall quality of the WIA-Scale and provide first large-scale evidence on the effectiveness of WIAs for sustainability learning. While the results on the latter are correlational, causal relationships seem plausible and some of the scales used include directionality (e.g., institution-evoked motivation and empowerment to act for sustainability). Several likely explanations are discussed for the suggested causality, e.g., the influence of social norms (Cialdini & Jacobson, 2021; Fritzsche et al., 2018; Keizer & Schultz, 2018), the notion of “embodied” or “grounded” cognition, i.e., viewing material and social environments as co-constituents of learning (Barsalou, 2008; Brock, 2022; Fugate et al., 2019), experience of positive examples and associated hopefulness (Grund & Brock, 2019) and possible effects of increased individual and collective self-efficacy belief (e.g., Bandura, 1997; Jugert et al., 2016) (cf. chapter 2.3). These findings contrast mixed evidence from earlier comparisons between certified and uncertified organisations (e.g., Boeve-de Pauw & van Petegem, 2013; Olsson et al., 2019; Spínola, 2015), suggesting that while certificates may be important for organisational development, they are not necessarily associated with real-world WIA experience, and consequently effectiveness.

Concerning future use, the WIA-Scale is proposed as a process indicator for high quality sustainable education at the level of educational institutions, and can be used both as part of assessments and, in different length, as a tool for reflective organisational development (cf. Wals & Mathie, 2022). In a concluding remark, the relevance of integrating sustainability in the everyday (“default”) experience at educational institutions is underscored, arguing that in empowering learners for a more sustainable future, WIAs to sustainability can be viewed as a central component of contemporary quality education (Laurie et al., 2016; UNESCO, 2020).

3.2.4. Status, Visions, Drivers and Challenges for Whole-School Sustainability from the Perspective of School Leaders (Mixed-Methods Analysis, Study 4: Holst, Brock, et al., 2025)¹⁵

School education is the largest formal area of education with around 11.1 million learners at German general or vocational schools in 2024 (Destatis, 2025a, 2025b). Considering the time spent in and around schools, it is clear that both formal and informal learning at and around schools is critical to sustainability learning as a key concern for quality education in the face of global challenges. In light of the socialising effects of the everyday experience (cf. Barth et al., 2012; Holst, Grund, & Brock, 2024), whole-school sustainability requires close linkage with general school development (Mogren et al., 2019; Müller et al., 2020). In facilitating quality development processes, norm setting and communication, and generally through organisational leadership, school principals are consequently in a central position when it comes to realising sustainability at schools (Leo & Wickenberg, 2013; Mogren & Gericke, 2017; Zachariou & Kadji-Beltran, 2009). The perceptions of school leaders are thus of considerable relevance for understanding the current state of sustainability integration and practice in school education (status quo indicator). They can also provide valuable insights into school leaders' visions for future schools, challenges to sustainability, and possible drivers (facilitative indicators) (Tilbury & Janousek, 2006). Yet while their critical role is widely recognised (e.g., Cebrián et al., 2022; Evans et al., 2012; e.g., Müller et al., 2021; Zachariou & Kadji-Beltran, 2009), systematic, national-scale studies on the views of principals on sustainability in schools and in the school system are scarce.

Against this background, the fourth study that forms part of the dissertation aims to develop more systemic knowledge of school leaders' perspectives on the current status, visions, challenges, and drivers concerning sustainability in school education. To this end, the mixed-method study combines qualitative content analysis of data from 80 qualitative interviews with principals from all federal states, school forms and different socio-demographic contexts (average lengths around 30 minutes), with a subsequent representative survey in Germany ($n = 1,310$ school leaders). As part of the interviews, open questions and quantitative scales were used to assess principals' preconceptions of sustainability, descriptions of the current status, visions for the future, perceived challenges and drivers as well as other conditions the school leaders saw as relevant. The scales for the representative survey were developed on the

¹⁵ The research article summarised here was originally published in the *Journal of Cleaner Production* (© 2025 The Authors. Published by Elsevier Ltd). The full text is included in the Appendix (8.1.4).

basis of key findings from the qualitative analysis, i.e., on the current and wished-for (ideal) status as well as the occurrence of challenges and drivers (for methodological details and descriptive statistics, see the full manuscript in the Appendix (8.1.4)). Sampling and data collection from a large database and, in the case of the interviews, initial coding, was commissioned to a service provider (Forsa)¹⁶. The triangulated findings are jointly reported, offering a system-wide perspective on the views of principals on sustainability in school education.

Before a working definition of sustainability was provided, the interviews started with an open-ended exploration of principals' preconceptions. It was found that most principals already had a general understanding of sustainability as being associated with environmental or social issues requiring changes in action. In terms of types of such changes, school leaders primarily focused on individual-centred behavioural changes, thereby often referring to easy to implement activities (e.g., waste separation, energy saving) and omitting high-impact actions (e.g., nutrition, mobility). Fewer principals addressed collective and structural changes (e.g., shifts in societal values, political participation and actions, infrastructural change). This finding is mirrored in the depictions of current actions at their own schools later in the interviews, which recurrently focused on behavioural changes of engaged individuals and single projects (e.g., gardening, energy saving, waste separation).

Matching such a focus on isolated, additive activities, 62% of principals in the subsequent representative survey in Germany described the current status of sustainability integration at their schools as non-existent, isolated (e.g., in single projects, few subjects) or occasional (in regular projects, some subjects) (cf. Figure 7). At the same time, principals described different visions for future schools. School leaders recurrently detailed their vision of an ideal school as one in which sustainability is 'normality', a vital, self-reinforcing and collectively lived organisational principal, and embedded in a sustainable systemic environment (e.g., resourced and integrated in laws, curricula and quality criteria). Again, such different visions were also found in the representative survey: While only 19% saw the currently dominant add-on mode as desirable, 80% of principals wished for a whole-school integration, i.e., a frequent, very frequent or omnipresent sustainability integration (e.g., at least in many subjects, school development and cooperation, to a principal guiding everyday school life).

¹⁶ In case of the representative survey, the commissioning to Forsa was conducted in cooperation with the Verband Bildung und Erziehung (VBE).

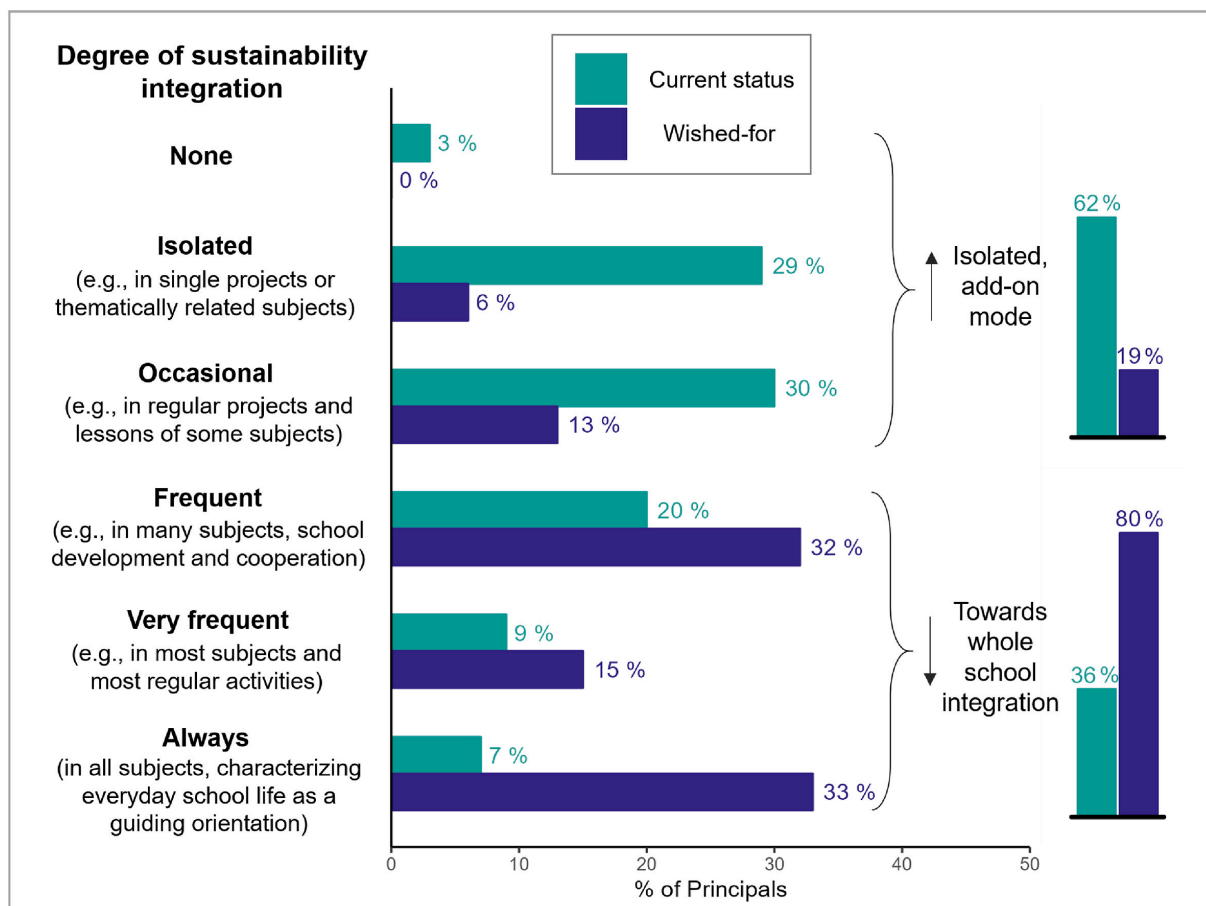


Figure 7 (Figure 1 in Holst et al., 2025): Current and wished-for integration of sustainability in schools ($n = 1,310$ principals, representative for Germany).

Asked about key challenges to sustainability, the principals repeatedly pointed to, among others, a lack of resources (personnel, time, budgets), structural integration (e.g., in laws, curricula, quality standards), dependency on local authorities (e.g., for infrastructure) as well as current rule systems and mindsets that hinder sustainability. Of the latter, normalised unsustainability, strong performance- and grade-orientation, lack of flexibility, systemic inertia, fear of change, perceived overload as well as a focus on cost reduction and paths of least resistance were regularly highlighted. In the quantitative survey, over 70% of principals agreed that the lack of time and personnel and the higher prioritisation of other tasks and demands were a key challenge for sustainability in schools (Figure 8). Further, 54% saw a lack of financial resources as a key obstacle, and 40% agreed that the strong orientation of schools towards exams and performance was a major challenge. The latter agreement on performance pressure as a key issue was particularly high among school leaders active in selective secondary schools (Gymnasien; 57%).

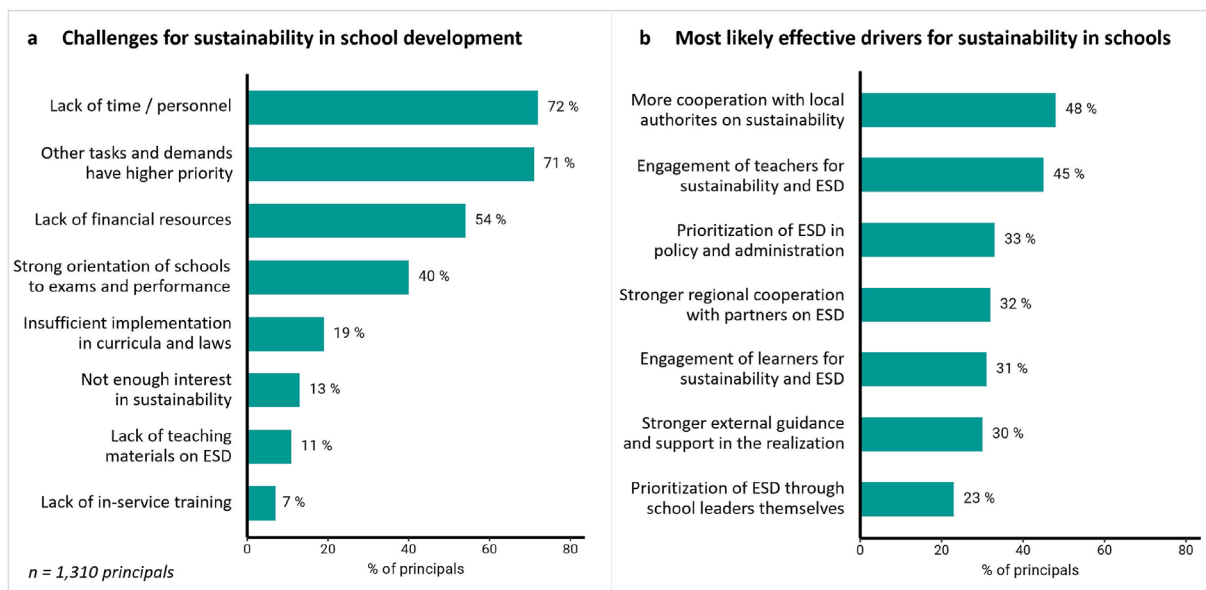


Figure 8 (Figure 2 in Holst et al., 2025): Principals' perspective on challenges and drivers for sustainability in school development (*n* = 1,310; representative for Germany). (a) Occurrence of challenges for sustainability and Education for Sustainable Development (ESD) in school development from the perspective of principals in Germany. (b) Most likely effective drivers for sustainability and ESD in school development from the perspective of principals in Germany.

Focusing on drivers to overcome current challenges, the principals pointed to a need for considerably higher prioritisation of sustainability by decision-makers at all levels. In terms of specific stakeholders, they highlighted contributions both inside the school (e.g., themselves, teachers, learners) and outside the school (e.g., education policy and ministries, local authorities, NGOs, higher education institutions). Also, non-stakeholder specific drivers were discussed, such as possible governance arrangements (e.g., in terms of flexibility and steering), higher valuation of education and sustainability (e.g., sustainability as an objective of quality education), windows of opportunity (crises, other pressing issues such as digitalisation) as well as favourable support structures (e.g., availability of programs, external support, teacher training). In the representative survey, answers on most likely effective drivers spread widely, suggesting that the importance of such drivers is context specific (Figure 8). The drivers most frequently viewed as likely to be effective are more cooperation with local authorities on sustainability, more teacher engagement, and higher prioritisation of ESD in policy and administration.

Overall, the study found that while principals wished for sustainability to be a core element of school education, they described its current status as considerably lower. Such a perceived vision-practice gap was also found among learners and educators both in Germany (Grund & Brock, 2022) and internationally (e.g., Kadji-Beltran et al., 2013; Simovska & Prøsch, 2016).

Based on the triangulated findings, the article discusses four recurring and interconnected patterns in the data on the status, visions, challenges, and drivers¹⁷:

- (1) a focus on single and often fragmented actions (e.g., low-cost and easy-to-implement activities instead of structural and high-impact key-points (on types of low- and high-impact activities, cf. Bilharz & Schmitt, 2011; IPCC, 2022));
- (2) individualisation and diffusion of responsibility (e.g., a normality of focusing on behavioural changes by individuals and a reliance on single engaged stakeholders);
- (3) a perceived lack of personnel, time and other resources, which is associated with a prioritisation of other demands, an overcrowding of curricula and a need for effective training for educators and leaders focused on whole-school sustainability; and
- (4) a widely spread paradigm of approaching sustainability as an additive (e.g., low structural integration of sustainability in the school system, perceived normality of unsustainability, a strong focus on grades and performance).

In response to these patterns, a stronger emphasis is suggested in the discussion on

- (1) structural changes towards sustainability (e.g., a focus on changing rule systems, infrastructures and social norms that define default modes instead of single actions);
- (2) collective action (e.g., empowering for democratic and political participation, fostering efficacy experiences, engaging in public-sphere actions);
- (3) a stronger prioritisation of sustainability at all levels (e.g., in regulatory frameworks, curricula and school development standards, by local authorities as well as by school leaders and educators themselves); and, along with this,
- (4) a stronger integration of sustainability with quality education (operationalised, e.g., in quality assessment systems and instruments).

In summary, the relevance of more collective, structure-oriented and political sustainability learning is discussed, which is prioritised as a core feature of quality education. While the analysis was conducted in the German school system, some of the findings and implications are argued to be of potential relevance also for other countries and international programmes (e.g., EU, UN, or UNESCO). Also, the 6-point scale on sustainability integration is proposed as an indicator to assess whole-school sustainability from the perspective of leaders.

¹⁷ For details on each pattern and derived implications, see the full manuscript.

4. Joint Discussion: Measuring and Fostering Sustainability in Education

As disruptive geopolitical, technological and societal shifts rattle the global world order, achieving a just reconciliation of human prosperity with environmental integrity remains a major existential challenge for humanity in the 21st century. Transitioning into a safe and just corridor for collective sustainable wellbeing (e.g., O'Mahony, 2022) requires substantial shifts in policies and infrastructures as well as, in iterative connection, patterns in and paradigms underlying human thinking and acting. As highlighted by many, such transition is associated with a considerable degree of individual, social and societal learning (e.g., Barth, 2015; Sterling, 2016). Consequently, a sustainable education is stressed not only in the sustainability sciences, but also in the public discourse and by (inter-)national organisations as a keystone of SD. Viewed from an educational perspective, this links to a pedagogic responsibility to not only react to societal contexts, but to empower learners to critically evaluate current conditions and engage in the shaping of their futures (cf. Klafki, 1996/2007). In this sense, it has been argued in chapter 1 that education and learning are not only called for in a time of unsustainability, but that the emancipatory empowerment of learners to deal with their social and political contexts is highly compatible with foundational purposes and functions of a timely adequate education. Such a 'sustainable education' may contribute to the development of the capacities and capabilities to be able to critically engage with and make meaningful contributions to safe and just societies (UNESCO, 2020, 2023a). Yet while systemic and transformative objectives have been formulated and a wide body of literature exists on sustainability in education (cf. chapters 1 and 2), a lack of operationalisation within valid and reliable methodological frameworks for large-scale assessments has been identified at the macro- and meso-levels of education systems. Consequently, there has been a lack of national-scale data on the status, quality and effectiveness of systemic sustainability integration and organisational practice.

Taking the case of Germany as an exemplary education system, the four individual studies that make up part of the dissertation have addressed these conceptual, methodological and empirical gaps in different ways: At the macro-level, the analysis of 11,000 documents and development of an input-operationalisation for the SDG indicator 4.7.1 allows for a system-wide overview of the current status, trends and large-scale patterns in sustainability and ESD integration in policies, curricula, the training of educators and performance assessments (Holst, Singer-Brodowski, et al., 2024). At the meso-level of educational institutions within their regional educational landscapes, the systematic literature review on whole-institution sustainability offers a conceptual synthesis of how to characterise WIAs to sustainability across different areas of education as they are embedded in a wider systemic environment (Holst, 2023). On this basis, the WIA-Scale, a quantitative instrument to assess experienced WIA

realisation (process-indicator), was developed, pretested, validated and applied in a first large-scale assessment (Holst, Grund, & Brock, 2024). In surveying 2,985 learners and educators from all federal states and different areas of education, everyday experiences at the meso-level of educational institutions could be assessed with respect to both the current status and the effectiveness of WIAs at the micro-level of learning. Focusing on the largest and longest formal area of education, the fourth study systematically assessed the perspectives of school principals as key stakeholders in the school system on the current status, wishes for the future as well as challenges and drivers (Holst, Brock, et al., 2025). On the basis of the mixed-method analysis of data from 80 interviews and a representative survey with 1,310 school leaders, recurring patterns were identified concerning the macro-, meso- and micro-levels of school education. Together, the four studies attempted to

- (a) advance the conceptualisation of a systemic integration and organisational practice of sustainability in education;
- (b) develop indicators to operationalise and systematically assess sustainable education at the macro- and meso-levels of education systems;
- (c) provide evidence on the status and effectiveness of sustainable education based on large-scale data from an exemplary national context (Germany); and
- (d) improve the knowledge base on possible pathways towards implementation.

In the following sections, the overarching results of the four studies and possible implications are jointly discussed. First, the key findings are synthesised and embedded in the (inter-) national discourse (4.1). Here, the focus lies particularly on contextualising the observation that a substantial integration of sustainability in education seems highly wished-for, likely effective, yet far from default in both framework conditions and organisational practice. In the second sub-chapter (4.2), key implications are transferred into opportunities for policy and practice. Emphasising learnings for a more effective sustainable education, implications for a more purposive, experiential, political and structural focus are outlined. Subsequently, reflections on methodological contributions and limitations to the measuring of a sustainable education as well as on the research setting and positionality are discussed (4.3). Connecting dots between these sections, pathways and questions for future research are outlined (4.4), emphasising the links with quality education, implications for research on sustainability in education systems and educational institutions as well as opportunities for transfer beyond what is widely perceived as education. Concluding remarks sum up the dissertation (5).

4.1. Systemic Sustainability Integration and Organisational Practice: Wished-for, likely Effective, yet far from Default – a Synthesis of the Main Findings

Asked for their visions of an ideal future school, principals interviewed as part of the mixed-method study on school education in Germany recurrently highlighted sustainability as a *“‘natural’ or ‘default’ guiding principle for all actions and activities”* (Holst, Brock, et al., 2025, p. 4). In the representative survey ($n = 1,310$), 80% of principals in Germany described their wished-for school as one which addresses sustainability across many to all subjects, school development and various everyday activities (ibid.). This desire is in line with the perspectives of learners and educators across different areas of education (e.g., Grund & Brock, 2022; SOS United Kingdom, 2024) and is mirrored in surveys with leaders of higher education institutions in Germany and globally (Stifterverband für die Deutsche Wissenschaft e.V., 2022; Toman et al., 2023). What many of the interviewed principals abstractly referred to in their visions is discussed, in much of the literature, under the concept of a Whole Institution Approach (WIA), where sustainability is becoming the *“default mode of all rules-in-use”* (Holst, 2023, p. 1015). WIAs can, as the systematic review in this dissertation outlines, be described as *“continuous and participative organizational learning processes aimed at institutional coherence on sustainability, consistently linking the formal and informal (hidden) curricula”* (ibid.). As a conceptualising and operationalising contribution, the WIA model synthesised from the international literature links the discourses from all areas of education and is comprised of a set of five core principles, seven highly interconnected areas of action as well as the deeply intertwined culture of and at an organisation (ibid.).

While the concept of WIAs has in recent years received considerable attention, the empirical studies that have compared sustainability-certified and und uncertified organisations, as an indicator for WIA implementation, have yielded mixed results (e.g., Cincera & Krajhanzl, 2013; Olsson et al., 2019; Spínola, 2015; for an overview: cf. Niebert, 2021) and a general lack of knowledge of its effectiveness has been described (Kohl et al., 2022). In this context, the first national-scale application of the developed and validated WIA-Scale shows clear indications for not only the measurability, but also the effectiveness of WIAs (Holst, Grund, & Brock, 2024). Concretely, learners in general and vocational schools and higher education institutions ($n = 2,985$) who experienced more sustainability in line with the WIA felt strongly more motivated and empowered by their educational institutions to contribute to sustainability, viewed themselves as more knowledgeable about sustainability and described higher overall wellbeing. WIA experience was further found to be the strongest of various predictors for how sustainable learners act beyond their educational contexts. Educators who responded higher on the WIA-Scale felt strongly more motivated by their educational institution to contribute to sustainability, described higher wellbeing and better knowledge of SD and also viewed ESD

as more relevant. These findings suggest that WIA implementation may in fact be highly effective and that the mixed findings from comparing certified and uncertified organisations may point to the limitations of certificates as an indicator for WIA implementation rather than to a lack of effectiveness of WIAs.

As the previous two paragraphs indicate, the findings from this dissertation point not only to the high desirability of sustainable education, but also to the high potential effectiveness of coherent organisational practice. Yet at different levels, the four articles also show that such sustainable education is, at present, far from lived reality. In fact, the national-scale assessment of WIA experience among learners and educators descriptively shows a strongly right-skewed distribution of responses, indicating a medium to low overall status of systemic practice (Holst, Grund, & Brock, 2024). In line with this, the representative study among principals not only showed high desire for sustainability, but also a stark gap between the wished-for, ideal status on the one hand, and a considerably lower status-quo on the other: In total, 62% of principals in Germany described the current practice of sustainability at their schools as non-existent, isolated or occasional (Holst, Brock, et al., 2025). Across the 80 interviews and the representative survey, four recurring and interconnected patterns were identified: *“(i) a focus on single and often fragmented actions, (ii) an individualization and diffusion of responsibility, (iii) a perceived lack of personnel, time, and other resources, and (iv) a paradigm of approaching sustainability as an additive”* (ibid., p. 7). These patterns in the perceptions of educational leaders of the practice at their schools and the systemic contexts in which they act are, in many ways, mirrored in the analysis of the macro-level policy environment. As an input-indicator for systemic integration of sustainability and ESD in line with SDG 4.7, over 11,000 documents in all formal areas the German education system, spanning a timeframe of ten years, were systematically analysed across the SDG 4.7.1 sub-indicators policies, curricula, education of educators and learner assessment. The analysis, which included an external expert evaluation, indicates that while momentum can be described in all areas of education, sustainability and ESD are at present overarchingly implemented as an isolated issue or “add-on” to an otherwise mostly unchanged education system (Holst, Singer-Brodowski, et al., 2024). In a systemic environment where sustainability is not an integrative objective of quality education, but an underprioritised addition, it seems not surprising that responsibility is individualised, action is fragmented and that individual stakeholders, like the interviewed principals themselves, mirror associated mindsets in the ways they approach education and sustainability.

In fact, as various scholars have argued, sustainability is not only not a guiding orientation of most contemporary western education, but often stands in opposition to prevailing rule-systems, incentives and narratives (e.g., neoliberal market orientation, growth-centeredness, individualism, meritocratic performance focus, disciplinary reductionism; e.g., Ball, 2012;

Biesta, 2009; Kopnina, 2015; Orr, 1994/2004; Sterling, 2003). In this sense, the medium to low level of coherent organisational practice and implementation into the macro-level policy environment as an “add-on” mirror underlying societal paradigms and (implicitly) assumed purposes of education (e.g., preparation for the workforce, providing grounds for economic competitiveness, social sorting and allocation; cf. Biesta, 2009; Sterling, 2024; for an exemplary analysis in England: Greer et al., 2023). In light of these societal paradigms and considering the theories-in-use (cf. Argyris & Schön, 1978), sustainability still appears to be positioned at the margins of modern education. Depicting the state of affairs, Sterling (2025, p. 238) refers to a “*worldview blindness*” in the debate on ESD. In reflecting on why ESD, as the educational concept foregrounded by UNESCO and others, falls short of its ambition, he argues that while the focus often lies on practice and policy, questions concerning the deeper cultural paradigms and, connected to this, the purposes of education receive less attention. This risks a situation in which ESD practice becomes “*conformative, or at best reformative rather than (as is often advocated or claimed) transformative*” (ibid.), e.g., by taking up dominant neoliberal narratives and, for example, technocentric, materialist, anthropocentric or reductionist perspectives. Indeed, if the idea of a whole-system approach was used as an analytical lens to describe the present state of education, characteristics would, in many places, likely rather include economic thinking, competitiveness and growth-orientation, among others (cf. Wals, 2020).

As an example, one recurring pattern in the study on sustainability in school education from the perspective of principals was the individualisation of responsibility in context of sustainability issues, which is in line with previous research in the field of climate education (e.g., Kranz et al., 2022). This finding is situated in a societal context where widespread neoliberal narratives suggest an exaggerated accentuation of freedom and responsibility on the part of the individual, accompanied by a rejection of collective (state) interventions (Lepenes, 2022). As McKenzie et al. (2015), Niebert (2021) and others have highlighted, the focusing on the private sphere risks a depoliticising of societal, structural and therefore political problems (cf. chapter 2.1). At the same time, unsustainability crises (e.g., climate change, loss of biodiversity, poverty) are often framed as global and therefore highly distant and abstract problems. As Grund and Brock (2019) have argued, such an epistemic misfit between the size and characteristics of problems (i.e., global, collective problems) and solutions (i.e., individualised responsibility for behavioral changes) may lead to demotivation and low perceived self-efficacy. In effect, the sketched accentuated individualist paradigm seems to contribute to explaining current patterns in practice and policy, while a shift towards more collective efficacy and public-sphere action could allow for a better fit between problems and solutions (cf. also Kranz et al., 2022).

As this example illustrates, activities at the levels of policy and practice are deeply intertwined with societal paradigms beyond the education system. Consequently, scholars in the field of sustainable education and beyond have suggested deeper paradigmatic shifts, as exemplified by Stephen Sterling's seminal work on a postmodern ecological worldview (Sterling, 2003) or the manifold scholars highlighting the relevance of a more relational and holistic paradigm as compared to widespread technocratic, materialist and anthropocentric perspectives (for an overview: Walsh et al., 2021). As was highlighted in chapter 1, education and learning, in a wide sense beyond the formal education system, bear the potential for higher-order (societal) learning where the structures and worldviews that have brought about current problems can critically be examined (cf. Barth, 2015; Barth & Michelsen, 2013; Sterling, 2004). In this light, the contributions in this dissertation simultaneously provide grounds for hope – sustainable education is wished-for by many and can likely be effective – and serve as a reminder of the power of dominant paradigms and the resistances to changing the (unsustainable) status-quo. Following on from this, the question arises what could overarchingly be learned from the findings in their surrounding research landscape for (more) effective sustainable education? Since the individual results of each of the four studies were discussed in detail in the respective manuscripts, the following section focuses on this question from a synthesising perspective.

4.2. Purposive, Experiential, Political and Structural: Learnings for more Effective Sustainable Education in Supportive Systemic Environments

Three decades after the Earth Summit in Rio de Janeiro (1992), sustainability and SD have, according to the self-reports of UNESCO member states, diffused widely into the policies and practices of education systems globally (cf. UNESCO, 2024a). For Germany, the national context of this dissertation, the reported score for the mainstreaming of ESD currently ranges between 0.9 and 1 on a scale from zero to one for the four sub-indicators of SDG 4.7.1 (policies, curricula, training of educators, assessments) (Destatis, 2025c). Yet national survey data among learners indicates that only around 23% of pupils and students rather (20%) or fully (3%) agree that their educational institution enables them to make meaningful contributions to solving the problems of sustainability (Grund & Brock, 2022; similar: Kress, 2025). Such a gap between rhetoric and practice is present not only within education, as the findings in this dissertation support, but also in international action on concrete sustainability problems, e.g., in context of climate change (cf. UNEP, 2025). Internationally, young people are well aware of and highly worried about the pressing reality of climate change and other sustainability issues, yet lack trust in sufficient government responses and, associated with this, feel betrayed rather than reassured (Hickman et al., 2021). In this light, it seems unsurprising that pessimism about the future, hopelessness and climate anxiety are widely spread among nowadays youth (Grund

& Brock, 2019; Ojala, 2012, 2016). In the context of education, the face-valid difference between rhetoric and self-reporting on the one hand, and experienced practice on the other, points to the necessity for a more evidence-based analysis of the current status, potential effectiveness and possible drivers of sustainable education. As was outlined in the previous sections, the four articles in this dissertation attempted to contribute to such a more refined conceptualisation, operationalisation and empirical assessment. Asking what may be learnings for more effective sustainable education, the following paragraphs draw on both insights from the four studies and the state of literature to offer reflections along four overarching points. Conceived of as impulses rather than a comprehensive list, they suggest that in order for sustainability in education to become more effective, it may have to become more (i) purposive, (ii) experiential, (iii) political and (iv) structural.

(i) A Sense of Purpose in Sustainable Education

Reconnecting with the question of purpose in education, as Biesta (2009) invites us to do, can be done from several avenues. First, it is a matter of political and philosophical debate what the purpose of education ought to be, i.e., what functions for individuals and societies it serves (ibid.; Barrett et al., 2006; Nikel & Lowe, 2010). Arguments for sustainability to be highly compatible with fundamental ideas and functions of education were introduced in chapter 1 with reference to, among others, Klafki's theory of a general education that empowers learners to confront epochal key challenges (Klafki, 1996/2007) and the manifold calls by practitioners, (inter-)national organisations and other policy-stakeholders for action towards sustainability. These perspectives provide a basis for arguing that, in a world of polycrisis, timely purposeful education should not only reproduce current societal conditions, but enable learners to emancipate themselves by forming their own perspectives, and to empower them to contribute to shaping a future they wish for. This latter focus on the perspectives of learners' links to a second way to consider purpose in education: The addressing of what feels relevant and purposeful to the recipients of education themselves. Surveys over the past decade have repeatedly found that issues related to sustainability are of high relevance to youth (e.g., Hickman et al., 2021; Ipsos European Public Affair, 2025; PwC, 2024; UNESCO, 2021b). Across the ages of lifelong learning, 80% of people globally responded as part of the UN People Climate Vote (n ~ 73,000) that they want their countries to do more on climate change (Flynn et al., 2024; cf. also Andre et al., 2024). Focused on education, 80% of respondents further expressed that they wished schools in their countries would give more emphasis to climate education (ibid.). This is consistent with the desires expressed by principals as highlighted in this dissertation (Holst, Brock, et al., 2025). As Brock and de Haan (2024) have pointed out, focusing on sustainability in education therefore means taking learners seriously in their experiences, worries and priorities, and linking what is learned more directly to the lifeworld

and salient emotional experience (cf. also Brock, Grund, & Holst, 2025). In an era marked by climate change, biosphere degradation, social inequality, geopolitical conflicts, disinformation and polarisation, the question is consequently no longer whether to address sustainability, but how to do so purposively. In fact, and sometimes less at focus, a transition towards sustainability can imply far-reaching opportunities for a tangibly better future: Studies on human wellbeing and contentment have found that people who find purpose in contributing to a more just society feel more satisfied with their lives overall (Schnell & Danbolt, 2023). And a survey in the G20 states found that 74% of respondents believed that *“human health and wellbeing are closely connected to the health and wellbeing of nature”* and 66% agreed that *“addressing climate change and environmental damage can bring many benefits to people”* (Ipsos, 2024, pp. 18–19). In line with this, the findings in study 3 not only point to the effectiveness of sustainability experience with respect to learning outcomes, but also to a link with the personal wellbeing of learners and educators (Holst, Grund & Brock, 2024). This is consistent with a focus on sustainable wellbeing which is increasingly emphasised both in the sustainability sciences (e.g., O'Mahony, 2022; Raworth, 2018; Rockström et al., 2023) and as a positive and motivationally aspiring narrative for ESD (Haan et al., in prep.).

In a nutshell, the first learning from this dissertation is quite simple: If education is to be more effective in empowering learners by endowing them with the capacities and capabilities to address sustainability problems, a reorienting of purpose, and therefore of priorities, is needed. As highlighted in the last section, sustainability in education currently tends to become reined in by dominant economic worldviews and conceptions of the purpose of education (cf. Sterling, 2024). This is also apparent in the perspectives of school leaders: At the time of surveying, 57% of school principals at German higher secondary schools saw the strong orientation of everyday school life towards exams and performance as a central hindering factor for sustainability at schools, and over 70% of principals describe the fact that other tasks and demands have higher priority as a challenge (Holst, Brock, et al., 2025). Systemically, such reorientation would imply shifting from sustainability as an underprioritised additive towards sustainability as an orienting principle of quality education (ibid.; Holst, Singer-Brodowski, et al., 2024). While such a systemic shift likely requires active higher-order learning (cf. Barth, 2015) among policy-makers and administrators, there is, already in the present state, space for repurposing at the local level: At and around educational institutions, the WIA, as conceptually synthesised, operationalised and assessed in this dissertation, can function as a vehicle for experimenting with directly tangible purpose shifts. Understood in this way, the WIA links in different ways to the layers of learning highlighted by Sterling (2010) in response to the debate on ESD 1/2 (cf. chapter 2.1). At the level of basic learning (ESD 1), the experience of descriptive norms and default ways of acting in a WIA seem to be a central factor in

predicting the sustainable behaviour of involved individuals (cf. study 3; Holst, Grund, & Brock, 2024). In terms of second-order learning (ESD 2), the participative approach specifically aims to motivate and empower learners as active and critical individuals and citizens capable of reflecting upon the assumptions underlying societal challenges and of approaching them in their own ways (cf. study 2; Holst, 2023; supported by the findings in study 3). If viewed as a way to provide space for collective experimentation with and implementation of alternative purposes and paradigms (cf. also study 4; Holst, Brock, et al., 2025), the WIA may further be considered an arena for third-order reflexive social learning (cf. Barth, 2015; Sterling, 2010). In this way, educational institutions can utilise the WIA not only as a framework for more coherent organisational development in times of unsustainability, but as a way to experiment with a concrete reordering of purposes. That this opportunity seems to exist not only shows in the data – 36% of principals describe that sustainability is already a frequent, very frequent or omnipresent theme at their schools – but also in manifold practical examples worldwide (e.g., Mathie & Wals, 2022).

(ii) Moving towards Experiential, Situated and Holistic Sustainability Learning

As the concept of WIAs invites a rethinking of the purpose of and practice at schools, universities and other contexts of learning, it certainly supports an alternative to the default way of addressing knowing: While much of current education focuses strongly on propositional knowing (exemplarily using the heuristic by Heron, 1992), advocates of WIAs to sustainability frequently refer to the importance of experiential, situated and practical knowing as critical to holistic and effective learning (e.g., O'Donoghue et al., 2018; Rieckmann, 2018; UNESCO, 2017a; overview in this dissertation: Holst, 2023). As the first large-scale application of the WIA-Scale in this dissertation indicates, such a more holistic perspective that considers not only content, but the socio-physical context and engaged, relational ways of learning, seems highly effective in terms of motivating and empowering learners and educators for sustainability (Holst, Grund, & Brock, 2024). Looking back at theories of experiential, situated and engaged learning, these conceptual characteristics and empirical findings strongly link to the works of John Dewey (e.g., *Experience and Education*, 1938). For Dewey (1938, p. 43), “*experience is always what it is because of a transaction taking place between an individual and what, at the time, constitutes his environment*”. With the concepts of *continuity*, building on the past, leading to purposive growth, and *interaction* foundational to experience, learning in the educational philosophy of Dewey is a highly social, interactive, situated and real-world oriented process. The emphasis on continuity further highlights the relevance of (in-)consistency between subsequent experiences (e.g., learning about the impact of nutrition on climate change in class, to subsequently finding no plant-based option as part of the lunch offerings). Studies on the “hidden curriculum” and the relevance of informal learning have

repeatedly supported such a notion of an educational institution always educating, whether intentionally or not (e.g., Barth et al., 2012; Gramatakos & Lavau, 2019; Winter & Cotton, 2012). Meaningful local embedding thereby refers not only to socio-physical situatedness directly at educational institutions (e.g., schools, universities, libraries, museums), but also to the lifeworld experiences in local communities and networks which can, in this light, be seen as real-world learning landscapes (Henderson & Tilbury, 2004; McMillin & Dyball, 2009; Shallcross et al., 2006). Considered as a process involving meaningful social and physical interaction, policy and practice engaging with WIAs may, in the future, thereby focus even more explicitly on connecting to the manifold socio-emotional dimensions of learning that are increasingly recognised in their imperativeness (Grund, 2025; Grund et al., 2024). Summarising the second overarching learning, it seems plausible that sustainability learning can become considerably more effective if a stronger emphasis is put on the socio-physical experience, local situatedness and a more holistic approach to learning.

(iii) Approaching Sustainability as what it is: Political

At least within the realm of environmental problems, most sustainability issues fit under what Garrett Hardin already in 1968 described as the *“Tragedy of the Commons”*, i.e., how common finite resources are depleted or destroyed based on individual, often rational self-interest. As decades of research on the governance of commons has indicated, such problems of collective irrationality can be resolved through the establishment of rules based on collective decision-making, both locally (e.g., Ostrom, 1990/2015) and globally (e.g., the CFC ban, climate treaties). As manifestations of past collective decisions, current physical and social (infra-)structures (e.g., fossil-based heating and transportation, normalised ways of acting) further define access to opportunities and create lock-ins and path dependencies (Albarracín et al., 2024; Driscoll, 2014; Goldstein et al., 2023). Yet while the collective nature of many sustainability problems is widely known, findings in this dissertation and other studies indicate that in education, moral responsibility for action towards mitigation is often attributed to individuals and their behaviours (Holst, Brock, et al., 2025; Kranz et al., 2022). It is, as a third overarching point to be made, therefore argued that it is critical for effective sustainable education to approach problems of unsustainability as that which they are: Collective, often structural and as such, highly political in terms of collective decision-making (cf. e.g., Håkansson et al., 2018; Niebert, 2019, 2021). This is, importantly, not to imply that behavioural changes were generally unimportant (e.g., on types of sustainable consumption, Geiger et al., 2018), but to highlight the interplay between individuals and their structural environment. In an evaluation of the effects of education on sustainability, Niebert (2021, p. 13) concludes that *“education can contribute by strengthening the political participation of learners and enabling them to question the mechanisms that have led to an overload of the planetary boundaries and to point out alternative courses*

of action". This aligns in with other calls for a stronger emphasis on political literacy in relation to sustainability in education (e.g., Huckle, 2009; Overwien, 2025; Rieckmann, 2026). As outlined in chapter 2.1 with reference to the Beutelsbach Consensus, empowerment for political participation is here understood as emancipatory, not following specific political parties but focused on supporting learners in becoming active citizens capable of involving themselves in decision-making on collective issues (cf. Niebert, 2021). Policy-making can support such a notion not only by generally strengthening political and citizenship education, but also by clarifying that the prohibition on overwhelming learners and the principle of controversy in political education do not in fact imply a requirement for neutrality (cf. Breitenmoser et al., 2024; A. S. Christensen & Grammes, 2020). Instead, there is, in many countries, even an obligation for state-employed teachers and lecturers to position themselves along the values engrained in the respective constitution (e.g., for human rights or against discrimination). In terms of organisational practice, educational institutions are highly suitable learning contexts that can both invite reflection on shared and conflicting values and provide spaces for the learning of democratic participation in a local microcosm (cf. Håkansson et al., 2018). Indeed, when considering the international literature on WIAs (Holst, 2023), participation is considered a core principle in virtually all publications. However, this is often not explicitly connected to the development of political literacy. As an approach that deliberately focuses on collective action, there is arguably much potential in the concept of a WIA to open formal and informal spaces for critical reflection, democratic engagement and transformative learning (on the latter, cf. Singer-Brodowski, 2016; Singer-Brodowski et al., 2022). While the interviews conducted with principals suggest that such a focus is currently barely set (Holst, Brock, et al., 2025), it may provide a valuable antidote to the ascribed individualisation of responsibility and instead, foster collective responsibility and agency (cf. Kranz et al., 2025). This perspective is not new either, again going back to Dewey (1916, *Democracy and Education*) and various others, but seems ever more important in a time in which populism and political polarisation are rising once again.

(iv) Creating the Conditions: On the Relevance of Structures and Standards

In social psychology, human behaviour is understood as a product of the reciprocal interaction between individuals' attributes and the environmental conditions around them (e.g., Bandura, 2001). Reviewing the determinants of behavioural changes across sectors, Albarracín et al. (2024) found that it does not appear to be changes in beliefs, attitudes and knowledge among individuals, but rather their habits and access to behavioural options that are most impactful. This is in line with research from other fields, such as on health behaviour (Cohen et al., 2000) or more generally within the cultural sciences (e.g., Hansen, 2011), highlighting the influence of structural factors and standards (formal, informal) on behavioural patterns. Seen in this

light, it is not surprising that in an education system where sustainability and ESD are mostly implemented as an “add-on” (study 1), it is often incoherently practiced (study 3) and responsibility lies on the shoulders of single engaged individuals (study 4). Consequently, based on the analysis of documents in the German education system, we have argued that “[a]lthough integration in structures involves more than anchoring in documents (e.g., mental structures), these formalizations set a frame for human action, provide orientation and are therefore an important lever for changing practice” (Holst, Singer-Brodowski, et al., 2024, p. 3920). Not only laws, curricula, assessment frameworks, but also available resources (e.g., funding, personnel), infrastructure (e.g., built learning environments), routines (e.g., the way in which days are structured), metrics of performance (e.g., grade orientation) and indicators of system-success (e.g., graduation rates) set and communicate what is ‘normal’ and expected within education. To normalise sustainability, i.e., to develop a culture of sustainability in education (cf. Holst, Fritz, et al., 2025), would thus necessitate redesigning rules, narratives, incentives and infrastructures in education. Linking back to the elaborations in chapter 2 on education as a process of empowerment rather than indoctrination, this may also be viewed in light of arguments made based on the capabilities approach: In the works of Martha Nussbaum, combined capabilities are considered a combination of internal capabilities (e.g., competencies and capacities) with suitable external conditions that allow for enactment (e.g., supportive (infra-)structures, legal circumstances) (Nussbaum, 1987; applied to sustainable education: Brock, 2022). Viewed in this way, the setting of conditions for sustainable education may be viewed as the creation of opportunity spaces for participatory and empowering educational processes. Linking this focus on conducive conditions (e.g., structures, standards) to the first learning on connecting more strongly to the question of purpose in education, the ambitions for sustainability in education (chapter 1) call for a new perspective on quality education as inherently sustainable, i.e., a sustainable quality education (cf. Barrett et al., 2006; Hopkins et al., 2020; Laurie et al., 2016; Nikel & Lowe, 2010). Along with a fundamental reprioritisation, such a perspective not only emphasises the reorienting of quality development and quality assurance systems (Ryan & Tilbury, 2013), assessments (Fischer et al., 2025) and metrics of performance (Brückner et al., 2025), but also the deliberate creation of more open spaces for democratic participation and engagement.

Towards Purposive, Experiential, Political and Structural Sustainable Education

Glancing across central learnings for (more) effective sustainable education, one overarching takeaway may be: Simply upscaling current activities on sustainability in education, i.e., adding more of the same, would likely not be an adequate response to the pressing reality of social and ecological crises. Early diagnosed with a nature-focused take by David Orr (1994/2004) and later further substantiated by Sterling (2003) and others, the empirical

contributions in this dissertation support the view that societal problems of unsustainability are deeply engrained in the paradigms, purpose, policy and practice of modern education. This is exemplified by a considerable rhetoric-action gap (already Vare, 2014), a lack of supportive enabling conditions and empowerment of educators (Holst, Singer-Brodowski, et al., 2024), low prioritisation and reliance on fragmented projects and engagement by individuals as well as by widespread rules-in-use and mindsets that impede sustainability (Holst, Brock, et al., 2025). Yet, together with other scholarly contributions over the past years, the dissertation also contributes to a higher specificity of what may be part of change in education that may not only lead to more effective policy and practice, but also considers the reorientation of paradigms and purpose beneath.

One such underlying question concerns the narration of envisioned futures: While ‘the future’ is nowadays often associated with far-reaching digitisation and social, geopolitical and environmental crises, this may also signal a contemporary crisis of hope, self-efficacy and of the binding power of positive and motivational visions for the future (cf. Grund & Brock, 2019; Wals, 2020). The abovementioned finding that only around a quarter of youth currently feel (rather) empowered by their educational institutions to contribute meaningfully to a more safe and just future (Grund & Brock, 2022; similarly: Kress, 2025) points to the roles that education has, and could have, in such a transition. The concept of WIAs as synthesised and further operationalised in this dissertation may thereby act as a seemingly highly effective vehicle to experiment with a concrete reprioritisation of purposes. The notion of WIAs further invites practitioners and policy-makers not only to reconsider the ‘why’ in education, but also to apply a more integrated perspective on learning, connecting socio-emotional and cognitive as well as conceptual and experiential, practical and participative approaches. In addressing societal and structural issues as such, this is connected with a view of educational practice as a space for active and collaborative learning of democratic citizenship. Allowing for a better fit between the size and constitution of problems and their solutions (cf. Grund & Brock, 2019), it has been argued that educational institutions can become microcosms not only of a sustainable society (Sterling, 2003), but of active democracy (cf. already Dewey, 1916). Instead of moralising sustainability as solely a matter of changes in individual behaviour (Kranz et al., 2022), education may empower learners to reflect upon and discuss the worldviews as well as political and economic decisions that brought current crises about and learn ways to envision alternative pathways and participate in their shaping (cf. also Niebert, 2019, 2021). To develop systemic environments conducive to an effective empowerment of learners, it has further been highlighted that not only the integration in documents and manifestation in resources, infrastructures, routines and performance measures is necessary, but that a larger shift of priorities towards sustainable quality education would be essential. Further questions

associated with such a shift are outlined, together with pathways for further research, at the end of this discussion. Before this, the following section lays out reflections on both the contributions and limitations of the overall dissertation, focusing particularly on indicator development, methodological and quality criteria related considerations, engrained normativity and on my own positionality.

4.3. Measuring Sustainable Education: Reflections on Contributions and Limitations

In the wider frame of research on the status, effectiveness as well as drivers of and barriers to sustainable education, this dissertation offers conceptual, methodological and empirical contributions at the levels of systemic policy integration and organisational practice (macro, meso; cf. Rode & Michelsen, 2008). It further assesses links between sustainability experience at educational institutions with learning outcomes at the micro-level. The research is thereby embedded in more than two decades of work on the development of valid, reliable as well as relevant, facilitative and feasible indicators for sustainability in education (a recent overview: Brock, Waltner, & Rabinowitz, 2025). Reflecting on contributions and limitations, the following paragraphs highlight the boundaries of the work by emphasising a range of other studies on relevant indicators, and discuss the overarching methodological approach with its strengths and weaknesses, inherent normativity and my own positionality.

A Contribution to an Increasingly Differentiated Field of Indicators

As was outlined in chapter 2, much of the early work on indicators for sustainable education has, as the global indicator for SDG 4.7.1, been criticised for a lack of reliability and validity, among others, as it was mostly based on countries' self-reporting. In recent years, an increasingly differentiated field of methodological approaches and datasets have been proposed to address different sub-fields and stages of education. At the level of learning outcomes, links have been strengthened to the field of environmental and sustainability-related psychology, focusing on constructs like changes in attitudes, motivation, agency and self-efficacy as well as behavioural changes (e.g., Grund & Brock, 2020, 2022; Olsson et al., 2020; Spliesgart et al., 2025) – some of which were utilised in this dissertation by assessing links between experienced sustainability as a WIA and learning outcomes (Holst, Grund, & Brock, 2024). Further, and connected to this, a number of frameworks have been developed to assess competence development among learners and educators (e.g., Annelin & Boström, 2023; Günther et al., 2022; Redman et al., 2021; Sass et al., 2022; Waltner et al., 2019; White et al., 2023). At the input-level, studies have focused on the availability of resources (Labanino et al., 2022) or, in the realm of document analyses, specifically at further training for educators (Waltner et al., 2018) or have adapted the procedure to other regional contexts (Breitenmoser

et al., 2026; Haan, 2021; Krah et al., 2021). At the meso-level of educational institutions, a certification-based output-indicator was further suggested and, in Germany, included in the national sustainability strategy (Hemmer et al., 2024). A range of self-assessment tools also exist for different types of educational institutions (Fischer et al., 2015; Urbanski & Filho, 2015). More recently, sustainability has been included in rankings of higher education institutions (on challenges and opportunities: Veidemane, 2022). While most of these works, as the ones in this dissertation, focus on some form of formal education, it is important to note that indicators are also being developed and applied in the wide field of non-formal education and learning (exemplarily in Germany: Brock & Grund, 2020; Widany & Schulte-Südbeck, 2025). As this incomprehensive overview highlights, there are numerous angles from which the key questions under consideration may be approached. The dissertation adds to this increasingly differentiated field by contributing approaches and empirical assessments of systemic policy integration and organisational practice at the level of full national education systems, taking Germany as an exemplary case. Such a birds-eye perspective can, as a characteristic of systemic monitoring approaches (Ioannidou, 2010), allow for the analysis of large-scale patterns, trends and effectiveness. In consideration of this general positioning of the work in the field of empirical assessments on sustainability in education, the following section discusses overarching methodological strengths, weaknesses and learnings.

Methodological Strengths, Weaknesses and Learnings

With the focus set on the system-level and large-scale patterns, the empirical studies in this dissertation contribute to a better comprehension of the ‘big picture’ of sustainability in education. This implies, on the other hand, that individual contexts with specific histories, actor constellations and local cultures were not the focal point of analysis. As noted in the systematic review on WIAs (Holst, 2023), local specificity is highly relevant to the concrete transformation processes associated with a sustainable education paradigm (for more context-specific analyses in different areas of education, see exemplarily Mogren & Gericke, 2019; Niedlich, Kummer, et al., 2020; Robinson et al., 2023; Sylvestre et al., 2013). Conversely, at the systemic level, the four studies in their individual ways each attempted to increase the validity, reliability, replicability and comparability of assessments. Concerning validity, the conceptual framework for evaluation of SDG 4.7.1 at the input-level, the concept synthesis of WIAs as well as the operationalisation of WIAs for assessments with learners, educators and leaders allow for a more concrete and comparable description of what a systemic integration and organisational practice of sustainability entails. In specifying the conceptual basis for assessments, the articles thereby contribute to stimulating debate about what exactly is meaningful to measure when it comes to sustainability in education. In terms of reliability,

replicability and comparability, the methodological frameworks as developed and applied attempt to contribute to more systematic, less biased and more easily reproducible and comparable assessments. Concerning transferability to other contexts, it may be argued that the resources needed for the presented assessments are not available in all contexts. While this is a valid criticism, particularly for national-scale surveys and document analyses with a large corpus of data, the scalability of the approaches may also be considered a strength: The WIA-Scale, for example, can be used not only for national or international-scale assessments, but also at a regional level, in specific areas of education or in individual educational institutions – not only for quantitative assessments of the status quo and developments, but also as a reflexive tool for organisational development (cf. Holst, 2024; Holst, Grund, & Brock, 2024). The same may be argued for the conceptual and methodological framework of the document analysis, which can also be used at other scales and for other than monitoring purposes (e.g., in regional assessments, within municipalities, as part of an organisational self-assessment; cf. Holst, Singer-Brodowski, et al., 2024).

Although the instruments are designed to reduce bias through systematised assessments, a certain degree of bias persists and warrants reflection, particularly in the interpretation of findings. For example, social desirability biases are hard to avoid in direct assessments of the status quo of sustainability when asking individuals who are professionally involved with or in other ways emotionally connected to what is being assessed (e.g., educators, leaders; cf. Holst, Brock, et al., 2025; Holst, Grund, & Brock, 2024). One way to mitigate this risk, at least in the context of educational institutions, lies in the questioning of learners rather than educators and leaders on what they experience as well as in the contrasting of perspectives of different groups of stakeholders. Also, assessing the current status alongside a desired status may reduce biases to over-report on the status-quo. In terms of the finding that educational stakeholders have a high desire for sustainability (similarly found by Grund & Brock, 2022; Kadji-Beltran et al., 2013), this likely also reflects a high overall awareness and agreeance to the abstract idea of sustainability in the general public (for Germany: Frick et al., 2025). As is widely known, this general support for the idea of sustainability does not simply translate to either behavioural changes or to support for sustainability-oriented politics (cf. Portus et al., 2024). Consequently, it is important to note that what cannot be inferred from the data is how individuals manage to beneficially combine or, if this is not possible, prioritise among different objectives (e.g., sustainability, economic prosperity, individual fulfillment).

As it comes to potential researcher biases, a range of measures were taken in each of the four studies to mitigate biases (cf. also the following section on positionality and normativity). For example, members of the German ESD expert fora were included in the selecting of the relevant document groups for the document analysis, and external experts were involved to

evaluate the descriptive findings along a standardized evaluation template, thereby distancing ourselves as authors from the evaluation of descriptive findings. Further, learners, educators and stakeholders from civil society, policymaking and administration were included in the expert review as part of the systematic review on WIAs as well as in the development and validation of the WIA-Scale. While such active involvement of relevant stakeholders likely increases validity, reliability and generalisability, the idea behind this may in the future be taken further across different indicator domains. Viewing indicators on sustainability in education even more as a product of transdisciplinary knowledge integration can support the creation of more socially robust and practically relevant knowledge (cf. Nowotny, 2003; on ESD indicators: Brockwell et al., 2022). As for national monitoring frameworks, it is important to note that such frameworks require a combination of assessment across different stages of education, indicator levels and types to provide a robust evidence base.

Research Setting and Positionality

One of the settings in which such a combination of indicators is being developed and assessed for a national education system is the setting in which this dissertation was written: the national ESD monitoring for Germany at Institut Futur (Freie Universität Berlin). Established in 2015, the ESD monitoring is led by Prof. Dr. Gerhard de Haan, who serves as the scientific advisor to the UNESCO “ESD for 2030” programme and the National Platform on ESD in Germany. The latter functions as a central coordination body for sustainability and ESD in the German education system. It is chaired by the Federal Ministry of Education, which is also funding the national ESD monitoring. The monitoring team is, as part of its work, actively involved in the scientific advisory to the national ESD policy networks (e.g., the National Platform, expert fora, partner networks). In this role, the ESD monitoring understands itself not only as a critical observer but also as constructively and supportively engaged (cf. Singer-Brodowski et al., 2021; Læssøe et al., 2013). This setting at the science-policy interface necessitates a reflexive positioning in differing roles, within relationships and concerning one’s own and others’ normativity, which we have reflected upon systematically inter alia as part of a collaborative autoethnography (for details, cf. Seggern et al., 2023).

Specifically, regarding normativity, the subject under study in the sustainability sciences, and thus also in this dissertation, is inherently and explicitly normative in its link to sustainability as a concept of social and environmental justice (cf. Ziegler & Ott, 2011). The use of the very concept of sustainability thereby warrants continuous reflection, considering its different uses in different contexts and by different stakeholders (cf. the introduction to the used concepts of sustainability and SD in chapter 1). Focusing on the role of normativity in science, scholars like Vogt and Weber (2020) argue, drawing on debates in scientific theory and ethics of science,

that values are not only engrained in explicitly normative fields (e.g., health, economics, education, sustainability), but are both unavoidable and, if considering ethics of responsibility a relevant quality criterion, desirable in all disciplines. Specifically, they argue that values, and thus normativity, are widely present in the constitution of research interests, questions and in the choice of theoretical, conceptual and methodological frameworks (in detail: Vogt, 2019). Rather than pretend to conduct value-free research, arguments are made for transparency and reflexivity about normativity as a quality criterion (cf. Seggern et al., 2023) as well as for the use of concrete measures to reflect upon and avoid potential biases in the research process.

In fact, my involvement with research in the field of sustainability transitions is motivated by an interest in contributing to a more socially just and environmentally viable future. Aware of this positionality and, at the same time, my understanding of scientific research as a process of rigorous, systematic knowledge production bound to scientific quality criteria (e.g., validity, reliability, reproducibility, comparability), a range of measures were deliberately taken to mitigate potential biases in the research process (cf. the preceding sections). From a philosophy of science perspective, the dissertation combines elements of critical rationalism (e.g., falsifiability) and hermeneutics (e.g., as part of rule-bound qualitative content analyses). The research is thereby understood as deliberately positioned in interaction with society, for example, when immanent critique is formulated based on comparisons between set objectives and observed policies and practices (on immanent critique, cf. Jaeggi, 2013). Viewing scientific research – in line with the principle of fallibilism – as a systematic process of producing provisional knowledge, the dissertation invites further research to critically engage with the conceptualisations suggested, methodological approaches developed and findings presented.

4.4. Implications for Future Research on Sustainable Education and Learning

The articles in this dissertation have attempted to contribute to a refined conceptualisation of the systemic policy integration and organisational practice of sustainability in education, more valid and reliable methodological frameworks for assessments and an enhanced evidence base on the status and effectiveness of as well as challenges and drivers for sustainability. In hindsight, there are elements to improve, open-ends and implications for future research that can be derived from the outlined reflections. The following paragraphs thus sketch pathways and questions that may be of relevance to the further evolving research agenda on sustainable education and learning. These considerations are structured in three sections, focusing on (i) the general notion of sustainable quality education and learning, (ii) concrete implications concerning education systems and educational institutions and (iii) opportunities for transfer beyond what is usually perceived as education.

As to the notion of quality education and learning becoming inherently sustainable, both conceptual and empirical questions arise. To date, arguments for sustainability as a pillar of quality education have suggested that a reordering of priorities in how quality is understood, developed and assured is necessary for education to become truly sustainable (e.g., Fischer et al., 2025; Holst, Brock, et al., 2025; Hopkins et al., 2020). Sustainable quality education can thereby be viewed as education and learning that entails the purpose, policies and practices to enable people with the capacities and capabilities to not only confront key challenges of our time, but to become involved in the shaping of a tangibly more safe and just future. Yet while initial studies have addressed the relation between sustainability and concepts of quality education (Laurie et al., 2016; Nikel & Lowe, 2010), the notion of sustainable quality education and learning requires further specification: How does sustainability, as a paradigmatic, normative orientation, relate to other principles and purposes of quality education (e.g., effectiveness, efficiency, equity, responsiveness; Nikel & Lowe, 2010; qualification, socialisation, subjectification; Biesta, 2009)? What tensions and mutual benefits exist between sustainability and other objectives desired in modern societies (e.g., integration into labour markets, empowerment for citizenship, social mobility)? What are the current dominant paradigms and enacted purposes in education and how do they, normatively and in concrete practice, impair or support sustainability (e.g., effects of neoliberal beliefs and competitive, meritocratic thinking)? As these exemplary questions indicate, a refined conceptual consideration of sustainable quality education may require a combination of conceptual and empirical work across different disciplines (e.g., in reviews, interviews, surveys) as well as transdisciplinary research and practice including the voices of key stakeholders in education systems (e.g., as part of Delphi studies, participative action research).

Keeping these general considerations of sustainable quality education and learning in mind, the following lines zoom in on more concrete implications for research on national education systems and educational institutions. As was highlighted, the developed and introduced indicators have, in this dissertation, been applied only to the exemplary national context of Germany. They and similar approaches are, however, transferrable to other regional, national or international contexts, which would allow (i) for comparative analyses that account for regional differences (e.g., historical, socio-cultural) and (ii) for more generalisable data on the status, effectiveness and relevant conditions to be gained. Specifically, analyses of different policy regimes and context-specific instruments, for example building on the SDG 4.7.1 framework, may help to identify patterns in framework conditions and practice at the system level or concerning specific sub-indicators (an application in Swiss teacher education: Breitenmoser et al., 2026; an assessment of patterns in higher education curricula: Weiss, Barth, & Wehrden, 2021). This, in turn, may in the future help to more clearly guide the development

of context-sensitive and effective policy instruments (e.g., regulatory, incentive-based, agenda-setting and communication, capacity building). Linked to the notion of sustainable quality education, such analyses may also focus specifically on assessing how sustainability is integrated and operationalised in quality development and assurance (e.g., assessments (cf. Fischer et al., 2025) and quality systems (cf. Ryan & Tilbury, 2013)). In linking analyses of systemic enabling conditions for sustainable education (e.g., availability of time and resources, political support, fitting infrastructure) to assessments of concrete educational practice and experience (e.g., through large-scale surveys with learners, educators and leaders), future research may thereby more clearly identify opportunity structures under which sustainable education is likely effective. In this, not only (un-)favourable conditions, but also the role of resistance to change at different levels requires consideration – research which is also continued as part of the national monitoring on ESD in Germany.

Concerning the concept of WIAs and its application within the formal and non-formal parts of education systems, the studies that make up part of this dissertation have contributed to a refined conceptualisation, operationalisation and improved assessment instruments. Yet there are elements to improve and pathways for future developments. In future studies, I would, among other things, more clearly and explicitly delineate the use of the terms institution and organisation (cf. chapter 2.3). While the term ‘institution’ was used in some instances as a shorthand for educational institutions (i.e., places and contexts where people gain education), the explicit differentiation between organisations and institutions (i.e., social systems of rules and norms that structure human behaviour) can enable not only more specific consideration of the manifold relevant organisational contexts and conditions, but also transferability to other social institutions. Focusing on the former, organisations associated with what is widely perceived as formal or non-formal education, the debate on WIAs has so far been concentrated largely around schools and higher education institutions (Holst, 2023). Thus, there is extensive opportunity for enhancing the work on WIAs in the fields of vocational education and training (VET) as well as in formal and non-formal adult education (e.g., Buckbesch & Heinen, 2024; Staudinger et al., 2026). A focus on socio-physical learning environments for adults (e.g., in VET or non-formal education) is thereby highly relevant, not least because it is adults, not youth, who are in positions of responsibility today, making important political and economic decisions that will shape the common future (cf. chapter 2). In line with a focus on decision-making in the public sphere, the studies in this dissertation have pointed to the potential for educational institutions following a WIA to act as spaces for participatory, democratic learning and collective action, where political literacy can be learned in practice (linking back to Dewey, 1916, 1938). Future research on organisational sustainability in education may thus draw on the conceptual works that link democracy and citizenship education with sustainability

learning (e.g., Huckle, 2009; Kenner & Singer-Brodowski, 2024; Niebert, 2019; Rieckmann, 2026) to empirically assess links between sustainability- and democracy-practice and learning outcomes within and around educational institutions. This may, for example, imply the inclusion of sustainability indicators (e.g., the WIA-Scale, sustainability competencies) in assessments of democratic education and vice versa (e.g., of democratic participation and political literacy in studies on sustainability). Strengthening this connection in assessments may further help to alleviate the widespread mindset of viewing sustainability action as a matter of mostly individual behavioural changes (Holst, Brock, et al., 2025; Kranz et al., 2022). Further concerning possible effects of a WIA, future studies may also draw on the discussed benefits and trade-offs with other dimensions of quality education. Specifically, surveys may address this by assessing relationships between, for example, organisational sustainability learning and other basic competencies (e.g., languages, MINT, emotional competence).

Beyond what is widely perceived as (non-)formal education, there are, as was highlighted above, implications from the articles that may be transferrable to other contexts of (societal) learning. Considering that the findings on the effectiveness of a more holistic, situated and participative sustainability experience are in line with research in social and environmental psychology (e.g., Cialdini & Jacobson, 2021; Fritzsche et al., 2018) and cognitive sciences (e.g., Barsalou, 2008; Fugate et al., 2019), an apparent next step would be the transfer to other types of organisations (e.g., ministries, hospitals, companies, nonprofit organisations). Beyond organisations, future studies may also consider (un-)sustainability experience of public infrastructure (e.g., mobility, energy, public spaces) as well as societal institutions beyond specific organisations (e.g., government, cf. T. Christensen, 2024; religion or the economy). Such a perspective on sustainability experience in the public domain may contribute to a better understanding of structural defaults (cf. German Council for Sustainable Development, 2024) and associated social and societal learning processes. Future studies could, in this context, further assess whether and how experiences of sustainability in local environments, public spaces and societal discourses are related to sustainability-related self-efficacy and motivation, trust in societal institutions and peoples' outlooks on the future. Considering that international data suggest that people tend to considerably underestimate others' willingness to act for sustainability (Andre et al., 2024), future research may thereby contribute to a refined understanding of the apparent gap between collective potentials and real-world outcomes.

5. Conclusions

In a nutshell, the findings in this dissertation indicate that high-quality sustainable education is desired by central stakeholders, likely effective in empowering learners and educators, but far from default in both policy and practice. This gap between aspirations and reality is mirrored in dominant societal paradigms and widespread conceptions of the purpose for education, favouring economic growth, competitiveness and individual fulfilment over collective wellbeing and environmental integrity. Such divergence between espoused theories and theories-in-use (Argyris & Schön, 1978) also shines through the journey that this dissertation has been. As an interdisciplinary project, conducted by a researcher with a background in both the natural- and social sciences, it is not too much to say that this dissertation did not fit easily into the discipline-oriented system of science- and higher education. The frictions that I have experienced as a result of the gap between the rhetoric of interdisciplinary science and present departmental practices connect me to practitioners and policy-makers committed to timely quality education who at times feel discouraged by the conditions around them. While this experience is wholly anecdotal, the dissertation set out to make systematic contributions to a more nuanced conceptualisation, operationalisation and assessment of systemic integration and organisational practice of sustainability in education.

In light of a reliance on self-reporting in international monitoring and a lack of methodological frameworks for large-scale scientific assessments of sustainability at the macro- and meso-levels of education systems, the four studies in this dissertation each attempted to increase the validity, reliability, replicability and comparability of analyses. With all of their limitations (cf. sections 3.2.1–3.2.4 and 4.3), I hope that the studies contribute to making the applied concepts (e.g., systemic policy integration, WIAs in organisational practice) more salient and thereby, more easily debatable within academia, policy-making and practice. By proposing ways to specifically operationalise indicators, it may become easier to not only report on the status and progress made, but also to more transparently consider how data is derived and interpreted. By this, the studies may provide an impetus for further debate on how to conceptualise and measure the status and quality of sustainability in education not only in a valid and reliable, but also in a relevant and meaningful way (cf. Brock, Waltner, & Rabinowitz, 2025).

As to overarching learnings for a potentially more effective sustainable education, four central lines of argumentation were laid out in the joint discussion. First, the relevance of a stronger link between sustainability and questions relating to the paradigms and purposes underlying policy and practice of education was highlighted. At the systemic level, this is associated with a focus on integrating sustainability as an orienting principle into the conceptualisation and assessment of quality education. At educational institutions, the concept of WIAs is further

suggested to be developed as a way of experimenting with locally tangible purpose shifts, providing an arena for reflexive higher-order social learning (cf. Barth, 2015; Sterling, 2010). Connecting to such local embeddedness, the second implication focused on moving towards more experiential, situated and holistic sustainability learning. While much of current education focuses on propositional knowing (cf. Heron, 1992), the findings on the effectiveness of WIAs provide further grounds for arguing for more engaged and relational learning grounded in its socio-physical context. Third, the findings in this dissertation and elsewhere suggest that insufficient focus is put on the political, economic and socio-cultural nature of decisions that have led to unsustainability. It is therefore argued that effective sustainable education requires an approach to sustainability problems that recognises them as collective, often structural, and therefore highly political issues. In this light, a stronger focus is suggested on linking ideas relating to sustainable education with the fostering of systemic thinking and political literacy, explicitly viewing such a focus as a process of emancipation rather than indoctrination. In organisational practice, this implies, for example, a focus on providing space for critical reflection, democratic engagement and transformative social learning. As a fourth overarching implication for more effective sustainable education, the reciprocal interaction between individuals and their environment is considered with respect to the setting of framework conditions (e.g., structures, standards). Connecting to the debate on the purposes of education in times of social and environmental disruptions, the idea of sustainable quality education is linked to the weighting of priorities in the development of laws, curricula, infrastructures, metrics of performance and system success as well as quality enhancement.

Viewed together, the studies point to manifold links between systemic framework conditions at the macro-level, organisational practice at the meso-level and learning at the micro-level of education systems. While the data suggests that experienced organisational practice of sustainability is related to learning among individuals and that this practice seems limited by framework conditions, further research is needed to specifically explore the more nuanced constellations of such relations. Examples of this include contextually different effective conditions, locally specific approaches and potential links between organisational practice and further outcomes (e.g., political literacy, collective wellbeing). Further questions remain for future studies to set a more decided focus on links with general quality development, learning among adults and transfer opportunities into the wider realms of social and societal learning.

As a concluding note, I hope that the developed methodological frameworks and underlying conceptualisations may help to more meaningfully and systematically trace the status and quality of sustainability in education. Through this, the work may add a small contribution not only to more robust assessments, but also to the sparking of hope for change.

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7. References

- Adams, R., Martin, S., & Boom, K. (2018). University culture and sustainability: Designing and implementing an enabling framework. *Journal of Cleaner Production*, 171, 434–445. <https://doi.org/10.1016/j.jclepro.2017.10.032>
- Aeschbach, V. M.-J., Schwichow, M., & Rieß, W. (2025). Effectiveness of climate change education—a meta-analysis. *Frontiers in Education*, 10, Article 1563816, 1–14. <https://doi.org/10.3389/feduc.2025.1563816>
- Agbedahin, A. V. (2019). Sustainable development, Education for Sustainable Development and the 2030 Agenda for Sustainable Development : Emergence, efficacy, eminence, and future. *Sustainable Development*, 27(4), 669–680. <https://doi.org/10.1002/sd.1931>
- 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>
- Albarracín, D., Fayaz-Farkhad, B., & Granados Samayoa, J. A. (2024). Determinants of behaviour and their efficacy as targets of behavioural change interventions. *Nature Reviews Psychology*(3), 377–392. <https://doi.org/10.1038/s44159-024-00305-0>
- Albert, M., Quenzel, G., Moll, F. de, Leven, I., McDonnell, S., Rysina, A., Schneekloth, U., & Wolfert, S. (2024). *Jugend 2024 – 19. Shell Jugendstudie: Pragmatisch zwischen Verdrossenheit und gelebter Vielfalt* (1. Auflage). Julius Beltz GmbH & Co. KG. <https://nbn-resolving.org/urn:nbn:de:bsz:31-epflicht-3163402>
- Andre, P., Boneva, T., Chopra, F., & Falk, A. (2024). Globally representative evidence on the actual and perceived support for climate action. *Nature Climate Change*, 14(3), 253–259. <https://doi.org/10.1038/s41558-024-01925-3>
- 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>
- Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2020). Environmental education outcomes for conservation: A systematic review. *Biological Conservation*, 241, Article 108224, 1–13. <https://doi.org/10.1016/j.biocon.2019.108224>
- Ardoin, N. M., Bowers, A. W., Roth, N. W., & 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>
- Argyris, C., & Schön, D. A. (1978). *Organizational learning: A theory of action perspective*. Addison-Wesley Pub. Co.

- Artino, A. R., La Rochelle, J. S., Dezee, K. J., & Gehlbach, H. (2014). Developing questionnaires for educational research: Amee Guide No. 87. *Medical Teacher*, 36(6), 463–474. <https://doi.org/10.3109/0142159X.2014.889814>
- Baars, S., Schellings, G. L. M., Joore, J. P., & van Wesemael, P. J. V. (2023). Physical learning environments' supportiveness to innovative pedagogies: Students' and teachers' experiences. *Learning Environments Research*, 26(2), 617–659. <https://doi.org/10.1007/s10984-022-09433-x>
- Baars, S., Schellings, G. L. M., Krishnamurthy, S., Joore, J. P., Brok, P. J. den, & van Wesemael, P. J. V. (2021). A framework for exploration of relationship between the psychosocial and physical learning environment. *Learning Environments Research*, 24(1), 43–69. <https://doi.org/10.1007/s10984-020-09317-y>
- Ball, S. J. (2012). *Global Education Inc: New Policy Networks and the Neoliberal Imaginary* (1st ed.). Routledge. <https://doi.org/10.4324/9780203803301>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman & Co.
- Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, 52(1), 1–26. <https://doi.org/10.1146/annurev.psych.52.1.1>
- Baraldi, C., & Corsi, G. (2016). *Niklas Luhmann: Education as a Social System*. Springer Briefs in Education. Springer International Publishing. <https://doi.org/10.1007/978-3-319-49975-8>
- Barratt Hacking, E., Scott, W., & Lee, E. (2010). *Evidence of Impact of Sustainable Schools*. Department for Children, Schools and Families.
- Barrett, A. M., Lowe, J., Nikel, J., Ukpo, E., & Chawla-Duggan, R. (2006). *The concept of quality in education: A review of the 'international' literature on the concept of quality in education*. EdQual RPC.
- Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, 59, 617–645. <https://doi.org/10.1146/annurev.psych.59.103006.093639>
- Barth, M [Matthias]. (2015). *Implementing sustainability in higher education: Learning in an age of transformation*. Routledge studies in sustainable development. Routledge Taylor & Francis. <https://doi.org/10.4324/9780203488355>
- Barth, M [Matthias], Fischer, D., Michelsen, G., Nemnich, C., & Rode, H. (2012). Tackling the Knowledge–Action Gap in Sustainable Consumption: Insights from a Participatory School Programme. *Journal of Education for Sustainable Development*, 6(2), 301–312. <https://doi.org/10.1177/0973408212475266>
- Barth, M [Matthias], Godemann, J., Rieckmann, M., & Stoltenberg, U. (2007). Developing key competencies for sustainable development in higher education. *International Journal of Sustainability in Higher Education*, 8(4), 416–430. <https://doi.org/10.1108/14676370710823582>

- Barth, M [Matthias], & Michelsen, G. (2013). Learning for change: an educational contribution to sustainability science. *Sustainability Science*, 8(1), 103–119. <https://doi.org/10.1007/s11625-012-0181-5>
- Barth, M [Matthias], & Thomas, I. (2012). Synthesising case-study research – ready for the next step? *Environmental Education Research*, 18(6), 751–764. <https://doi.org/10.1080/13504622.2012.665849>
- Benavot, A., & Williams, J. (2023). Can we transform global education without transforming how we monitor progress? *Journal of International Cooperation in Education*, 25(1), 42–61. <https://doi.org/10.1108/JICE-07-2022-0020>
- Bettencourt, L. M. A., & Kaur, J. (2011). Evolution and structure of sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, 108(49), 19540–19545. <https://doi.org/10.1073/pnas.1102712108>
- Beveridge, D., McKenzie, M., Aikens, K., & Strobbe, K. M. (2019). A National Census of Sustainability in K-12 Education Policy: Implications for International Monitoring, Evaluation, and Research. *Canadian Journal of Educational Administration and Policy*(188), 36–52.
- Biermann, F., Hickmann, T., Sénit, C.-A., Beisheim, M., Bernstein, S., Chasek, P., Grob, L., Kim, R. E., Kotzé, L. J., Nilsson, M., Ordóñez Llanos, A., Okereke, C., Pradhan, P., Raven, R., Sun, Y., Vijge, M. J., van Vuuren, D., & Wicke, B. (2022). Scientific evidence on the political impact of the Sustainable Development Goals. *Nature Sustainability*, 5(9), 795–800. <https://doi.org/10.1038/s41893-022-00909-5>
- Biermann, F., Kanie, N., & Kim, R. E. (2017). Global governance by goal-setting: the novel approach of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability*, 26–27, 26–31. <https://doi.org/10.1016/j.cosust.2017.01.010>
- Biesta, G. (2002). Bildung and Modernity: The Future of Bildung in a World of Difference. *Studies in Philosophy and Education*, 21(4-5), 343–351. <https://doi.org/10.1023/A:1019874106870>
- Biesta, G. (2009). Good education in an age of measurement: on the need to reconnect with the question of purpose in education. *Educational Assessment, Evaluation and Accountability*, 21(1), 33–46. <https://doi.org/10.1007/s11092-008-9064-9>
- Bilharz, M., & Schmitt, K. (2011). Going Big with Big Matters. The Key Points Approach to Sustainable Consumption. *GAIA - Ecological Perspectives for Science and Society*, 20(4), 232–235. <https://doi.org/10.14512/gaia.20.4.5>
- Birney, A., & Reed, J. (2009). *Sustainability and renewal: findings from the Leading Sustainable Schools research project: A research study highlighting the characteristics of sustainable schools and the leadership qualities required to develop sustainable schools*. National College for Leadership of Schools and Children's Services.

- Boeve-de Pauw, J., Gericke, N., Olsson, D., & Berglund, T. (2015). The Effectiveness of Education for Sustainable Development. *Sustainability*, 7(11), 15693–15717. <https://doi.org/10.3390/su71115693>
- Boeve-de Pauw, J., & van Petegem, P. (2013). A Cross-Cultural Study of Environmental Values and Their Effect on the Environmental Behavior of Children. *Environment and Behavior*, 45(5), 551–583. <https://doi.org/10.1177/0013916511429819>
- Bohunovsky, L., Radinger-Peer, V., & Penker, M. (2020). Alliances of Change Pushing Organizational Transformation Towards Sustainability across 13 Universities. *Sustainability*, 12(7), 1–20. <https://doi.org/10.3390/su12072853>
- Bøjer, B. (2019). *Unlocking learning spaces: An examination of the interplay between the design of learning spaces and pedagogical practices* [Industrial PhD], The Royal Danish Academy of Fine Arts, Schools of Architecture, Design and Conservation.
- Bosetti, V., Colantone, I., Vries, C. E. de, & Musto, G. (2025). Green backlash and right-wing populism. *Nature Climate Change*, 15(8), 822–828. <https://doi.org/10.1038/s41558-025-02384-0>
- Bosevska, J., & Kriewaldt, J. (2020). Fostering a whole-school approach to sustainability: Learning from one school's journey towards sustainable education. *International Research Geographical Environmental Education*, 29(1), 55–73. <https://doi.org/10.1080/10382046.2019.1661127>
- Brand, U., Muraca, B., Pineault, É., Sahakian, M., Schaffartzik, A., Novy, A., Streissler, C., Haberl, H., Asara, V., Dietz, K., Lang, M., Kothari, A., Smith, T., Spash, C., Brad, A., Pichler, M., Plank, C., Velegakis, G., Jahn, T., . . . Görg, C. (2021). From planetary to societal boundaries: an argument for collectively defined self-limitation. *Sustainability: Science, Practice and Policy*, 17(1), 264–291. <https://doi.org/10.1080/15487733.2021.1940754>
- Breitenmoser, P., Holst, J., & Niebert, K. (2026). Von der Kür zur Kernaufgabe: Stand und Perspektiven der Bildung für nachhaltige Entwicklung (BNE) in der Schweizer Gymnasiallehrpersonenbildung. *Beiträge Zur Lehrerinnen- Und Lehrerbildung (BzL)*, 44(1), 77-95. <https://doi.org/10.36950/bzl.44.1.2026.10412>
- Breitenmoser, P., Keller-Schneider, M., & Niebert, K. (2024). Navigating controversy and neutrality: pre-service teachers' beliefs on teaching climate change. *Environmental Education Research*, 31(11), 2097–2115. <https://doi.org/10.1080/13504622.2024.2375335>
- Breiting, S., Mayer, M., & Mogensen, F. (2005). *Quality Criteria for ESD-Schools: Guidelines to enhance the quality of Education for Sustainable Development*. SEED, ENSI.
- Brent Edwards, D., Sustarsic, M., Chiba, M., McCormick, M., Goo, M., & Perriton, S. (2020). Achieving and Monitoring Education for Sustainable Development and Global Citizenship: A Systematic Review of the Literature. *Sustainability*, 12(4), Article 1383, 1–57. <https://doi.org/10.3390/su12041383>

- Bridges, D. (2008). Educationalization: On the Appropriateness of Asking Educational Institutions to Solve Social and Economic Problems. *Educational Theory*, 58(4), 461–474. <https://doi.org/10.1111/j.1741-5446.2008.00300.x>
- Brock, A. (2022). *Materialität menschlicher Freiheiten: Gerechtigkeit als Bildungsauftrag: Relationen zwischen Umwelt und Sozialem gestalten*. Springer VS. <https://doi.org/10.1007/978-3-658-37314-6>
- Brock, A., & Grund, J. (2020). *Non-formale Bildung für nachhaltige Entwicklung: Divers, volatil und dabei feste Säulen der Nachhaltigkeitstransformation*.
- Brock, A., Grund, J., & Holst, J. (2025). Wie kann motivierende und effektive BNE gelingen? Rahmenbedingungen und Wege erfolgreicher Umsetzung. In KMK & BMZ (Eds.), *Orientierungsrahmen Globale Entwicklung – Bildung für nachhaltige Entwicklung in der gymnasialen Oberstufe* (pp. 58–67). Engagement Global gGmbH, Bonn 2025.
- Brock, A., & Haan, G. de. (2024). Nachhaltigkeitsbezogene Bildung heißt, die (Er-)Lebenswelt vieler Jugendlicher ernst zu nehmen. In A. Fritz Carrapatoso, M. Wilhelm, M. Rehm, & V. Reinhardt (Eds.), *Wirksamer Unterricht in BNE: Bildung für nachhaltige Entwicklung: Unterrichtsqualität: Perspektiven von Expertinnen und Experten* (pp. 37–46). Schneider Verlag, Hohengehren GmbH.
- Brock, A., Haan, G. de, Etzkorn, N., & Singer-Brodowski, M. (Eds.). (2018). *Wegmarken zur Transformation – Nationales Monitoring von Bildung für nachhaltige Entwicklung in Deutschland*. Verlag Barbara Budrich.
- Brock, A., Waltner, E.-M., & Rabinowitz, D. (2025). Cross-disciplinary Perspectives on Developing Global Datasets and Indicators for Monitoring Climate Change Education and Communication (CCE). *Discover Sustainability*, 6, Article 1390, 1–22. <https://doi.org/10.1007/s43621-025-01763-z>
- Brockwell, A. J., Mochizuki, Y., & Sprague, T. (2022). Designing indicators and assessment tools for SDG Target 4.7: a critique of the current approach and a proposal for an 'Inside-Out' strategy. *Compare: A Journal of Comparative and International Education*, 54(5), 731–749. <https://doi.org/10.1080/03057925.2022.2129957>
- Brückner, M., Lysgaard, J. A., Elf, N., & Reid, A. (2025). Conceptions and dimensions of quality in environmental and sustainability education. *Environmental Education Research*, 1–39. <https://doi.org/10.1080/13504622.2025.2604767>
- Brundiers, K., Barth, M [Matthias], Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S., Dripps, W., Habron, G., Harré, N., Jarchow, M., Losch, K., Michel, J., Mochizuki, Y., Rieckmann, M., Parnell, R., Walker, P., & Zint, M. (2021). Key competencies in sustainability in higher education—Toward an agreed-upon reference framework. *Sustainability Science*, 16(1), 13–29. <https://doi.org/10.1007/s11625-020-00838-2>

- Buckbesch, M., & Heinen, E. (2024). *Guidebook SustainableALE: Sustainable organisational development in Adult Education*. Institut für Internationale Zusammenarbeit des Deutschen Volkshochschul-Verbandes.
- Buckler, C., & Creech, H. (2014). *Shaping the Future We Want: UN Decade of Education for Sustainable Development (2005-2014). Final Report*. United Nations Educational, Scientific and Cultural Organization.
- Bundesverfassungsgericht. (2021). *Beschluss vom 24. März 2021 (Aktenzeichen: 1 BvR 2656/18)*.
- Caeiro, S., Sandoval Hamon, L. A., Martins, R., & Bayas Aldaz, C. E. (2020). Sustainability Assessment and Benchmarking in Higher Education Institutions-A Critical Reflection. *Sustainability*, 12(2), 1–30. <https://doi.org/10.3390/su12020543>
- Calmbach, M., Flaig, B. B., Gaber, R., Gensheimer, T., Möller-Slawinski, H., Schleer, C., & Wisniewski, N. (2024). *Wie ticken Jugendliche? 2024: Lebenswelten von Jugendlichen im Alter von 14 bis 17 Jahren in Deutschland* (Band 11133). Bundeszentrale für politische Bildung.
- Campanelli, P. (2008). Testing Survey Questions. In E. D. de Leeuw, J. J. Hox, & D. A. Dillman (Eds.), *International Handbook of Survey Methodology*.
- Cebrián, G., Mogas, J., Palau, R., & Fuentes, M. (2022). Sustainability and the 2030 Agenda within schools: A study of school principals' engagement and perceptions. *Environmental Education Research*, 28(6), 845–866. <https://doi.org/10.1080/13504622.2022.2044017>
- Chancel, L., Piketty, T., Saez, E., & Zucman, G. (2022). *World inequality report 2022*. Harvard University Press.
- Cheeseman, A., Sharon Alexandra Wright, T., Murray, J., & McKenzie, M. (2019). Taking stock of sustainability in higher education: a review of the policy literature. *Environmental Education Research*, 25(12), 1697–1712. <https://doi.org/10.1080/13504622.2019.1616164>
- Christensen, A. S., & Grammes, T. (2020). The Beutelsbach Consensus – the approach to controversial issues in Germany in an international context. *Acta Didactica Norden*, 14(4), 1–19. <https://doi.org/10.5617/adno.8349>
- Christensen, T. (2024). *The Whole-of-Government Approach in EU Research and Innovation Policy: Key Recommendations*. European Commission, Directorate-General for Research and Innovation.
- Cialdini, R. B., & Jacobson, R. P. (2021). Influences of social norms on climate change-related behaviors. *Current Opinion in Behavioral Sciences*, 42, 1–8. <https://doi.org/10.1016/j.cobeha.2021.01.005>

- Cincera, J., & Krajhanzl, J. (2013). Eco-Schools: what factors influence pupils' action competence for pro-environmental behaviour? *Journal of Cleaner Production*, 61, 117–121. <https://doi.org/10.1016/j.jclepro.2013.06.030>
- Clark, W. C. (2007). Sustainability science: A room of its own. *Proceedings of the National Academy of Sciences*, 104(6), 1737–1738. <https://doi.org/10.1073/pnas.0611291104>
- Clark, W. C., & Dickson, N. M. (2003). Sustainability science: The emerging research program. *Proceedings of the National Academy of Sciences*, 100(14), 8059–8061. <https://doi.org/10.1073/pnas.1231333100>
- Clark, W. C., & Harley, A. G. (2020). Sustainability Science: Toward a Synthesis. *Annual Review of Environment and Resources*, 45(1), 331–386. <https://doi.org/10.1146/annurev-environ-012420-043621>
- Cohen, D. A., Scribner, R. A., & Farley, T. A. (2000). A structural model of health behavior: A pragmatic approach to explain and influence health behaviors at the population level. *Preventive Medicine*, 30(2), 146–154. <https://doi.org/10.1006/pmed.1999.0609>
- Collins, D. (2003). Pretesting survey instruments: An overview of cognitive methods. *Quality of Life Research*, 12, 229–238. <https://doi.org/10.1023/A:1023254226592>
- Conlon, T. J. (2004). A review of informal learning literature, theory and implications for practice in developing global professional competence. *Journal of European Industrial Training*, 28(2/3/4), 283–295. <https://doi.org/10.1108/03090590410527663>
- Corres, A., Rieckmann, M., Espasa, A., & Ruiz-Mallén, I. (2020). Educator Competences in Sustainability Education: A Systematic Review of Frameworks. *Sustainability*, 12(23), 9858. <https://doi.org/10.3390/su12239858>
- Council of Europe. (2018). *Reference Framework of Competences for Democratic Culture: Volume 2: Descriptors of competences for democratic culture*. Council of Europe Publishing.
- Council of the European Union. (2022). *Council Recommendation of 16 June 2022 on learning for the green transition and sustainable development 2022/C 243/01*.
- Cristóvão, A. M., Valente, S., Rebelo, H., & Ruivo, A. F. (2023). Emotional education for sustainable development: A curriculum analysis of teacher training in Portugal and Spain. *Frontiers in Education*, 8, Article 1165319, 1–9. <https://doi.org/10.3389/feduc.2023.1165319>
- Cross, D., Shaw, T., Epstein, M., Pearce, N., Barnes, A., Burns, S., Waters, S., Lester, L., & Runions, K. (2018). Impact of the Friendly Schools whole-school intervention on transition to secondary school and adolescent bullying behaviour. *European Journal of Education*, 53(4), 495–513. <https://doi.org/10.1111/ejed.12307>
- Davies, I., & Pike, G. (2009). Global Citizenship Education: Challenges and Possibilities. In R. Lewin (Ed.), *The handbook of practice and research in study abroad: Higher education and the quest for global citizenship* (1st ed.). Routledge.

- Destatis. (2025a). *Anzahl der Schüler an berufsbildenden Schulen in Deutschland im Schuljahr 2023/2024 nach Bundesländern*. Veröffentlicht von J. Rudnicka, 26.11.2025.
- Destatis. (2025b). *Anzahl der Schülerinnen und Schüler an allgemeinbildenden Schulen in Deutschland in den Schuljahren von 1992/1993 bis 2024/2025*. Veröffentlicht von Statista Research Department, 26.11.2025.
- Destatis. (2025c). *Integration von 'Global Citizenship Education' und 'Bildung für nachhaltige Entwicklung' im Bildungswesen*. Statistisches Bundesamt (Destatis). <https://sdg-indikatoren.de/4-7-1/>
- Deutsche UNESCO-Kommission. (2014). *Vom Projekt zur Struktur: Projekte, Maßnahmen und Kommunen der UN-Dekade "Bildung für nachhaltige Entwicklung"*.
- Dewey, J. (1916). *Democracy and education*. Macmillan.
- Dewey, J. (1938). *Experience and education* (First Collier Book Edition 1963, Nineteenth Printing 1976). New York: Kappa Delta Pi.
- Didham, R. J., & Ofei-Manu, P. (2018). Chapter 4: Advancing policy to achieve quality Education for Sustainable Development. In A. Leicht, J. Heiss, & W. J. Byun (Eds.), *Issues and trends in Education for Sustainable Development* (pp. 87–110). United Nations Educational, Scientific and Cultural Organization.
- Djordjevic, A., & Cotton, D. (2011). Communicating the sustainability message in higher education institutions. *International Journal of Sustainability in Higher Education*, 12(4), 381–394. <https://doi.org/10.1108/14676371111168296>
- Driscoll, P. A. (2014). Breaking Carbon Lock-In: Path Dependencies in Large-Scale Transportation Infrastructure Projects. *Planning Practice & Research*, 29(3), 317–330. <https://doi.org/10.1080/02697459.2014.929847>
- Eberz, S., Lang, S., Breitenmoser, P., & Niebert, K. (2023). Taking the Lead into Sustainability: Decision Makers' Competencies for a Greener Future. *Sustainability*, 15(6), Article 4986, 1–24. <https://doi.org/10.3390/su15064986>
- European Court of Human Rights. (2024). *Violations of the European Convention for failing to implement sufficient measures to combat climate change (ECHR 087)*.
- Evans, N., Whitehouse, H., & Gooch, M. (2012). Barriers, Successes and Enabling Practices of Education for Sustainability in Far North Queensland Schools: A Case Study. *The Journal of Environmental Education*, 43(2), 121–138. <https://doi.org/10.1080/00958964.2011.621995>
- Fanning, A. L., O'Neill, D. W., Hickel, J., & Roux, N. (2022). The social shortfall and ecological overshoot of nations. *Nature Sustainability*, 5(1), 26–36. <https://doi.org/10.1038/s41893-021-00799-z>
- Fend, H. (2009). *Neue Theorie der Schule: Einführung in das Verstehen von Bildungssystemen*. VS Verlag für Sozialwissenschaften. <https://doi.org/10.1007/978-3-531-91788-7>

- Ferreira, J.-A., Ryan, L., & Tilbury, D. (2007). Mainstreaming education for sustainable development in initial teacher education in Australia: A review of existing professional development models. *Journal of Education for Teaching*, 33(2), 225–239. <https://doi.org/10.1080/02607470701259515>
- Fischbach, R., Kolleck, N., & Haan, G. de. (2015). *Auf dem Weg zu nachhaltigen Bildungslandschaften: Lokale Netzwerke erforschen und gestalten*. Springer Fachmedien Wiesbaden; Imprint: Springer VS. <https://doi.org/10.1007/978-3-658-06978-0>
- Fischer, D. (2011). Monitoring Educational Organizations' Culture of Sustainable Consumption: Initiating and Evaluating Cultural Change in Schools and Universities. *Journal of Social Science*, 7(1), 63–75. <https://doi.org/10.3844/jssp.2011.63.75>
- Fischer, D. (2014). *Der Beitrag von Schule zur Bewältigung der globalen Konsumherausforderung* [Dissertation]. Fakultät Nachhaltigkeit, Leuphana Universität Lüneburg.
- Fischer, D., Jenssen, S., & Tappeser, V. (2015). Getting an empirical hold of the sustainable university: A comparative analysis of evaluation frameworks across 12 contemporary sustainability assessment tools. *Assessment & Evaluation in Higher Education*, 40(6), 785–800. <https://doi.org/10.1080/02602938.2015.1043234>
- Fischer, D., King, J., & Redman, A. (2025). Rethinking Learning Assessment in Education for Sustainable Development: A Call for Action. *Journal of Education for Sustainable Development*, 19(1), 58–75. <https://doi.org/10.1177/09734082251355050>
- Fischer, D., King, J., Rieckmann, M., Barth, M [Matthias], Büssing, A., Hemmer, I., & Lindau-Bank, D. (2022). Teacher Education for Sustainable Development: A Review of an Emerging Research Field. *Journal of Teacher Education*, 73(5), 509–524. <https://doi.org/10.1177/00224871221105784>
- Fleer, M., & Hammer, M. (2013). Emotions in Imaginative Situations: The Valued Place of Fairytales for Supporting Emotion Regulation. *Mind, Culture, and Activity*, 20(3), 240–259. <https://doi.org/10.1080/10749039.2013.781652>
- Flynn, C., Jardon, S. T., Fisher, S., Blayney, M., Ward, A., Smith, H., Struthoff, P., & Fillingham, Z. (2024). *Peoples' Climate Vote 2024: Results*. United Nations Development Programme (UNDP).
- Forssten Seiser, A., Mogren, A., Gericke, N., Berglund, T., & Olsson, D. (2023). Developing school leading guidelines facilitating a whole school approach to education for sustainable development. *Environmental Education Research*, 29(5), 783–805. <https://doi.org/10.1080/13504622.2022.2151980>
- Fredriksson, U., N. Kusanagi, K., Gougoulakis, P., Matsuda, Y., & Kitamura, Y. (2020). A comparative study of curriculums for education for sustainable development (ESD) in Sweden and Japan. *Sustainability*, 12(3), Article 1123, 1–16. <https://doi.org/10.3390/su12031123>

- Frick, V., Fülling, J., Harms, C., Grothmann, T., & Marken, G. (2025). *Umweltbewusstsein in Deutschland 2024: Kurzbericht zur Bevölkerungsumfrage*. Umweltbundesamt.
- Fritsche, I., Barth, M [Markus], Jugert, P., Masson, T., & Reese, G. (2018). A social identity model of pro-environmental action (SIMPEA). *Psychological Review*, 125(2), 245–269. <https://doi.org/10.1037/rev0000090>
- Fugate, J. M. B., Macrine, S. L., & Cipriano, C. (2019). The role of embodied cognition for transforming learning. *International Journal of School & Educational Psychology*, 7(4), 274–288. <https://doi.org/10.1080/21683603.2018.1443856>
- Gallwey, S. (2016). ‘Capturing Transformative Change in Education: The Challenge of Tracking Progress towards SDG Target 4.7’. *Policy and Practice: A Development Education Review*, 23, 124–138.
- Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, 36(3), 399–417. <https://doi.org/10.1016/j.respol.2007.01.003>
- Geiger, S. M., Fischer, D., & Schrader, U. (2018). Measuring What Matters in Sustainable Consumption: An Integrative Framework for the Selection of Relevant Behaviors. *Sustainable Development*, 26(1), 18–33. <https://doi.org/10.1002/sd.1688>
- German Council for Sustainable Development. (2024). *It’s the politics, stupid: The Responsibility of State and Society for Sustainable Living Environments*. https://www.nachhaltigkeitsrat.de/wp-content/uploads/2024/07/20240321_RNE_Statement_Its_the_politics_stupid.pdf
- German Rectors’ Conference. (2025). *Kulturen der Nachhaltigkeit – Hochschulen als Zukunftswerkstätten der nachhaltigen Entwicklung stärken: Empfehlung der 41. Mitgliederversammlung der HRK am 4.11.2025 in Osnabrück*.
- Giangrande, N., White, R. M., East, M., Jackson, R., Clarke, T., Saloff Coste, M., & Penha-Lopes, G. (2019). A Competency Framework to Assess and Activate Education for Sustainable Development: Addressing the UN Sustainable Development Goals 4.7 Challenge. *Sustainability*, 11(10), Article 2832, 1–16. <https://doi.org/10.3390/su11102832>
- Gibb, N. (2016). *Getting climate-ready: a guide for schools on climate action*; 2016. United Nations Educational, Scientific and Cultural Organization.
- Ginzky, H., & Menger, M. (2023). *Ukraine War and Sustainability Policy: Sustainability Policy - Key to Stability, Security and Resilience: Lessons for Sustainability Policy - Discussion Paper*. German Environmental Agency.
- Giri, D. R., Neupane, B. P., Dahal, N., & Subedi, D. (2025). Enhancing school performance through whole school intervention: a case study. *Frontiers in Education*, 10, Article 1533586, 1–11. <https://doi.org/10.3389/feduc.2025.1533586>
- Glasser, H. (2007). Minding the gap: the role of social learning in linking our stated desire for a more sustainable world to our everyday actions and policies. In A. E. J. Wals (Ed.),

- Social learning towards a sustainable world* (pp. 33–61). Wageningen Academic Publishers. https://doi.org/10.3920/9789086865949_005
- Goldman, D., Ayalon, O., Baum, D., & Weiss, B. (2018). Influence of 'green school certification' on students' environmental literacy and adoption of sustainable practice by schools. *Journal of Cleaner Production*, 183, 1300–1313. <https://doi.org/10.1016/j.jclepro.2018.02.176>
- Goldstein, J. E., Neimark, B., Garvey, B., & Phelps, J. (2023). Unlocking “lock-in” and path dependency: A review across disciplines and socio-environmental contexts. *World Development*, 161, Article 106116, 1–15. <https://doi.org/10.1016/j.worlddev.2022.106116>
- Goller, A., & Rieckmann, M. (2022). What do We Know About Teacher Educators' Perceptions of Education for Sustainable Development? A Systematic Literature Review. *Journal of Teacher Education for Sustainability*, 24(1), 19–34. <https://doi.org/10.2478/jtes-2022-0003>
- Göpel, M. (2016). *The Great Mindshift: How a New Economic Paradigm and Sustainability Transformations go Hand in Hand*. Springer eBook Collection Earth and Environmental Science: Volume 2. Springer Open. <https://doi.org/10.1007/978-3-319-43766-8>
- Gough, A. (2016). Teacher Education for Sustainable Development: Past, Present and Future. In W. Leal Filho & P. Pace (Eds.), *World Sustainability Series. Teaching Education for Sustainable Development at University Level* (pp. 109–122). Springer International Publishing. https://doi.org/10.1007/978-3-319-32928-4_8
- Government of Ireland. (2022). *ESD to 2030: Second National Strategy on Education for Sustainable Development*. <https://assets.gov.ie/static/documents/second-national-strategy-on-education-for-sustainable-development-esd-to-2030-ad1ca48f.pdf>
- Gramatakos, A. L., & Lavau, S. (2019). Informal learning for sustainability in higher education institutions. *International Journal of Sustainability in Higher Education*, 20(2), 378–392. <https://doi.org/10.1108/IJSHE-10-2018-0177>
- Grauer, C., Fischer, D., & Frank, P. (2022). Time and sustainability: A missing link in formal education curricula. *The Journal of Environmental Education*, 53(1), 22–41. <https://doi.org/10.1080/00958964.2021.2009429>
- Greer, K., King, H., & Glackin, M. (2023). The ‘web of conditions’ governing England’s climate change education policy landscape. *Journal of Education Policy*, 38(1), 69–92. <https://doi.org/10.1080/02680939.2021.1967454>
- Grund, J. (2025). *Emotional Competence in Sustainability Education – Relevance, Foundations and Implications* [Dissertation]. Freie Universität Berlin. <https://doi.org/10.17169/refubium-50511>
- Grund, J., & Brock, A. (2019). Why We Should Empty Pandora’s Box to Create a Sustainable Future: Hope, Sustainability and Its Implications for Education. *Sustainability*, 11(3), Article 893, 1–20. <https://doi.org/10.3390/su11030893>

- Grund, J., & Brock, A. (2020). Education for Sustainable Development in Germany: Not Just Desired but Also Effective for Transformative Action. *Sustainability*, 12(7), Article 2838, 1–20. <https://doi.org/10.3390/su12072838>
- Grund, J., & Brock, A. (2022). *Formale Bildung in Zeiten von Krisen – die Rolle von Nachhaltigkeit in Schule, Ausbildung und Hochschule. Kurzbericht des Nationalen Monitorings zu Bildung für nachhaltige Entwicklung (BNE) auf Basis einer Befragung von > 3.000 jungen Menschen und Lehrkräften*. Institut Futur, Freie Universität Berlin. <https://doi.org/10.17169/refubium-36890>
- Grund, J., & Holst, J. (2023). Emotional competence: The missing piece in school curricula? A systematic analysis in the German education system. *International Journal of Educational Research Open*, 4, Article 100238, 1–9. <https://doi.org/10.1016/j.ijedro.2023.100238>
- Grund, J., Singer-Brodowski, M., & Büssing, A. G. (2024). Emotions and transformative learning for sustainability: a systematic review. *Sustainability Science*, 19(1), 307–324. <https://doi.org/10.1007/s11625-023-01439-5>
- Grunwald, A. (2010). Wider die Privatisierung der Nachhaltigkeit – Warum ökologisch korrekter Konsum die Umwelt nicht retten kann. *GAIA - Ecological Perspectives for Science and Society*, 19(3), 178–182. <https://doi.org/10.14512/gaia.19.3.6>
- Günther, J., Overbeck, A. K., Muster, S., Tempel, B. J., Schaal, S [Steffen], Schaal, S [Sonja], Kühner, E., & Otto, S. (2022). Outcome indicator development: Defining education for sustainable development outcomes for the individual level and connecting them to the SDGs. *Global Environmental Change*, 74, Article 102526, 1–10. <https://doi.org/10.1016/j.gloenvcha.2022.102526>
- Haan, G. de. (2008). Gestaltungskompetenz als Kompetenzkonzept der Bildung für nachhaltige Entwicklung. In *Kompetenzen der Bildung für nachhaltige Entwicklung* (pp. 23–43). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-90832-8_4
- Haan, G. de (2010). The development of ESD-related competencies in supportive institutional frameworks. *International Review of Education*, 56(2-3), 315–328. <https://doi.org/10.1007/s11159-010-9157-9>
- Haan, G. de. (2021). Bildung für nachhaltige Entwicklung in Luxemburg: Eine Bestandsaufnahme. In LUCET & SCRIPT (Ed.), *Nationaler Bildungsbericht Luxemburg 2021* (pp. 211–225). Luxemburg: Imprimerie Centrale.
- Haan, G. de, Brock, A., Grund, J., Holst, J., Schneider, M., Schönherr, C., & Widany, S. (in prep.). Die Zukunft der Bildung für nachhaltige Entwicklung. Wohlergehen als verändertes Paradigma [Working Title].

- Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable Development Goals: A need for relevant indicators. *Ecological Indicators*, 60, 565–573.
<https://doi.org/10.1016/j.ecolind.2015.08.003>
- Håkansson, M., Östman, L., & van Poeck, K. (2018). The political tendency in environmental and sustainability education. *European Educational Research Journal*, 17(1), 91–111.
<https://doi.org/10.1177/1474904117695278>
- Hamann, K. R. S., Wullenkord, M. C., Reese, G., & van Zomeren, M. (2024). Believing That We Can Change Our World for the Better: A Triple-A (Agent-Action-Aim) Framework of Self-Efficacy Beliefs in the Context of Collective Social and Ecological Aims. *Personality and Social Psychology Review : An Official Journal of the Society for Personality and Social Psychology, Inc*, 28(1), 11–53.
<https://doi.org/10.1177/10888683231178056>
- Hansen, K. P. (2011). *Kultur und Kulturwissenschaft: Eine Einführung* (4., vollst. überarb. Aufl.). UTB: Vol. 1846. A. Francke Verlag.
- Hargreaves, L. G. (2008). The whole-school approach to education for sustainable development: From pilot projects to systemic change. *Policy and Practice: A Development Education Review*(6), 69–74.
- Hemmer, I., Lude, A., Mainka, S., Schwarz, V., Bagoly-Simó, P., Ullrich, M., Labanino, R., & Winter, M. (2024). Sind (BNE-)Schullabels geeignete Indikatoren, um die Implementierung von Bildung für nachhaltige Entwicklung ins schulische Bildungssystem zu messen? Ergebnisse eines empirischen Projektes. *ZEP – Zeitschrift Für Internationale Bildungsforschung Und Entwicklungspädagogik*, 2024(2), 4–11.
<https://doi.org/10.31244/zep.2024.02.02>
- Henderson, K., & Tilbury, D. (2004). *Whole-School Approaches to Sustainability: An International Review of Sustainable School Programs. A Report Prepared by the Australian Research Institute in Education for Sustainability (ARIES) for The Department of the Environment and Heritage, Australian Government*.
- Heron, J. (1992). *Feeling and Personhood: Psychology in Another Key*. Sage Publications.
- Hickel, J. (2020). Quantifying national responsibility for climate breakdown: An equality-based attribution approach for carbon dioxide emissions in excess of the planetary boundary. *The Lancet. Planetary Health*, 4(9), e399-e404. [https://doi.org/10.1016/S2542-5196\(20\)30196-0](https://doi.org/10.1016/S2542-5196(20)30196-0)
- Hickman, C., Marks, E., Pihkala, P., Clayton, S., Lewandowski, R. E., Mayall, E. E., Wray, B., Mellor, C., & van Susteren, L. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: A global survey. *The Lancet. Planetary Health*, 5(12), e863-e873. [https://doi.org/10.1016/S2542-5196\(21\)00278-3](https://doi.org/10.1016/S2542-5196(21)00278-3)

- Hodgson, G. M. (2006). What Are Institutions? *Journal of Economic Issues*, 40(1), 1–25.
<https://doi.org/10.1080/00213624.2006.11506879>
- Holst, J. (2023). Towards Coherence on Sustainability in Education: A Systematic Review of Whole Institution Approaches. *Sustainability Science*, 18, 1015–1030.
<https://doi.org/10.1007/s11625-022-01226-8>
- Holst, J. (2024). Whole Institution Approach: Erfassung erlebter Nachhaltigkeit (WIA-Skala). In J. Holst, A. Brock, & J. Grund (Eds.), *Messinstrumente aus dem Nationalen BNE-Monitoring. Indikatoren des nationalen BNE-Monitorings und ihre Übertragbarkeit auf das kommunale Bildungsmonitoring*. KOSMO Spektrum digital.
<https://doi.org/10.5281/zenodo.13898591>
- Holst, J., Brock, A., Grund, J., Schlieszus, A.-K., & Singer-Brodowski, M. (2025). Whole-school sustainability at the core of quality education: Wished-for by principals but requiring collective and structural action. *Journal of Cleaner Production*, 519, Article 145897, 1–11.
<https://doi.org/10.1016/j.jclepro.2025.145897>
- Holst, J., Brock, A., Singer-Brodowski, M., & Haan, G. de (2020). Monitoring Progress of Change: Implementation of Education for Sustainable Development (ESD) within Documents of the German Education System. *Sustainability*, 12(10), Article 4306, 1–19.
<https://doi.org/10.3390/su12104306>
- Holst, J., Fritz, H., Nölting, B., Potthast, T., Betz, C., Lang, D. J., Ober, S., Parodi, O., Scheiding, C., Weynand, M., & Singer-Brodowski, M. (2025). Exploring Culture(s) of Sustainability at Higher Education Institutions: A Systematic Review of Concepts and Pathways. *International Journal of Sustainability in Higher Education*, 26(9), 489–506.
<https://doi.org/10.1108/IJSHE-08-2024-0550>
- Holst, J., Grund, J., & Brock, A. (2024). Whole Institution Approach: Measurable and highly effective in empowering learners and educators for sustainability. *Sustainability Science*, 19, 1359–1376. <https://doi.org/10.1007/s11625-024-01506-5>
- Holst, J., Singer-Brodowski, M., Brock, A., & Haan, G. de (2024). Monitoring SDG 4.7: Assessing Education for Sustainable Development in Policies, Curricula, Training of Educators and Student Assessment (Input-Indicator). *Sustainable Development*, 32(4), 3908–3923. <https://doi.org/10.1002/sd.2865>
- Hopkins, C., Michelsen, G., Salite, I., Siegmund, A., Wagner, D., Yokoi, A., Fischer, D., Kohl, K., Razak, D., & Tilleczeck, K. (2020). Sustainability as a purpose on the new path of learning for the future. In UNESCO (Ed.), *Humanistic Futures of Learning: Perspectives from UNESCO Chairs and UNITWIN Networks* (pp. 58–62).
- Huckle, J. (2009). Consulting the UK ESD community on an ESD indicator to recommend to Government: an insight into the micro-politics of ESD. *Environmental Education Research*, 15(1), 1–15. <https://doi.org/10.1080/13504620802578509>

- Hunt, P., Barrios, L., Telljohann, S. K., & Mazyck, D. (2015). A whole school approach: Collaborative development of school health policies, processes, and practices. *The Journal of School Health*, 85(11), 802–809. <https://doi.org/10.1111/josh.12305>
- International Commission on the Futures of Education. (2021). *Reimagining our futures together: A new social contract for education*. UNESCO.
- International Court of Justice. (2025). *Obligations of States in respect of Climate Change*. 23 July 2025 Advisory Opinion.
- Ioannidou, A. (2010). Educational monitoring and reporting as governance instruments for evidence-based education policy. In S. K. Amos (Ed.), *International perspectives on education and society: Vol. 12. International education governance* (pp. 155–172). Emerald. [https://doi.org/10.1108/S1479-3679\(2010\)0000012011](https://doi.org/10.1108/S1479-3679(2010)0000012011)
- IPCC. (2022). *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf <https://doi.org/10.1017/9781009157926.025>
- Ipsos. (2024). *Global Commons Survey: G20 + Global Report: attitudes to planetary stewardship and segmentation*. Commissioned by Earth4All and the Global Commons Alliance, Partners: The Policy Institute Kings College, ISWE, Wellbeing Economy Alliance. <https://earth4all.life/wp-content/uploads/2024/10/Global-Commons-Survey-2024-Global-2.pdf>
- Ipsos European Public Affair. (2025). *European Parliament Europabarometer: Youth Survey 2024*. Responsible: Magdalena Starostin; Contributing Authors: Cristina Cella, Gonzalo Velasco Monasterio. European Parliament. <https://europa.eu/eurobarometer/api/deliverable/download/file?deliverableId=96862>
- Ison, R., & Russell, D. B. (Eds.). (2000). *Agricultural extension and rural development: Breaking out of traditions; A second-order systems perspective* (1. publ). Cambridge University Press. <http://www.loc.gov/catdir/samples/cam032/98051725.html>
- Jackson, P. W. (1968). *Life in Classrooms*. New York, Holt, Rinehart and Winston. <https://doi.org/10.2307/1162100>
- Jaeggi, R. (2013). *Kritik von Lebensformen* (Erste Auflage, Jubiläumsausgabe). Suhrkamp-Taschenbuch Wissenschaft. Suhrkamp.
- Jahn, T., Bergmann, M., & Keil, F. (2012). Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics*, 79, 1–10. <https://doi.org/10.1016/j.ecolecon.2012.04.017>
- Janssens, L., Kuppens, T., Mulà, I., Staniskiene, E., & Zimmermann, A. B. (2021). Do European quality assurance frameworks support integration of transformative learning for sustainable development in higher education? *International Journal of*

- Sustainability in Higher Education*, 23(8), 148–173. <https://doi.org/10.1108/IJSHE-07-2021-0273>
- Jickling, B. (1992). Viewpoint: Why I Don't Want My Children to Be Educated for Sustainable Development. *The Journal of Environmental Education*, 23(4), 5–8. <https://doi.org/10.1080/00958964.1992.9942801>
- Jickling, B., & Spork, H. (1998). Education for the Environment: a critique. *Environmental Education Research*, 4(3), 309–327. <https://doi.org/10.1080/1350462980040306>
- Jickling, B., & Wals, A. E. J. (2008). Globalization and environmental education: looking beyond sustainable development. *Journal of Curriculum Studies*, 40(1), 1–21. <https://doi.org/10.1080/00220270701684667>
- Jóhannesson, I. Á., Norðdahl, K., Óskarsdóttir, G., Pálsdóttir, A., & Pétursdóttir, B. (2011). Curriculum analysis and education for sustainable development in Iceland. *Environmental Education Research*, 17(3), 375–391. <https://doi.org/10.1080/13504622.2010.545872>
- Jucker, R. (2002). “Sustainability? Never heard of it!”. *International Journal of Sustainability in Higher Education*, 3(1), 8–18. <https://doi.org/10.1108/14676370210414146>
- Jugert, P., Greenaway, K. H., Barth, M [Markus], Büchner, R., Eisentraut, S., & Fritsche, I. (2016). Collective efficacy increases pro-environmental intentions through increasing self-efficacy. *Journal of Environmental Psychology*, 48, 12–23. <https://doi.org/10.1016/j.jenvp.2016.08.003>
- Kadji-Beltran, C., Zachariou, A., & Stevenson, R. B. (2013). Leading sustainable schools: exploring the role of primary school principals. *Environmental Education Research*, 19(3), 303–323. <https://doi.org/10.1080/13504622.2012.692770>
- Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *The American Psychologist*, 58(9), 697–720. <https://doi.org/10.1037/0003-066X.58.9.697>
- Karlsson, M., Alfredsson, E., & Westling, N. (2020). Climate policy co-benefits: a review. *Climate Policy*, 20(3), 292–316. <https://doi.org/10.1080/14693062.2020.1724070>
- Kates, R. W. (2011). What kind of a science is sustainability science? *Proceedings of the National Academy of Sciences of the United States of America*, 108(49), 19449–19450. <https://doi.org/10.1073/pnas.1116097108>
- Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., McCarthy, J. J., Schellnhuber, H. J., Bolin, B., Dickson, N. M., Faucheux, S., Gallopin, G. C., Grübler, A., Huntley, B., Jäger, J., Jodha, N. S., Kasperson, R. E., Mabogunje, A., Matson, P., . . . Svedlin, U. (2001). Environment and development. Sustainability science. *Science*, 292(5517), 641–642. <https://doi.org/10.1126/science.1059386>
- Keizer, K., & Schultz, P. W. (2018). Social Norms and Pro-Environmental Behaviour. In L. Steg & J. I. M. de Groot (Eds.), *BPS textbooks in psychology. Environmental psychology*:

- An introduction* (Second edition, pp. 179–188). John Wiley & Sons, Inc.
<https://doi.org/10.1002/9781119241072.ch18>
- Kenner, S. (2020). Politische Bildung: Citizenship Education in Germany from marginalization to new challenges. *Journal of Social Science Education*, 19(1), 118–135.
<https://doi.org/10.4119/jsse-1618>
- Kenner, S., & Singer-Brodowski, M. (2024). Politische Bildung und Bildung für nachhaltige Entwicklung – eine Annäherung in Spannungsfeldern. *Wochenschau*, 75(24s), 8–13.
- King, J., Brundiers, K., & Fischer, D. (2024). Student agency in a sustainability-oriented assessment process: exploring expansive learning in student-led rubric co-design. *Assessment & Evaluation in Higher Education*, 49(6), 851–863.
<https://doi.org/10.1080/02602938.2024.2333031>
- Kioupi, V., & Voulvoulis, N. (2019). Education for Sustainable Development: A Systemic Framework for Connecting the SDGs to Educational Outcomes. *Sustainability*, 11(21), Article 6104, 1–18. <https://doi.org/10.3390/su11216104>
- Klafki, W. (1996/2007). *Neue Studien zur Bildungstheorie und Didaktik: Zeitgemäße Allgemeinbildung und kritisch-konstruktive Didaktik* (6. Edition). Beltz Verlag.
- Kohl, K., Hopkins, C., Barth, M [Matthias], Michelsen, G., Dlouhá, J., Razak, D. A., Abidin Bin Sanusi, Z., & Toman, I. (2022). A whole-institution approach towards sustainability: A crucial aspect of higher education's individual and collective engagement with the SDGs and beyond. *International Journal of Sustainability in Higher Education*, 23(2), 218–236. <https://doi.org/10.1108/IJSHE-10-2020-0398>
- Kolleck, N. (2019). The emergence of a global innovation in education: diffusing Education for Sustainable Development through social networks. *Environmental Education Research*, 25(11), 1635–1653. <https://doi.org/10.1080/13504622.2019.1675593>
- König, A. (2017). Sustainability science as a transformative social learning process. In A. König & J. R. Ravetz (Eds.), *Key issues in environment and sustainability. Sustainability science: Key issues*. Routledge.
- Kopnina, H. (2012). Education for sustainable development (ESD): the turn away from 'environment' in environmental education? *Environmental Education Research*, 18(5), 699–717. <https://doi.org/10.1080/13504622.2012.658028>
- Kopnina, H. (2015). Neoliberalism, pluralism and environmental education: The call for radical re-orientation. *Environmental Development*, 15, 120–130.
<https://doi.org/10.1016/j.envdev.2015.03.005>
- Kopnina, H., & Cherniak, B. (2016). Neoliberalism and justice in education for sustainable development: a call for inclusive pluralism. *Environmental Education Research*, 22(6), 827–841. <https://doi.org/10.1080/13504622.2016.1149550>

- Korteling, J. E., & Toet, A. (2022). Cognitive Biases. In *Encyclopedia of Behavioral Neuroscience, 2nd edition* (pp. 610–619). Elsevier. <https://doi.org/10.1016/B978-0-12-809324-5.24105-9>
- Krah, J. M., Reimann, J., & Molitor, H. (2021). Sustainability in Brandenburg Study Programs. Perspectives for Anchoring Sustainability in Higher Education Curricula. *Sustainability*, 13(7), Article 3958, 1–32. <https://doi.org/10.3390/su13073958>
- Kranz, J., Breitenmoser, P., Laherto, A., Krug, A., Schwichow, M., & Tasquier, G. (2025). Science Education for Collective Agency in the Climate Crisis: A Social Identity Approach. *Research in Science Education*, 55(4), 1149–1168. <https://doi.org/10.1007/s11165-025-10282-w>
- Kranz, J., Schwichow, M., Breitenmoser, P., & Niebert, K. (2022). The (Un)political Perspective on Climate Change in Education—A Systematic Review. *Sustainability*, 14(7), Article 4194, 1–44. <https://doi.org/10.3390/su14074194>
- Kress, D. (2025). *Nachhaltigkeitsbarometer 2025: Sozioökonomische Themen gewinnen die Oberhand - Wir MÜSSEN eure Fehler ausbaden!* Greenpeace e.V. https://www.greenpeace.de/publikationen/GP_Nachhaltigkeitsbarometer_2025.pdf
- Kuckartz, U. (2014). *Qualitative Text Analysis: A Guide to Methods, Practice & Using Software*. SAGE Publications Ltd. <https://doi.org/10.4135/9781446288719>
- Kuckartz, U. (2019). Qualitative Text Analysis: A Systematic Approach. In G. Kaiser & N. Presmeg (Eds.), *Compendium for Early Career Researchers in Mathematics Education* (pp. 181–197). Springer International Publishing. https://doi.org/10.1007/978-3-030-15636-7_8
- Kvamme, O. A. (2021). Rethinking Bildung in the Anthropocene: The Case of Wolfgang Klafki. *HTS Teologiese Studies/Theological Studies*, 77(3), 1–9. <https://doi.org/10.4102/hts.v77i3.6807>
- Labanino, R. P., Lude, A., Winter, M., Mainka, S., Hemmer, I., Bagoly-Simó, P., Hartmann, J., & Ullrich, M. (2022). Measuring Financial, Personnel and Material Resources for Education for Sustainable Development in the German School System: A Proposal for the German Educational Monitoring and Reporting. *Journal of Education for Sustainable Development*, 16(1-2), 42–60. <https://doi.org/10.1177/09734082221117603>
- Læssøe, J., Feinstein, N. W., & Blum, N. (2013). Environmental education policy research – challenges and ways research might cope with them. *Environmental Education Research*, 19(2), 231–242. <https://doi.org/10.1080/13504622.2013.778230>
- Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., & Thomas, C. J. (2012). Transdisciplinary research in sustainability science: practice, principles, and challenges. *Sustainability Science*, 7(S1), 25–43. <https://doi.org/10.1007/s11625-011-0149-x>
- Laurie, R., Nonoyama-Tarumi, Y., McKeown, R., & Hopkins, C. (2016). Contributions of Education for Sustainable Development (ESD) to Quality Education: A Synthesis of

- Research. *Journal of Education for Sustainable Development*, 10(2), 226–242.
<https://doi.org/10.1177/0973408216661442>
- Lawrence, M., Homer-Dixon, T., Janzwood, S., Rockström, J., Renn, O., & Donges, J. F. (2024). Global polycrisis: the causal mechanisms of crisis entanglement. *Global Sustainability*, 7(e6), 1–16. <https://doi.org/10.1017/sus.2024.1>
- Leach, M., Reyers, B., Bai, X., Brondizio, E. S., Cook, C., Díaz, S., Espindola, G., Scobie, M., Stafford-Smith, M., & Subramanian, S. M. (2018). Equity and sustainability in the Anthropocene: a social–ecological systems perspective on their intertwined futures. *Global Sustainability*, 1(e6), 1–13. <https://doi.org/10.1017/sus.2018.12>
- Leicht, A., Heiss, J., & Byun, W. J. (Eds.). (2018). *Issues and Trends in Education for Sustainable Development*. Paris 07 SP, France. United Nations Educational, Scientific and Cultural Organization.
- Lenton, T. M., Xu, C., Abrams, J. F., Ghadiali, A., Loriani, S., Sakschewski, B., Zimm, C., Ebi, K. L., Dunn, R. R., Svenning, J.-C., & Scheffer, M. (2023). Quantifying the human cost of global warming. *Nature Sustainability*, 6(10), 1237–1247.
<https://doi.org/10.1038/s41893-023-01132-6>
- Leo, U., & Wickenberg, P. (2013). Professional norms in school leadership: Change efforts in implementation of education for sustainable development. *Journal of Educational Change*, 14(4), 403–422. <https://doi.org/10.1007/s10833-013-9207-8>
- Lepenes, P. (2022). *Verbot und Verzicht: Politik aus dem Geiste des Unterlassens* (Erste Auflage, Originalausgabe). Edition Suhrkamp: Vol. 2787. Suhrkamp.
- Livingstone, D. W. (2001). Adults' informal learning: definitions, findings, gaps and future research. *WALL Working Paper*(21).
<https://tspace.library.utoronto.ca/handle/1807/2735>
- Lönngren, J., & van Poeck, K. (2021). Wicked problems: a mapping review of the literature. *International Journal of Sustainable Development and World Ecology*, 28(6), 481–502.
<https://doi.org/10.1080/13504509.2020.1859415>
- Lotz-Sisitka, H., Wals, A. E. J., Kronlid, D., & McGarry, D. (2015). Transformative, transgressive social learning: rethinking higher education pedagogy in times of systemic global dysfunction. *Current Opinion in Environmental Sustainability*, 16, 73–80.
<https://doi.org/10.1016/j.cosust.2015.07.018>
- Lozano, R., Ceulemans, K., Alonso-Almeida, M., Huisingh, D., Lozano, F. J., Waas, T., Lambrechts, W., Lukman, R., & Hugé, J. (2015). A review of commitment and implementation of sustainable development in higher education: results from a worldwide survey. *Journal of Cleaner Production*, 108, 1–18.
<https://doi.org/10.1016/j.jclepro.2014.09.048>
- Luhmann, N. (1998). *Die Gesellschaft der Gesellschaft*. Suhrkamp-Taschenbuch Wissenschaft. Suhrkamp.

- Macintyre, T. K.-J., Tilbury, D., & Wals, A. E. J. (2025). *Education and Learning for Sustainable Futures: 50 Years of Learning for Environment and Change* (1st ed.). Routledge Research in Education, Society and the Anthropocene Series. Taylor & Francis Group.
<https://ebookcentral.proquest.com/lib/kxp/detail.action?docID=31653391>
- Marron, R. K., & Naughton, D. (2019). *Monitoring Progress Towards SDG Target 4.7 in Europe: Proposed Framework and Tools*. Bridge 47 Network.
- Mathie, R. G., & Wals, A. E. J. (2022). *Whole school approaches to sustainability: Exemplary practices from around the world*. Wageningen University. <https://edepot.wur.nl/566782>
- McKenzie, M., Bieler, A., & McNeil, R. (2015). Education policy mobility: reimagining sustainability in neoliberal times. *Environmental Education Research*, 21(3), 319–337.
<https://doi.org/10.1080/13504622.2014.993934>
- McMillin, J., & Dyball, R. (2009). Developing a Whole-of-University Approach to Educating for Sustainability. *Journal of Education for Sustainable Development*, 3(1), 55–64.
<https://doi.org/10.1177/097340820900300113>
- The MECCE Project. (2023). *Monitoring, Evaluating, and Reporting on Action for Climate Empowerment: A Toolkit to Support Country-Level Leadership*. Sustainability and Education Policy Network.
- Mele, C., Pels, J., & Polese, F. (2010). A Brief Review of Systems Theories and Their Managerial Applications. *Service Science*, 2(1-2), 126–135.
https://doi.org/10.1287/serv.2.1_2.126
- Michelsen, G., Adomßent, M., Bormann, I., Burandt, S., & Fischbach, R. (2011). *Indikatoren der Bildung für nachhaltige Entwicklung: Ein Werkstattbericht*. Deutsche UNESCO-Kommission e.V.
- Michelsen, G., & Fischer, D. (2017). Sustainability and education. In M. von Hauff & C. Kuhnke (Eds.), *Sustainable Development Policy: A European Perspective* (1st ed.). Routledge.
- Millican, R. (2022). A Rounder Sense of Purpose: Competences for Educators in Search of Transformation. In P. Vare, N. Lausset, & M. Rieckmann (Eds.), *Sustainable Development Goals Series. Competences in Education for Sustainable Development: Critical Perspectives* (1st ed., pp. 35–43). Springer Cham. https://doi.org/10.1007/978-3-030-91055-6_5
- Mogensen, F., & Schnack, K. (2010). The action competence approach and the ‘new’ discourses of education for sustainable development, competence and quality criteria. *Environmental Education Research*, 16(1), 59–74.
<https://doi.org/10.1080/13504620903504032>
- Mogren, A., & Gericke, N. (2017). ESD implementation at the school organisation level, part 1 – investigating the quality criteria guiding school leaders’ work at recognized ESD

- schools. *Environmental Education Research*, 23(7), 972–992.
<https://doi.org/10.1080/13504622.2016.1226265>
- Mogren, A., & Gericke, N. (2019). School Leaders' Experiences of Implementing Education for Sustainable Development—Anchoring the Transformative Perspective. *Sustainability*, 11(12), Article 3343, 1–21. <https://doi.org/10.3390/su11123343>
- Mogren, A., Gericke, N., & Scherp, H.-A. (2019). Whole school approaches to education for sustainable development: A model that links to school improvement. *Environmental Education Research*, 25(4), 508–531. <https://doi.org/10.1080/13504622.2018.1455074>
- Moutet, L., Bernard, P., Green, R., Milner, J., Haines, A., Slama, R., Temime, L., & Jean, K. (2025). The public health co-benefits of strategies consistent with net-zero emissions: a systematic review. *The Lancet Planetary Health*, 9(2), e145-e156.
[https://doi.org/10.1016/S2542-5196\(24\)00330-9](https://doi.org/10.1016/S2542-5196(24)00330-9)
- Mūkoma, W., & Flisher, A. J. (2004). Evaluations of health promoting schools: A review of nine studies. *Health Promotion International*, 19(3), 357–368.
<https://doi.org/10.1093/heapro/dah309>
- Müller, U., Hancock, D. R., Stricker, T., & Wang, C. (2021). Implementing ESD in Schools: Perspectives of Principals in Germany, Macau, and the USA. *Sustainability*, 13(17), Article 9823, 1–16. <https://doi.org/10.3390/su13179823>
- Müller, U., Hancock, D. R., Wang, C., Stricker, T., Cui, T., & Lambert, M. (2022). School Leadership, Education for Sustainable Development (ESD), and the Impact of the COVID-19 Pandemic: Perspectives of Principals in China, Germany, and the USA. *Education Sciences*, 12(12), 853. <https://doi.org/10.3390/educsci12120853>
- Müller, U., Lude, A., & Hancock, D. R. (2020). Leading Schools towards Sustainability. Fields of Action and Management Strategies for Principals. *Sustainability*, 12(7), Article 3031, 1–20. <https://doi.org/10.3390/su12073031>
- National Platform ESD c/o BMBF. (2017). *Nationaler Aktionsplan Bildung für nachhaltige Entwicklung: Der deutsche Beitrag zum UNESCO-Weltaktionsprogramm*.
https://www.bmbf.de/bmbf/shareddocs/downloads/files/nationaler_aktionsplan_bildung_fuer_nachhaltige_entwicklung.pdf?__blob=publicationFile&v=2
- Nazir, J., Pedretti, E., Wallace, J., Montemurro, D., & Inwood, H. (2011). Reflections on the Canadian Experience With Education for Climate Change and Sustainable Development. *Canadian Journal of Science, Mathematics and Technology Education*, 11(4), 365–380. <https://doi.org/10.1080/14926156.2011.624673>
- Niebert, K. (2019). Effective sustainability education is political education. *On Education. Journal for Research and Debate*, 2(4), 1–5. <https://doi.org/10.25656/01:23040>
- Niebert, K. (2021). Lessons learned from Covid-19. Why sustainability education needs to become political. *Progress in Science Education (PriSE)*, 4(3), 1–14.
<https://doi.org/10.25321/PRISE.2021.1169>

- Niedlich, S., Bauer, M., Doneliene, M., Jaeger, L., Rieckmann, M., & Bormann, I. (2020). Assessment of Sustainability Governance in Higher Education Institutions—A Systemic Tool Using a Governance Equalizer. *Sustainability*, 12(5), Article 1816, 1–17. <https://doi.org/10.3390/su12051816>
- Niedlich, S., Kummer, B., Bauer, M., Rieckmann, M., & Bormann, I. (2020). Cultures of sustainability governance in higher education institutions: A multi-case study of dimensions and implications. *Higher Education Quarterly*, 74, 373–390. <https://doi.org/10.1111/hequ.12237>
- Nikel, J., & Lowe, J. (2010). Talking of fabric: a multi-dimensional model of quality in education. *Compare: A Journal of Comparative and International Education*, 40(5), 589–605. <https://doi.org/10.1080/03057920902909477>
- Nikel, J., & Müller, S. (2008). Indikatoren einer Bildung für nachhaltige Entwicklung. In I. Bormann (Ed.), *Kompetenzen der Bildung Für Nachhaltige Entwicklung: Operationalisierung, Messung, Rahmenbedingungen, Befunde* (1st ed., pp. 233–251). VS Verlag für Sozialwissenschaften GmbH. https://doi.org/10.1007/978-3-531-90832-8_16
- Nikiforova, A. A. (2022). The Systems Approach. *Knowledge Organization*, 49(7), 529–542. <https://doi.org/10.5771/0943-7444-2022-7-529>
- Nowotny, H. (2003). Democratising expertise and socially robust knowledge. *Science and Public Policy*, 30(3), 151–156. <https://doi.org/10.3152/147154303781780461>
- Nussbaum, M. (1987). *Nature, function and capability: Aristotle on Political Distribution*. WIDER Working Papers. World Institute for Development Economics Research of the United Nations University, Helsinki.
- O’Byrne, D., Dripps, W., & Nicholas, K. A. (2015). Teaching and learning sustainability: An assessment of the curriculum content and structure of sustainability degree programs in higher education. *Sustainability Science*, 10(1), 43–59. <https://doi.org/10.1007/s11625-014-0251-y>
- O’Donoghue, R., Taylor, J., & Vente, V. (2018). Chapter 5: How are learning and training environments transforming with ESD? In A. Leicht, J. Heiss, & W. J. Byun (Eds.), *Issues and trends in Education for Sustainable Development* (pp. 111–132). United Nations Educational, Scientific and Cultural Organization.
- O’Neill, D. W., Fanning, A. L., Lamb, W. F., & Steinberger, J. K. (2018). A good life for all within planetary boundaries. *Nature Sustainability*, 1(2), 88–95. <https://doi.org/10.1038/s41893-018-0021-4>
- Oeberst, A., & Imhoff, R. (2023). Toward Parsimony in Bias Research: A Proposed Common Framework of Belief-Consistent Information Processing for a Set of Biases. *Perspectives on Psychological Science : A Journal of the Association for Psychological Science*, 18(6), 1464–1487. <https://doi.org/10.1177/17456916221148147>

- Ojala, M. (2012). Hope and climate change: the importance of hope for environmental engagement among young people. *Environmental Education Research*, 18(5), 625–642. <https://doi.org/10.1080/13504622.2011.637157>
- Ojala, M. (2016). Facing Anxiety in Climate Change Education: From Therapeutic Practice to Hopeful Transgressive Learning. *Canadian Journal of Environmental Education (CJEE)*, 21, 41–56. <https://cjee.lakeheadu.ca/article/view/1393>
- Olson, K. (2010). An Examination of Questionnaire Evaluation by Expert Reviewers. *Field Methods*, 22(4), 295–318. <https://doi.org/10.1177/1525822X10379795>
- 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>
- Olsson, D., Gericke, N., Boeve-de Pauw, J., Berglund, T., & Chang, T. (2019). Green schools in Taiwan – Effects on student sustainability consciousness. *Global Environmental Change*, 54, 184–194. <https://doi.org/10.1016/j.gloenvcha.2018.11.011>
- Olsson, D., Gericke, N., Sass, W., & Boeve-de Pauw, J. (2020). Self-perceived action competence for sustainability: the theoretical grounding and empirical validation of a novel research instrument. *Environmental Education Research*, 26(5), 742–760. <https://doi.org/10.1080/13504622.2020.1736991>
- O'Mahony, T. (2022). Toward Sustainable Wellbeing: Advances in Contemporary Concepts. *Frontiers in Sustainability*, 3, Article 807984. <https://doi.org/10.3389/frsus.2022.807984>
- Orr, D. W. (1994/2004). *Earth in mind: On education, environment, and the human prospect* (10th anniversary ed.). Island Press.
- Ostrom, E. (1990/2015). *Governing the commons: The evolution of institutions for collective action* (Canto Classics edition 2015). Cambridge University Press. <https://doi.org/10.1017/CBO9781316423936>
- Otto, I. M., Donges, J. F., Cremades, R., Bhowmik, A., Hewitt, R. J., Lucht, W., Rockström, J., Allerberger, F., McCaffrey, M., Doe, S. S., Lenferna, A., Morán, N., van Vuuren, D. P., & Schellnhuber, H. J. (2020). Social tipping dynamics for stabilizing Earth’s climate by 2050. *Proceedings of the National Academy of Sciences of the United States of America*, 117(5), 2354–2365. <https://doi.org/10.1073/pnas.1900577117>
- Overwien, B. (2025). Politische Bildung und nachhaltige Entwicklung. In S. Frech, R. Geyer, & M. Oberle (Eds.), *Politische Bildung für nachhaltige Entwicklung: Potenziale und Perspektiven* (pp. 57–71). Landeszentrale für politische Bildung Baden-Württemberg, Stuttgart.
- Parson, E., & Clark, W. C. (1995). Sustainable development as social learning: Theoretical perspectives and practical challenges. In L. H. Gunderson, Holling C.S., & S. S. Light

- (Eds.), *Bridges and Barriers: The renewal of ecosystems and institutions* (pp. 428–460). Columbia University Press.
- Parsons, T. (1951). *The Social System*. Routledge & Kegan Paul Ltd.
- Pettig, F., & Singer-Brodowski, M. (2024). Learning in Relation with a Changing World: Thinking Beyond ESD 1 and ESD 2 Towards ESD 3. *Journal of Education for Sustainable Development*, 18(2), 176–201. <https://doi.org/10.1177/09734082251347383>
- Pham-Truffert, M., Metz, F., Fischer, M., Rueff, H., & Messerli, P. (2020). Interactions among Sustainable Development Goals: Knowledge for identifying multipliers and virtuous cycles. *Sustainable Development*, 28(5), 1236–1250. <https://doi.org/10.1002/sd.2073>
- Portus, R., Aarnio-Linnanvuori, E., Dillon, B., Fahy, F., Gopinath, D., Mansikka-Aho, A., Williams, S.-J., Reilly, K., & McEwen, L. (2024). Exploring the environmental value action gap in education research: a semi-systematic literature review. *Environmental Education Research*, 30(6), 833–863. <https://doi.org/10.1080/13504622.2024.2314060>
- PwC. (2024). *Global Youth Outlook 2024: A voice for youth action on the Sustainable Development Goals*. <https://www.pwc.com/gx/en/government-public-services/assets/the-global-youth-outlook-2024.pdf>
- Ramísio, P. J., Pinto, L. M. C., Gouveia, N., Costa, H., & Arezes, D. (2019). Sustainability Strategy in Higher Education Institutions: Lessons learned from a nine-year case study. *Journal of Cleaner Production*(222), 300–309. <https://doi.org/10.1016/j.jclepro.2019.02.257>
- Raworth, K. (2012). *A safe and just space for humanity. Can we live within the doughnut?* Oxfam Discussion Papers.
- Raworth, K. (2018). *Doughnut economics: Seven ways to think like a 21st-century economist*. Penguin Books.
- Redman, A., & Wiek, A. (2021). Competencies for Advancing Transformations Towards Sustainability. *Frontiers in Education*, 6, Article 785163. <https://doi.org/10.3389/feduc.2021.785163>
- Redman, A., Wiek, A., & Barth, M [Matthias] (2021). Current practice of assessing students' sustainability competencies: A review of tools. *Sustainability Science*, 16(1), 117–135. <https://doi.org/10.1007/s11625-020-00855-1>
- Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., & Stringer, L. C. (2010). What is Social Learning? *Ecology and Society*, 15(4). <https://doi.org/10.5751/ES-03564-1504r01>
- Reinhardt, S. (2016). The Beutelsbach Consensus. Advance online publication. <https://doi.org/10.4119/UNIBI/JSSE-V15-I2-1523> (11-13 Pages / JSSE - Journal of Social Science Education, 2-2016 Controversial Issues in the Political Classroom).

- Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures*, 44(2), 127–135. <https://doi.org/10.1016/j.futures.2011.09.005>
- Rieckmann, M. (2018). Chapter 2: Learning to transform the world: key competencies in ESD. In A. Leicht, J. Heiss, & W. J. Byun (Eds.), *Issues and trends in Education for Sustainable Development* (pp. 39–60). United Nations Educational, Scientific and Cultural Organization.
- Rieckmann, M. (2026). Transformation-Literate Citizens: Advancing Sustainable Development Through Education. In B. Grabkowsky & T. Blaha (Eds.), *Intensive Livestock Production in Transition: Analyses, Concepts and Strategies for Sustainability Transformation of the Livestock Value Chain* (1st ed. 2026, pp. 379–389). Springer Nature Switzerland; Imprint Springer. https://doi.org/10.1007/978-3-031-97872-2_21
- Rieckmann, M., & Barth, M [Matthias]. (2022). Educators' Competence Frameworks in Education for Sustainable Development. In P. Vare, N. Lausset, & M. Rieckmann (Eds.), *Sustainable Development Goals Series. Competences in Education for Sustainable Development: Critical Perspectives* (1st ed., pp. 19–26). Springer Cham. https://doi.org/10.1007/978-3-030-91055-6_3
- Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), 155–169. <https://doi.org/10.1007/BF01405730>
- Robinson, J., Alhakim, A. D., Ma, G., Alam, M., Da Brando, F. R., Braune, M., Brown, M., Côté, N., Espinosa, D. C. R., Garza, A. K., Gorman, D., Hajer, M., Madden, J., Melnick, R., Metras, J., Newman, J., Patel, R., Raven, R., Sergienko, K., . . . Wiek, A. (2023). Odd couples: reconciling academic and operational cultures for whole-institution sustainability governance at universities. *International Journal of Sustainability in Higher Education*, 24(8), 1949–1969. <https://doi.org/10.1108/IJSHE-07-2022-0244>
- Rockström, J., Gupta, J., Qin, D., Lade, S. J., Abrams, J. F., Andersen, L. S., Armstrong McKay, D. I., Bai, X., Bala, G., Bunn, S. E., Ciobanu, D., DeClerck, F., Ebi, K., Gifford, L., Gordon, C., Hasan, S., Kanie, N., Lenton, T. M., Loriani, S., . . . Zhang, X. (2023). Safe and just Earth system boundaries. *Nature*, 619(7968), 102–111. <https://doi.org/10.1038/s41586-023-06083-8>
- Rode, H., & Michelsen, G. (2008). Levels of indicator development for education for sustainable development. *Environmental Education Research*, 14(1), 19–33. <https://doi.org/10.1080/13504620701843327>
- Ryan, A., & Tilbury, D. (2013). Uncharted waters: Voyages for Education for Sustainable Development in the higher education curriculum. *The Curriculum Journal*, 24(2), 272–294. <https://doi.org/10.1080/09585176.2013.779287>

- Sachs, J. D., Lafortune, G., Fuller, G., & Drumm, E. (2023). *Implementing the SDG Stimulus. Sustainable Development Report 2023*. <https://doi.org/10.25546/102924>
- Sass, W., Claes, E., Pauw, J. B., Maeyer, S. de, Schelfhout, W., van Petegem, P., & Isac, M. M. (2022). Measuring professional action competence in education for sustainable development (PACesd). *Environmental Education Research*, 28(2), 260–275. <https://doi.org/10.1080/13504622.2021.1976731>
- Schank, C., & Rieckmann, M. (2019). Socio-economically Substantiated Education for Sustainable Development: Development of Competencies and Value Orientations Between Individual Responsibility and Structural Transformation. *Journal of Education for Sustainable Development*, 13(1), 67–91. <https://doi.org/10.1177/0973408219844849>
- Schein, E. H., & Schein, P. (2017). *Organizational culture and leadership* (5th edition). John Wiley and Sons.
- Scheunpflug, A., & Asbrand, B. (2006). Global education and education for sustainability. *Environmental Education Research*, 12(1), 33–46. <https://doi.org/10.1080/13504620500526446>
- Scheunpflug, A., & Costa, J. (2025). Bildung für nachhaltige Entwicklung. *Zeitschrift Für Erziehungswissenschaft*. Advance online publication. <https://doi.org/10.1007/s11618-025-01333-z>
- Schneidewind, U. (2013). Transformative Literacy. Understanding and Shaping Societal Transformations. *GAIA - Ecological Perspectives for Science and Society*, 22(2), 82–86. <https://doi.org/10.14512/gaia.22.2.5>
- Schnell, T., & Danbolt, L. J. (2023). The Meaning and Purpose Scales (MAPS): Development and multi-study validation of short measures of meaningfulness, crisis of meaning, and sources of purpose. *BMC Psychology*, 11(1), Article 304, 1–17. <https://doi.org/10.1186/s40359-023-01319-8>
- Schopp, K., Bornemann, M., & Potthast, T. (2020). The Whole-Institution Approach at the University of Tübingen: Sustainable Development Set in Practice. *Sustainability*, 12(3), Article 861, 1–24. <https://doi.org/10.3390/su12030861>
- Seggern, J. von, Holst, J., & Singer-Brodowski, M. (2023). The self in the mirror: fostering researchers' reflexivity in transdisciplinary and transformative studies at the science-policy interface. *Ecology and Society*, 28(2), Article 17. <https://doi.org/10.5751/ES-14057-280217>
- Shallcross, T., Loubser, C., Le Roux, C., O'Donoghue, R., & Lupele, J. (2006). Promoting sustainable development through whole school approaches: An international, intercultural teacher education research and development project. *Journal of Education for Teaching*, 32(3), 283–301. <https://doi.org/10.1080/02607470600782427>
- Shallcross, T., & Robinson, J. (1999). A Model of Participation in Continuing Professional Development and Evaluation through Action Research in Educating for Sustainability.

- Journal of in-Service Education*, 25(3), 403–422.
<https://doi.org/10.1080/13674589900200098>
- Simovska, V., & Prøsch, Å. K. (2016). Global social issues in the curriculum: Perspectives of school principals. *Journal of Curriculum Studies*, 48(5), 630–649.
<https://doi.org/10.1080/00220272.2015.1114150>
- Singer-Brodowski, M. (2016). Transformatives Lernen als neue Theorie-Perspektive in der BNE. In Forum Umweltbildung im Umweltdachverband GmbH (Ed.), *Jahrbuch Jahrbuch Bildung für nachhaltige Entwicklung – Im Wandel* (pp. 130–139).
- Singer-Brodowski, M., Brock, A., Etzkorn, N., & Otte, I. (2019). Monitoring of education for sustainable development in Germany – insights from early childhood education, school and higher education. *Environmental Education Research*, 25(4), 492–507.
<https://doi.org/10.1080/13504622.2018.1440380>
- Singer-Brodowski, M., Brock, A., Grund, J., & Haan, G. de (2021). Reflections on the science–policy interface within education for sustainable development in Germany. *Environmental Education Research*, 27(4), 554–570.
<https://doi.org/10.1080/13504622.2020.1813691>
- Singer-Brodowski, M., Förster, R., Eschenbacher, S., Biberhofer, P., & Getzin, S. (2022). Facing Crises of Unsustainability: Creating and Holding Safe Enough Spaces for Transformative Learning in Higher Education for Sustainable Development. *Frontiers in Education*, 7, Article 787490, 1–17. <https://doi.org/10.3389/feduc.2022.787490>
- Singer-Brodowski, M., Henkel, G.-M., Reith, A., Frank, P., & Rieckmann, M. (2025). What is needed to act as a professional change agent for sustainability? A scoping review. *International Review of Education*(72), 11–35. <https://doi.org/10.1007/s11159-024-10092-8>
- Slavin, R. E., & Madden, N. A. (2013). Success for All at 27: New Developments in Whole-School Reform. *Journal of Education for Students Placed at Risk (JESPAR)*, 18(3-4), 169–176. <https://doi.org/10.1080/10824669.2013.862095>
- SOS United Kingdom. (2024). *Sustainability Skills Survey 2023-24. Research into Students' Experiences of Teaching and Learning on Sustainable Development*.
- Southern African Development Community. (2022). *Education for Sustainable Development in the Southern African Development Community: Regional Strategic Framework 2022-2030*.
- Spangenberg, J. H. (2011). Sustainability science: a review, an analysis and some empirical lessons. *Environmental Conservation*, 38(3), 275–287.
<https://doi.org/10.1017/S0376892911000270>
- Spínola, H. (2015). Environmental literacy comparison between students taught in eco-schools and ordinary schools in the Madeira Island Region of Portugal. *Science Education International*, 26 (3), 392–413. <https://digituma.uma.pt/handle/10400.13/1361>

- Spliesgart, A., Heinzel, S., Gutberlet, P., Heitfeld, M., Blumenschein, P., Frick, V., & Keller, J. (2025). Measuring socio-ecological handprints. *Environmental Psychology Open*, Article 25. Advance online publication. <https://doi.org/10.69805/epo.v29.a25>
- Sriskandarajah, N., Bawden, R., Blackmore, C., Tidball, K. G., & Wals, A. E. (2010). Resilience in learning systems: case studies in university education. *Environmental Education Research*, 16(5-6), 559–573. <https://doi.org/10.1080/13504622.2010.505434>
- Standing Conference of the Ministers of Education and Cultural Affairs. (2024). *Empfehlung der Kultusministerkonferenz zur Bildung für nachhaltige Entwicklung in der Schule (Beschluss der Kultusministerkonferenz vom 13.06.2024)*. https://www.kmk.org/fileadmin/veroeffentlichungen_beschluesse/2024/2024_06_13-BNE-Empfehlung.pdf
- Staudinger, V., Fischer, D., & Holst, J. (2026). Nachhaltige Ernährungsbildung in der non-formalen Bildung: Potenziale des Whole Institution Approachs. *Haushalt in Bildung Und Forschung*(1/2026).
- Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: The Great Acceleration. *Anthropocene Review*, 2(1), 81–98. <https://doi.org/10.1177/2053019614564785>
- Stepanek Lockhart, A. (2018). Monitoring ESD: Lessons learned and ways forward. In A. Leicht, J. Heiss, & W. J. Byun (Eds.), *Issues and Trends in Education for Sustainable Development* (pp. 215–231). Paris 07 SP, France. United Nations Educational, Scientific and Cultural Organization.
- Sterling, S. (2001). *Sustainable Education: Re-visioning Learning and Change. Schumacher briefing: Vol. 6*. Green Books for the Schumacher Society.
- Sterling, S. (2003). *Whole Systems Thinking as a Basis for Paradigm Change in Education: Explorations in the Context of Sustainability* [PhD]. University of Bath, United Kingdom.
- Sterling, S. (2004). Higher Education, Sustainability, and the Role of Systemic Learning. In P. B. Corcoran & A. E. J. Wals (Eds.), *Higher Education and the Challenge of Sustainability* (pp. 49–70). Kluwer Academic Publishers. https://doi.org/10.1007/0-306-48515-X_5
- Sterling, S. (2009). Sustainable Education. In D. Gray, L. Colucci-Gray, & E. Camino (Eds.), *Science, Society and Sustainability* (1st ed.). Routledge.
- Sterling, S. (2010). Learning for resilience, or the resilient learner? Towards a necessary reconciliation in a paradigm of sustainable education. *Environmental Education Research*, 16(5-6), 511–528. <https://doi.org/10.1080/13504622.2010.505427>
- Sterling, S. (2016). A Commentary on Education and Sustainable Development Goals. *Journal of Education for Sustainable Development*, 10(2), 208–213. <https://doi.org/10.1177/0973408216661886>

- Sterling, S. (2017). Assuming the Future: Repurposing Education in a Volatile Age. In B. Jickling & S. Sterling (Eds.), *Palgrave studies in education and the environment. Post-Sustainability and environmental education: Remaking education for the future* (pp. 31–45). Palgrave Macmillan. https://doi.org/10.1007/978-3-319-51322-5_3
- Sterling, S. (2024). *Learning and sustainability in dangerous times: The Stephen Sterling reader*. Agenda Publishing.
<https://www.cambridge.org/core/product/identifier/9781788216920/type/BOOK>
- Sterling, S. (2025). Truly Transformative? Why ESD Falls Short in Epochal Times. *Journal of Education for Sustainable Development*, 19(2), 235–247.
<https://doi.org/10.1177/09734082251336543>
- Stevenson, R. B. (2007). Schooling and environmental education: contradictions in purpose and practice. *Environmental Education Research*, 13(2), 139–153.
<https://doi.org/10.1080/13504620701295726>
- Stifterverband für die Deutsche Wissenschaft e.V. (2022). *Lage und Entwicklung der Hochschulen aus Sicht ihrer Leitungen, Ausgabe 2022: Hochschul-Barometer - Stimmungsbarometer | Die transformative Hochschule | Nachhaltigkeit an der Hochschule*.
- Supran, G., & Oreskes, N. (2021). Rhetoric and frame analysis of ExxonMobil's climate change communications. *One Earth*, 4(5), 696–719.
<https://doi.org/10.1016/j.oneear.2021.04.014>
- Sylvestre, P., Wright, T., & Sherren, K. (2013). Exploring Faculty Conceptualizations of Sustainability in Higher Education: Cultural Barriers to Organizational Change and Potential Resolutions. *Journal of Education for Sustainable Development*, 7(2), 223–244.
<https://doi.org/10.1177/0973408214526491>
- Taylor, A., & Enggass, K. (2009). *Linking architecture and education: Sustainable design for learning environments*. University of New Mexico Press.
- Thacker, S., Adshead, D., Fay, M., Hallegatte, S., Harvey, M., Meller, H., O'Regan, N., Rozenberg, J., Watkins, G., & Hall, J. W. (2019). Infrastructure for sustainable development. *Nature Sustainability*, 2(4), 324–331. <https://doi.org/10.1038/s41893-019-0256-8>
- Tilbury, D. (1995). 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>
- Tilbury, D. (2007). Monitoring and Evaluation during the UN Decade of Education for Sustainable Development. *Journal of Education for Sustainable Development*, 1(2), 239–254. <https://doi.org/10.1177/097340820700100214>
- Tilbury, D., & Galvin, C. (2022). *Input Paper: A Whole School Approach to Learning for Environmental Sustainability*. European Commission.

<https://education.ec.europa.eu/sites/default/files/2022-02/input-paper-whole-school-approach-sustainability.pdf>

- Tilbury, D., & Janousek, S. (2006). *Development of a National Approach to Monitoring, Assessment and Reporting on the Decade of Education for Sustainable Development: Summarising Documented Experiences on the Development of ESD Indicators and Networking with Expert Groups on ESD Indicators*. Sydney: Australian Research Institute of Education for Sustainability and Australian Government Department of the Environment and Water Resources.
- Tilbury, D., Janousek, S., Elias, D., & Bacha, J. (2007). *Asia-Pacific Guidelines for the Development of National ESD Indicators*. Bangkok: UNESCO.
- Timm, J.-M., & Barth, M [Matthias] (2021). Making education for sustainable development happen in elementary schools: the role of teachers. *Environmental Education Research*, 27(1), 50–66. <https://doi.org/10.1080/13504622.2020.1813256>
- Toman, I., van't Land, H., & Harris, M. (2023). *3rd IAU Global Survey Report on Higher Education and Research for Sustainable Development: Accelerating Action for the SDGs in Higher Education*. International Association of Universities (IAU).
- Torsdottir, A. E., Sinnes, A. T., Olsson, D., & Wals, A. (2023). Do students have anything to say? Student participation in a whole school approach to sustainability. *Environmental Education Research*, 30(4), 519–543. <https://doi.org/10.1080/13504622.2023.2213427>
- Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science (New York, N.Y.)*, 185(4157), 1124–1131. <https://doi.org/10.1126/science.185.4157.1124>
- UNECE. (2005). *UNECE strategy for education for sustainable development. Adopted at the High-level meeting of Environment and Education Ministries (Vilnius, 17–18 March 2005)*. CEP/AC.13/2005/3/Rev.1.
- UNECE. (2009). *UNECE Steering Committee on Education for Sustainable Development: Report on Progress made by the Expert Group for Indicators for Education for Sustainable Development - Guidance for Reporting on the Implementation of the UNECE Strategy for Education for Sustainable Development*. ECE/CEP/AC.13/2009/5.
- UNECE. (2022). *Implementation of the UNECE strategy for ESD across the ECE region (2015–2018)*. https://unece.org/sites/default/files/2022-09/Implementation%20of%20the%20UNECE%20Strategy_web_final_05.09.2022.pdf
- UNEP. (2025). *Emissions Gap Report 2025: Off Target - Continued Collective inaction puts Global Temperature Goal at Risk* [Olhoff, A., chief editor; Lamb, W.; Kuramochi, T.; Rogelj, J.; den Elzen, M.; Christensen, J.; Fransen, T.; Pathak, M.; Tong, D. (eds)]. Nairobi. <https://doi.org/10.59117/20.500.11822/48854>

- UNESCO. (2014). *UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development*. United Nations Educational, Scientific and Cultural Organization.
- UNESCO. (2017a). *Implementing the Whole-School Approach under the Global Action Programme on Education for Sustainable Development: Information Note for National Coordinators of UNESCO's Associated Schools Project Network* (23.03.2017). United Nations Educational, Scientific and Cultural Organization.
- UNESCO. (2017b). *Measurement Strategy for SDG Target 4.7: Proposal by GAML Task Force 4.7*. GAML4/17. <http://uis.unesco.org/sites/default/files/documents/gaml4-measurement-strategy-sdg-target4.7.pdf>
- UNESCO. (2019a). *Proposal for monitoring of SDG indicators 4.7.1, 12.8.1 and 13.3.1*. TCG6/REF/14. United Nations Educational, Scientific and Cultural Organization. <https://tcg.uis.unesco.org/wp-content/uploads/sites/4/2019/08/TCG6-REF-14-Proposal-for-monitoring-of-SDG-indicators-4.7.1-12.8.1-and-13.3.1.pdf>
- UNESCO. (2019b). *TCG6/REF/4. SDG indicator 4.7.1: Proposal for a measurement strategy*. United Nations Educational, Scientific and Cultural Organization. <https://tcg.uis.unesco.org/wp-content/uploads/sites/4/2019/08/TCG6-REF-4-4.7.1-Proposal-for-measurement-strategy.pdf>
- UNESCO. (2020). *Education for Sustainable Development. A roadmap*. United Nations Educational, Scientific and Cultural Organization.
- UNESCO. (2021a). *Berlin Declaration on Education for Sustainable Development*. United Nations Educational, Scientific and Cultural Organization.
- UNESCO. (2021b). *The World in 2030: Public Survey Report*. Editorial Team: Tarja Turtia, Tim Francis, Ellen Ledger; Data management: Joshua Bennett. <https://unesdoc.unesco.org/ark:/48223/pf0000375950.locale=en>
- UNESCO. (2023a). *Recommendation on Education for Peace and Human Rights, International Understanding, Cooperation, Fundamental Freedoms, Global Citizenship and Sustainable Development: CL/4487*.
- UNESCO. (2023b). *SDG Resources for Educators – Quality Education*. <https://web.archive.org/web/20220121083949/https://en.unesco.org/themes/education/sdgs/material/04>
- UNESCO. (2024a). *Global Education Monitoring Report, 2024/5, Leadership in education – Lead for learning*. Paris, UNESCO. <https://doi.org/10.54676/EFLH5184>
- UNESCO. (2024b). *Young people call for climate change education to adapt: In partnership with the GEM Report, the MECCE Project, TAG and Earth Guardians*. <https://www.unesco.org/gem-report/en/2024gemreport-petition>

- United Nations. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. <http://www.un-documents.net/wced-ocf.htm>
<https://doi.org/10.2307/2621529>
- United Nations. (1992). *Rio Declaration on Environment and Development: Report of the United Nations Conference on Environment and Development, A/CONF.151/26 (Vol. I)*.
- United Nations General Assembly. (2015). 70/1. *Transforming Our World: The 2030 Agenda for Sustainable Development*.
- United Nations General Assembly. (2017). *Education for sustainable development in the framework of the 2030 Agenda for Sustainable Development: Resolution 72/222*.
- Unterhalter, E. (2019). The Many Meanings of Quality Education: Politics of Targets and Indicators in SDG 4. *Global Policy*, 10(S1), 39–51. <https://doi.org/10.1111/1758-5899.12591>
- Urbanski, M., & Filho, W. L. (2015). Measuring sustainability at universities by means of the Sustainability Tracking, Assessment and Rating System (STARS): Early findings from STARS data. *Environment, Development and Sustainability*, 17(2), 209–220.
<https://doi.org/10.1007/s10668-014-9564-3>
- 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, 1–12.
<https://doi.org/10.1016/j.jenvp.2022.101782>
- van Mierlo, B., & Beers, P. J. (2020). Understanding and governing learning in sustainability transitions: A review. *Environmental Innovation and Societal Transitions*, 34, 255–269.
<https://doi.org/10.1016/j.eist.2018.08.002>
- Vare, P. (2014). *Are There Inherent Contradictions in Attempting to Implement Education for Sustainable Development in Schools?* [Thesis submitted for the degree of Doctor of Education]. University of Bath.
- Vare, P., & Scott, W. (2007). Learning for a Change: Exploring the Relationship Between Education and Sustainable Development. *Journal of Education for Sustainable Development*, 1(2), 191–198. <https://doi.org/10.1177/097340820700100209>
- Veidemann, A. (2022). Education for Sustainable Development in Higher Education Rankings: Challenges and Opportunities for Developing Internationally Comparable Indicators. *Sustainability*, 14(9), Article 5102, 1–20. <https://doi.org/10.3390/su14095102>
- Verhulst, E., & Lambrechts, W. (2015). Fostering the incorporation of sustainable development in higher education. Lessons learned from a change management perspective. *Journal of Cleaner Production*, 106, 189–204.
<https://doi.org/10.1016/j.jclepro.2014.09.049>

- Vladimirova, K., & Le Blanc, D. (2016). Exploring Links Between Education and Sustainable Development Goals Through the Lens of UN Flagship Reports. *Sustainable Development*, 24(4), 254–271. <https://doi.org/10.1002/sd.1626>
- Vogt, M. (2019). *Ethik des Wissens: Freiheit und Verantwortung der Wissenschaft in Zeiten des Klimawandels*. Oekom Verlag.
<https://ebookcentral.proquest.com/lib/kxp/detail.action?docID=6389406>
- Vogt, M., & Weber, C. (2020). The Role of Universities in a Sustainable Society. Why Value-Free Research is Neither Possible nor Desirable. *Sustainability*, 12(7), Article 2811, 1–21. <https://doi.org/10.3390/su12072811>
- Wals, A. E. J. (2011). Learning Our Way to Sustainability. *Journal of Education for Sustainable Development*, 5(2), 177–186. <https://doi.org/10.1177/097340821100500208>
- Wals, A. E. J. (2012). *Shaping the Education of Tomorrow: 2012 Full-length Report on the UN Decade of Education for Sustainable Development* (DESD Monitoring & Evaluation - 2012). UNESCO Education Sector.
- Wals, A. E. J. (2015). *Beyond unreasonable doubt: Education and learning for socio-ecological sustainability in the anthropocene*. Wageningen University. <https://edepot.wur.nl/365312>
- Wals, A. E. J. (2020). Transgressing the hidden curriculum of unsustainability: towards a relational pedagogy of hope. *Educational Philosophy and Theory*, 52(8), 825–826. <https://doi.org/10.1080/00131857.2019.1676490>
- Wals, A. E. J., & Benavot, A. (2017). Can we meet the sustainability challenges? The role of education and lifelong learning. *European Journal of Education*, 52(4), 1–10. <https://doi.org/10.1111/ejed.12250>
- Wals, A. E. J., Bjønness, B., Eikeland, I., & Sinnes, A. (Eds.). (2024). *Whole School Approaches to Sustainability: Education Renewal in Times of Distress*. Springer International Publishing AG. <https://doi.org/10.1007/978-3-031-56172-6>
- Wals, A. E. J., Geerling-Eijff, F., Hubeek, F., van der Kroon, S., & Vader, J. (2008). All Mixed Up? Instrumental and Emancipatory Learning Toward a More Sustainable World: Considerations for EE Policymakers. *Applied Environmental Education & Communication*, 7(3), 55–65. <https://doi.org/10.1080/15330150802473027>
- Wals, A. E. J., & Kieft, G. (2010). *Education for Sustainable Development: Research overview*. Sida review / Swedisch International Development Cooperation Agency; No. 2010:13). <https://edepot.wur.nl/161396>
- Wals, A. E. J., & Mathie, R. G. (2022). Whole School Responses to Climate Urgency and Related Sustainability Challenges. In M. A. Peters & R. Heraud (Eds.), *Encyclopedia of Educational Innovation* (pp. 1–8). Springer Singapore. https://doi.org/10.1007/978-981-13-2262-4_263-2

- Wals, A. E. J., van der Hoeven, N., & Blanken, H. (2009). *The acoustics of social learning : designing learning processes that contribute to a more sustainable world*. Wageningen Academic Publishers.
- Walsh, Z., Böhme, J., & Wamsler, C. (2021). Towards a relational paradigm in sustainability research, practice, and education. *Ambio*, 50(1), 74–84. <https://doi.org/10.1007/s13280-020-01322-y>
- Waltner, E.-M., Rieß, W., & Brock, A. (2018). Development of an ESD Indicator for Teacher Training and the National Monitoring for ESD Implementation in Germany. *Sustainability*, 10(7), Article 2508, 1–17. <https://doi.org/10.3390/su10072508>
- Waltner, E.-M., Rieß, W., & Mischo, C. (2019). Development and Validation of an Instrument for Measuring Student Sustainability Competencies. *Sustainability*, 11(6), Article 1717, 1–20. <https://doi.org/10.3390/su11061717>
- Warner, B. P., & Elser, M. (2015). How Do Sustainable Schools Integrate Sustainability Education? An Assessment of Certified Sustainable K–12 Schools in the United States. *The Journal of Environmental Education*, 46(1), 1–22. <https://doi.org/10.1080/00958964.2014.953020>
- Webb, A., Iyengar, R., Hopkins, C., & Kohl, K. (2025). Policy Perspectives on Education for Sustainable Development: Taking stock of the Field in the era of the UN Sustainable Development Goals. *Journal of Education for Sustainable Development*, 19(1), 5–17. <https://doi.org/10.1177/09734082251377001>
- Weiss, M., & Barth, M [Matthias] (2019). Global research landscape of sustainability curricula implementation in higher education. *International Journal of Sustainability in Higher Education*, 20(4), 570–589. <https://doi.org/10.1108/IJSHE-10-2018-0190>
- Weiss, M., Barth, M [Matthias], & Wehrden, H. von (2021). The patterns of curriculum change processes that embed sustainability in higher education institutions. *Sustainability Science*, 16(5), 1579–1593. <https://doi.org/10.1007/s11625-021-00984-1>
- Weiss, M., Barth, M [Matthias], Wiek, A., & Wehrden, H. von (2021). Drivers and Barriers of Implementing Sustainability Curricula in Higher Education - Assumptions and Evidence. *Higher Education Studies*, 11(2), 42. <https://doi.org/10.5539/hes.v11n2p42>
- White, P. J., Ardoin, N. M., Eames, C., & Monroe, M. C. (2023). Agency in the Anthropocene: Supporting document to the PISA 2025 Science Framework. *OECD Education Working Papers*. Advance online publication. <https://doi.org/10.1787/8d3b6cfa-en>
- Widany, S., & Schulte-Südbeck, M. (2025). *Nationale Befragung: Lernen für Nachhaltigkeit in non-formalen und in-formellen Settings*. <https://doi.org/10.17169/REFUBIUM-47897>
- Willis, G. B. (1999). *Cognitive Interviewing: A "How To" Guide*. Research Triangle Institute.

- Winter, J., & Cotton, D. (2012). Making the hidden curriculum visible: sustainability literacy in higher education. *Environmental Education Research*, 18(6), 783–796.
<https://doi.org/10.1080/13504622.2012.670207>
- WWF. (2011). *Pathways: to education for sustainable development: A practical tool for planning a whole school approach*. WWF-UK.
- Wyn, J., Cahill, H., Holdsworth, R., Rowling, L., & Carson, S. (2000). Mindmatters, a whole-school approach promoting mental health and wellbeing. *Australian and New Zealand Journal of Psychiatry*, 34(4), 594–601. <https://doi.org/10.1080/j.1440-1614.2000.00748.x>
- Xiao, H., Liu, Y., & Ren, J. (2023). Synergies and trade-offs across sustainable development goals: A novel method incorporating indirect interactions analysis. *Sustainable Development*, 31(2), 1135–1148. <https://doi.org/10.1002/sd.2446>
- Zachariou, A., & Kadji-Beltran, C. (2009). Cypriot primary school principals' understanding of education for sustainable development key terms and their opinions about factors affecting its implementation. *Environmental Education Research*, 15(3), 315–342.
<https://doi.org/10.1080/13504620902862902>
- Ziegler, R., & Ott, K. (2011). The quality of sustainability science: a philosophical perspective. *Sustainability: Science, Practice and Policy*, 7(1), 31–44.
<https://doi.org/10.1080/15487733.2011.11908063>
- Ziervogel, G., Cowen, A., & Ziniades, J. (2016). Moving from Adaptive to Transformative Capacity: Building Foundations for Inclusive, Thriving, and Regenerative Urban Settlements. *Sustainability*, 8(9), Article 955, 1–20. <https://doi.org/10.3390/su8090955>
- Zou, Q. (2023). The Sustainable Development Program with the Neoliberal Approach: A Reflection on The UN Decade of Education for Sustainable Development. *European Journal of Sustainable Development*, 12(3), 321.
<https://doi.org/10.14207/ejsd.2023.v12n3p321>

8. Appendices

8.1. Publications Included in the Dissertation

In accordance with §12, §14, and §16 of the guidelines for cumulative dissertations enacted at the Faculty of Sustainability of Leuphana University Lüneburg (2012), the contributions of my co-authors and me to the four research studies are presented in the following sections, each followed by the respective published research article. The relative weight of my own contribution in relation to the contributions of my co-authors is indicated by a weighting factor. In accordance with § 12 of the guidelines for cumulative dissertations, the following differentiation was applied:

- Single author = own contribution amounts to 100%.
- Co-author with predominant contribution = own contribution is greater than the individual share of all other co-authors and is at least 35%.
- Co-author with equal contribution = (1) own contribution is as high as the share of other co-authors, (2) no other co-author has a contribution higher than the own contribution, and (3) the own contribution is at least 25%.
- Co-author with important contribution = own contribution is at least 25%, but is insufficient to qualify as single authorship, predominant or equal contribution.
- Co-author with small contribution = own contribution is less than 20%.

Weighing Factor according to § 14 of the guideline for cumulative dissertations:

- Single author: 1.0
- Co-author with predominant contribution: 1.0
- Co-author with equal contribution: 1.0
- Co-author with important contribution: 0.5
- Co-author with small contribution: 0

In line with § 16 of the guideline for cumulative dissertations, I avouch that all information given in this appendix is true in each instance and overall.

Place, Date

Signature

8.1.1. Article 1: Holst, Singer-Brodowski et al. (2024)

Bibliography	Holst, J., Singer-Brodowski, M., Brock, A., & Haan, G. de – Monitoring SDG 4.7: Assessing Education for Sustainable Development in Policies, Curricula, Training of Educators and Student Assessment (Input-Indicator) – <i>Sustainable Development</i> – 2024 – https://doi.org/10.1002/sd.2865
Publication Status	Published in <i>Sustainable Development</i> (2024; Impact Factor ¹⁸ : 8.2 (2024))
Specific Contributions	JH : Writing – original draft (lead), Writing – review & editing (lead), Methodology (lead), Formal analysis (lead), Conceptualization (lead). MSB : Writing – original draft (supporting), Writing – review & editing (supporting), Methodology (supporting), Formal analysis (supporting), Conceptualization (supporting). AB : Writing – original draft (supporting), Writing – review & editing (supporting), Methodology (supporting), Formal analysis (supporting), Conceptualization (supporting). GdH : Writing – review & editing (supporting), Conceptualization (supporting)
Weighing Factor	1.0 (Predominant contribution)
Presentations at Conferences	-

Abbreviations:

JH: Jorrit Holst

MSB: Prof. Dr. Mandy Singer-Brodowski

AB: Dr. Antje Brock

GdH: Prof. Dr. Gerhard de Haan

Supplementary Material:

<https://onlinelibrary.wiley.com/action/downloadSupplement?doi=10.1002%2Fsd.2865&file=sd2865-sup-0001-Supinfo.pdf>

¹⁸ The Impact Factor for each journal is reported based on information from the journal websites in February 2026.

RESEARCH ARTICLE



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Monitoring SDG 4.7: Assessing Education for Sustainable Development in policies, curricula, training of educators and student assessment (input-indicator)

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Abstract

Education is viewed as a critical keystone in achieving the Sustainable Development Goals (SDGs). Specifically, Education for Sustainable Development (ESD) is meant to enable everyone to contribute to sustainable development (SDG 4.7). This target is monitored using the global indicator 4.7.1 – mainstreaming of ESD in policies, curricula, training of educators and student assessment. Here, we offer a conceptual and methodological framework for assessments of SDG 4.7.1 (input-level) that addresses both quality and depth of implementation and speed of change. The approach combines document analysis with external expert evaluation and is applied to 10-year data (>11,000 documents) from all formal areas of education in Germany (early childhood education, school education, vocational education and training, higher education). Currently, ESD is mostly implemented in Germany as an “add-on” to the educational system, with all sub-indicators ranging from “isolated mentioning” of ESD and related concepts to “partial integration”. Across most areas of education, the sub-indicator training of educators was evaluated as most deficient. With regard to the speed of change, it was found that the implementation of ESD is dynamic, with all sub-indicators having been evaluated as increasing. The proposed framework can increase the validity, reliability, and comparability of both country reporting and scientific assessments of SDG 4.7.1. We argue for independent and integrative monitoring across input, process, output and outcome to complement self-reporting and to support evidence-informed policymaking on sustainability in education.

KEYWORDS

Sustainable Development Goals (SDGs), SDG 4.7, Education for Sustainable Development (ESD), monitoring & evaluation, document analysis, input-indicator, early childhood education & school education, vocational education & higher education

1 | TOWARD SDG 4.7 – RESPONDING TO AN EXISTENTIAL CHALLENGE

Sustainable Development (SD) encompasses an ambitious global agenda for the development of resilient, socially just human life within

the limits of planet Earth. With 17 globally agreed upon goals, 169 targets and well over 200 indicators, the Sustainable Development Goals (SDGs) are currently the core normative framework for global sustainability efforts (e.g., Biermann et al., 2017; Biermann et al., 2022). Although the SDGs are not without controversy due to their

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inherently conflicting goals (Hickel, 2019; Holden et al., 2017; Spangenberg, 2017), the general necessity and urgency to move toward global sustainability is virtually undisputed in academia and international politics (e.g., Richardson et al., 2023; Rockström et al., 2023; United Nations General Assembly, 2023). As important as the SDGs are, the findings of the mid-term report on their implementation are very sobering (Sachs et al., 2023): Currently, none of the 17 goals are on track, and in some cases progress is reported to be going backwards. Nonetheless, the authors remind us that all of the goals are still achievable (ibid.). For this transition, the mid-term report highlights universal quality education as a critical SD pathway, among others. This is supported by studies on assessments of the SDGs and their interactions, in which quality education (SDG 4) and particularly SDG 4.7 are described as having a strong positive relationship with various other SDGs (Dalampira & Nastis, 2020; Fonseca et al., 2020; Pham-Truffert et al., 2020; Vladimirova & Le Blanc, 2016; Xiao et al., 2023). In this vein, linking education with sustainability has been discussed as fundamental for change toward sustainability both in the fields of education (Agbedahin, 2019; Sterling, 2003, 2016; Wals & Benavot, 2017) and sustainability research (Abson et al., 2017; Otto et al., 2020; Sachs et al., 2019; Van Poeck et al., 2020).

Correspondingly, target 4.7 of the SDGs calls for education systems worldwide to “ensure [by 2030] that all learners acquire the knowledge and skills needed to promote sustainable development” (United Nations General Assembly, 2015, p. 21). Against this backdrop, Education for Sustainable Development (ESD) is approached by UNESCO and its member states as “an enabler for all 17 SDGs” and a “foundation for the required transformation” (UNESCO, 2021). Consequently, the final declaration at the UNESCO World Conference on ESD in 2021 set a commitment for member states to “[e]nsure that ESD is a foundational element of our education systems at all levels” (UNESCO, 2021, p. 2).

To be able to meet this commitment as well as the objective set in SDG 4.7, it is of critical importance to systematically monitor and evaluate the degree to which ESD and sustainability are being integrated within education systems (Brent Edwards et al., 2020; Kioupi & Voulvoulis, 2019; Stepanek Lockhart, 2018). Such data provide the basis for observing trends, identifying progress and gaps as well as deriving necessary policy measures to strengthen the implementation of ESD. As with all SDGs, the development of concrete and facilitative indicators for the integration of sustainability in education is crucial for its governance and practical implementation (Biermann et al., 2017; Hák et al., 2016; Kim, 2023). Currently, the global indicator for target 4.7 of the SDGs is described as the “extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment” (UNESCO, 2017, 2019a, 2019b). However, this indicator has not yet been sufficiently operationalized for independent and scientific assessments (Brent Edwards et al., 2020; Giangrande et al., 2019). Monitoring is currently based on countries' self-reporting using a dichotomous (yes/no) assessment scheme as well as qualitative highlighting of best-practice cases (UNESCO, 2019a, 2019b). This

reliance on countries' self-reporting results in a bias toward positive reporting (e.g., Nazir et al., 2011), which most likely does not reflect the real status of target 4.7. Taking the example of Germany, the current score on the global indicator for SDG 4.7.1 is reported at 1.0 for national education policies (range: 0–1), 0.904 for curricula, 0.95 for teacher education and 0.917 for student assessment (Destatis, 2023). However, the results derived from independent data from the national monitoring of ESD in Germany (e.g., Grund & Brock, 2020; Holst et al., 2020) are significantly different. While there is considerable support for the integration of ESD into the German education system, including through a large participatory multi-stakeholder process (Nationale Plattform BNE c/o BMBF, 2017; Singer-Brodowski et al., 2020), the discrepancies between self-reporting scores and evaluations by independent monitoring provide good reasons for complementing countries' self-reporting on SDG 4.7 with independent evaluations to allow for evidence-informed policy-making (Lingard, 2013).

Also, with regard to operationalization, the conceptual openness of the current global indicator 4.7.1. is viewed by some authors as problematic because, among other reasons, “it is not clear how comparisons of this indicator across countries should be interpreted” (Brent Edwards et al., 2020, p. 35) and because the term “*mainstreaming*” is not sufficiently concrete with regard to depth of integration (Gallwey, 2016). However, a more nuanced approach to measuring SDG 4.7.1 at the input-level of documents has not yet been proposed. Aware of the necessity of monitoring ESD across the different indicator levels (inputs, e.g., in documents; processes, e.g., assessments of Whole Institution Approaches; outputs and outcomes, e.g., assessments of competencies) and the need to develop both international and more context-specific indicators, we focus here on measurement strategies for the assessment of ESD at the input-level of documents. While we are proposing a way to further operationalize SDG 4.7.1 and apply in one illustrative context (Germany), the approach can also be used as a general input-indicator for ESD in other contexts.

Various authors have already conducted document analyses on ESD (e.g., Beveridge et al., 2019; Fredriksson et al., 2020; De Haan, 2021; Holst et al., 2020; Krah et al., 2021). However, evaluating the results of these studies has often proved difficult and, because of the lack of clear criteria for “sufficient” or “satisfactory” ESD implementation, it has not been possible to compare evaluations across different contexts and over time. This also accounts for past document analyses as part of the monitoring of ESD in Germany, where the focus has primarily been on whether the goals set by stakeholders themselves were met and how the observed status compared to other contexts described in the international literature (Holst et al., 2020). We thus see a considerable need for a conceptual and methodological framework for evaluating the current status quo and progress toward implementing SDG 4.7. Such a framework must allow for more standardized assessments that provide greater reliability and validity, and thus better comparability across contexts and over time.

In this article, we (1) propose an input-level framework for indicating and systematically assessing ESD, and specifically SDG 4.7,

based on lexical document analysis and external expert evaluation. We (2) report on the results of an assessment of the operationalized indicator 4.7.1 based on a longitudinal analysis of >11,000 documents from early-childhood education, school education, vocational education and training, and higher education in Germany. By combining systematic document analysis with an external expert evaluation, we propose an operationalization that can be used both for independent scientific assessments and as part of countries reporting on SDG 4.7.

2 | MONITORING SDG 4.7.1 AT THE INPUT-LEVEL: BASELINE DOCUMENT ANALYSES AND CONCEPTUAL FRAMEWORK FOR OPERATIONALIZATION

At the international level, the UNECE expert group on indicators for ESD contributed to the design of ESD indicators during the United Nations Decade on ESD (UNECE, 2005). This provided a basis for countries to report on their progress (UNECE, 2009, 2022) and was intended to cover a broad range of educational areas and levels (e.g., input, output/outcome). While international reporting to date has mostly been based on countries' self-assessments, independent national monitoring of ESD has been carried out at Freie Universität Berlin in Germany since 2015. This monitoring includes conducting repeated document analyses to track the status and progress of ESD implementation at the input level of educational governance. Systematic assessments of documents are considered a fundamental part of educational monitoring (Ioannidou, 2010) as documents (e.g., policies, curricula) provide important leverage for integrating emerging concepts and objectives within the structures of education systems. In Germany, data have now been collected and analyzed over a 10-year period (from 2012 to 2021) in all areas of formal education (early childhood education, school education, vocational education and training, higher education). This longitudinal document analysis serves as an exemplary data base for the operationalization of indicator 4.7.1 in this article.

In the following sections, we first present a conceptual framework for assessing different degrees of implementation of sustainability and ESD in education system documents, in line with SDG 4.7. We then outline our methodological approach to document analysis and, building on the proposed conceptual framework for indicatorising SDG 4.7.1 at the input-level, and describe the process of expert evaluation. In the results, we first synthesize the core findings from the document analysis on the status of ESD and sustainability in Germany and then present the results of the external expert evaluation on SDG 4.7.1. In the discussion, we reflect upon the core implications of the findings, strengths and limitations of the approach, and ways to further operationalize and assess SDG 4.7.

Redesign? Integrate? Add-On? What does it mean to “mainstream ESD”?

As the fundamental basis for the development of indicators for SDG 4.7, it is necessary to consider the different degrees to which

ESD and sustainability may or may not be “implemented” or “mainstreamed” within education systems. From an implementation theory perspective, the mainstreaming of the social innovation of ESD (Bormann & Nickel, 2017) can be described as the scaling of an educational reform. Coburn (2003) identifies four dimensions of the scaling of such innovations in education: depth, sustainability (in the sense of durability), spread and shift in ownership. A document analysis, by its very nature, can hardly capture a shift in ownership (the fourth dimension of Coburn's approach). However, the proposed framework traces the scaling of ESD in documents in terms of (1) depth, quality and spread (Coburn's first and third dimensions) and (2) stability and speed of scaling (Coburn's second dimension) by analyzing data at different times. With regard to depth and quality, Sterling (2003, 282ff.) describes four different modes of implementation: “*denial*” (rejection, leading to no change), “*bolt-on*” (“accommodation”, resulting in surface level reforms where sustainability is added to an existing system without changing the underlying paradigms), “*build-in*” (“serious greening”, resulting in significant system changes) and “*redesign*” (whole system change, a “deep reordering of assumptions equivalent to epistemic change”). Since the early 2000s, various authors have referred to this heuristic for evaluating the depth and quality of sustainability implementation (e.g., Kolmos et al., 2016 on engineering education; Wals & Benavot, 2017 generally on education; Weiss & Barth, 2021 on curriculum change in higher education). For the conceptual framework proposed here, we adapt, refine, and further operationalize the heuristic for evaluating SDG 4.7.1. Regarding the second aspect of mainstreaming ESD, *speed of change*, it is important to consider the usual cycles in which different types of documents are revised. As both aspects are important for the evaluation of the status and progress of ESD implementation, the proposed framework for assessments of SDG 4.7.1 contains two modules for the two separate yet interrelated domains: (1) quality and depth and (2) speed of change. The first (depth) is considered as the foundational module, which can be utilized in one-off or continuous (longitudinal) assessments. The latter (speed of change) requires time series, either – where possible – through the inclusion of past data (e.g., old and new versions of curricula, laws, exams) or, through comparative surveys (ideally, as part of long-term monitoring). Both parts of the framework are introduced in the following.

2.1 | Quality and depth of implementation

With regard to depth of implementation, we adapt and operationalize Sterling (2003) heuristic for the evaluation of document analysis within six demarcated assessment categories: (1) No Mentioning, (2) Isolated Mentioning, (3) Add-On, (4) Partial Integration, (5) Substantial Integration and (6) Redesign (for an overview, see Figure 1). In line with Sterling's approach, we suggest focusing primarily on the quality of observed implementation patterns (e.g., Redesign, Integration, Add-On, Isolated Mentioning) rather than the sheer quantity of textual references to concepts such as ESD or sustainability. At the same time,

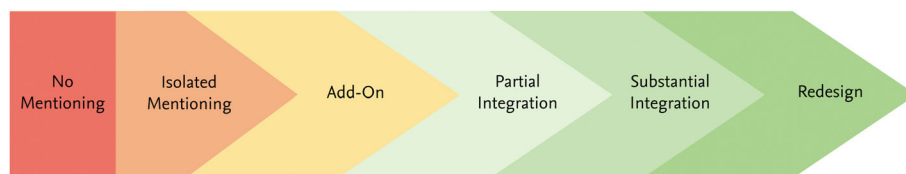


FIGURE 1 Conceptual framework for the depth of implementation of sustainability and Education for Sustainable Development (ESD) in education system documents; refined operationalization based on the underlying heuristic by Sterling (2003).

quantification is to some extent inherent in the categories presented below, considering that “Redesign” and “Substantial Integration”, by definition, require more textual references, while the categories of “No Mentioning” and “Isolated Mentioning” always imply low or non-existent quantities.

Redesign is described by Sterling (2003, p. 284) as transformation in the sense of “a deep, conscious reordering of assumptions equivalent to epistemic change, leading to change of paradigm”. Education is thereby re-thought “through a continuous learning process – to embody and reflect a whole system approach” to sustainability (ibid.:285). This paradigm shift (sustainability as a central objective of quality education) is manifested at all levels of education systems (e.g., policy, organizations and learning networks, specific learning environments and situations). In line with theories on leverage points for system changes, redesign addresses the “mindset or paradigm out of which the goals, rules, feedback structure arise” as well as the “goals of the system” itself (Abson et al., 2017; Meadows, 1997).

As the deepest form of implementation, which does not by definition require a fundamental shift in the underlying educational paradigms, **Substantial Integration** of ESD and sustainability in education system documents is operationalized to include the goal of ensuring “that all learners acquire the knowledge and skills needed to promote sustainable development” (UNESCO, 2020; United Nations General Assembly, 2015, p. 21) as a priority and guiding objective of all learning processes in a given sector of education (UNESCO, 2021). With reference to the sub-areas of the indicator for SDG 4.7, we propose operationalizing this as the following type of integration in the different areas of education:

1. **Policy:** Ambitious and binding education policy decisions and recommendations of the relevant actors in the respective education sector for the implementation of ESD and sustainability at all levels of the education sector. Key references for this are the roadmap of the UNESCO “ESD for 2030” program and the Berlin Declaration on the implementation of ESD (UNESCO, 2020, 2021).
2. **Curricula:** Cross-cutting integration of discipline-, subject- or occupation-specific goals (e.g., relevant competences), content (e.g., aspects of the SDGs, the socio-ecological transformation), didactic principles (e.g., action- and life world orientation, participation), and, if appropriate for the respective type of document, forms of organizational implementation (e.g., inclusion of the socio-physical learning environment as well as regional partners in

the sense of a whole institution approach; see Buckler & Creech, 2014; Holst, 2023).

3. **Training of educators:** Cross-cutting integration of ESD- and sustainability-specific competence goals in the relevant documents for the training and further education of educators (e.g., teachers, trainers, early childhood educators), that is, across all subjects, disciplines and age groups.
4. **Student performance assessments:** Design of examination questions in all subjects, disciplines, and professions in a form that takes into account other objectives of performance assessment and provides an incentive to promote and measure sustainability-related competences, including the critical and systemic examination of current non-sustainable development and the development of future-oriented possibilities for action.

By definition, such **Substantial Integration** implies both high *quality* and high *quantity* textual references. In contrast, **Partial Integration** requires a similarly high level of quality, but a lower level of quantity. This means that several, but not most, documents, groups or contexts apply an ambitious and binding conceptual understanding of ESD. Taking an example from Germany, partial integration might mean that there are high quality passages in texts on sustainability and ESD in the laws or curricula of several, but not most federal states.

The quality of implementation of **Add-On** differs from that of partial and substantial integration in that it refers to a pattern where the integration of textual references to SD, ESD and related concepts is predominantly of low quality and where such references are often simply added to objectives and explanations that are otherwise hardly changed at all. Sterling (2003, p. 282) describes this as “a ‘bolt-on’ of sustainability ideas to [an] existing system, which itself remains largely unchanged”. In the case of curricula, for example, this could mean adding the label “ESD” to courses without making substantial changes to their content, adding new electives on topics related to SD without making changes to the main body of compulsory courses, or modifying parts of courses or subjects so that they briefly touch on sustainability.

We suggest that isolated textual references to ESD/sustainability learning-related concepts (low quantity) that are not further contextualized and/or picked up in the rest of the document (low quality) should be considered as **Isolated Mentioning**.

The lowest proposed category (**No Mentioning**) implies that no anchoring can be identified at all.

2.2 | Speed of change

When assessing documents, speed of change always relates to the usual publication dates and revision cycles (e.g., school curricula are revised less frequently than, for example, examination questions). Moreover, speed of change can only refer to documents in which references to ESD/sustainability can be expected (e.g., no reference to sustainability or ESD could be expected in resolutions by ministries in response to the Covid-19 pandemic). Based on these considerations, we suggest operationalizing speed of change in five categories (Strong Increase, Medium Increase, Small Increase, No Change, Decrease; detailed operationalization: see methods). These can be evaluated either by external experts who have comprehensive knowledge of the fields of education (as in this study), or as part of countries' self-reporting (see discussion). Lastly, an assessment of speed of change requires data for comparisons across time, which may not always be available.

In the following section, we provide an introduction to the document analysis that serves as the data basis for external expert evaluation, and operationalize the conceptual framework within a code system for evaluations.

3 | METHODS FOR MEASURING SDG 4.7.1: DOCUMENT ANALYSIS AND EXPERT EVALUATION

3.1 | Systematic document analysis (quantitative, qualitative)

Since 2017, the national monitoring on ESD in Germany has conducted repeated large-scale document analyses, which serve as the data basis for reviewing the status and progress on SDG 4.7.1 at the input level. This current analysis includes a total of 11,061 documents (2017: 2795 (Brock et al., 2018; Singer-Brodowski, et al., 2019), 2019: 45078 (1713 new) (Holst et al., 2020), 2021/22: 11,061 (6553 new)) from all subdomains of the global indicator for 4.7: education policy, curricula, training of educators and student assessment. Table 1 provides an overview of the different types of documents included from each of the four areas of formal education (Early Childhood Education, School Education, Vocational Education and Training, Higher Education) for the four sub-indicators (Education Policy, Curricula, Training of Educators, Student Assessment).

The choice of document groups is based on (i) international indicators that were operationalized into groups of documents for assessment (Brock et al., 2018; Singer-Brodowski et al., 2019; UNECE, 2005), (ii) groups of documents specifically addressed in the National Action Plan on ESD (National Platform ESD c/o BMBF, 2017) and (iii) a systematic alignment of the document base with the subdomains of SDG 4.7.1 (education policy, curricula, training of educators, student assessment). A transdisciplinary knowledge exchange with members of the German ESD expert fora took place throughout all process steps. This iterative approach, which began in 2016,

gradually led to the inclusion of further groups of documents (e.g., exams in school education and didactic training of educators in higher education were assessed for the first time for this study).

Applying the same data collection procedure used for the 2017, 2018, and 2019 benchmark data, the new and updated data for all document groups included in this study were collected between November 2021 and January 2022. A total of 6553 additional documents were downloaded, inventoried and loaded into the data analysis software MAXQDA for this study, bringing the total dataset to 11,061 documents. All data were automatically searched for conceptual keywords relating to (i) ESD, (ii) Sustainability/Sustainable Development, (iii) Perspectives on and from ESD and (iv) Related educational concepts. An overview of all keywords used in the lexical analysis is provided in Figure 2.

Keywords on a conceptual level were chosen to address the thematic as well as the didactic level of ESD. All codings of identified text segments were checked manually, for example, to avoid miscoding, such as the use of "nachhaltig" (German for sustainable) only in the sense of "langfristig" (durable/long-term) instead of in the sense of the normative concept of sustainability/SD. As a coding rule, all segments where the coding did not seem entirely clear were strictly coded as "uncertain" and discussed in a peer debriefing (Spall, 1998) with three researchers to reach consensus or, where this was not possible, to vote on the coding. The coded text segments within each group of documents were analyzed both quantitatively and qualitatively.

3.2 | External Expert Evaluation

After reports had been finalized in German for each area of education, six external experts on ESD and educational measurement in the German education system were asked to evaluate the descriptive results according to the predefined system of categories. The experts were chosen based on their context of expertise, representing all areas of education, and their professional experience with indicator development as professors in the fields of general education and ESD. Table 2 provides an overview of the experts involved in the external evaluation with their institutional affiliation and context of expertise. The number and selection of experts took into account both the need for reliability and validity of evaluations, and the feasibility of applying the methodological framework in different contexts. Given the extensive and long-standing field knowledge and experience of the experts, in one specific area of education and more generally across all areas of education, it can be assumed that they were able to make robust assessments of the quality and speed categories based on the predefined template (below).

A template was developed (supplementary material) to standardize the external expert evaluation, including background information on the document analysis and the scales for evaluation (quality/depth, speed of change). As the descriptive basis for their judgments, the experts received a descriptive raw version of four reports on the most recent document analysis (in German: Brock & Holst, 2022; Holst, 2022; Holst & Singer-Brodowski, 2022; Singer-Brodowski &

TABLE 1 Document groups included in the systematic lexical document analysis sorted by areas of education and sub-indicators of SDG 4.7.1 (education policy, curricula, training of educators, student assessment).

	Education policy	Curricula	Training of educators	Student assessment
Early Childhood Education (ECE)	• Laws of all states and federal laws	• Educational plans from all states	• School curricula of courses in ECE from all federal states	
	• Education reports		• Course handbooks and study/examination regulations for all study programs at higher education institutions (HEI) for educators in ECE	
School Education (SE)	• Documents from the conferences of Ministers for Youth and Family Affairs (JFMK) / Education (KMK) and the Child and Youth Welfare Association (AGJ)	• School curricula of all 16 states for 9 selected subjects	• Course handbooks and study/examination regulations for teacher training at the 20 higher education institutions with most graduates in Germany	• Exams for degrees in secondary education (Abitur, Realschule, Hauptschule) from 2005 until 2021
	• Laws of all states			
Vocational Education and Training (VET)	• Documents from the Standing Conference of the Ministers of Education and Cultural Affairs (KMK) with focus on SE	• All new or modified training regulations since 2015	• Course handbooks and study/ examination regulations for teacher training in five selected states	• Regulations on exams in training regulations since 2015
	• Federal and state laws			
	• Federal Institute for VET (BIBB), KMK-Committee on VET			
Higher Education (HE)	• Education reports and data reports (BIBB)	• All new or modified frame-curricula for VET-schools since 2015	• Ordinance on Trainer Aptitude (AEVO) and regulations for further training of educators	
	• Guides for Educational Practice (BIBB) since 2015	• Course handbooks and course regulations of 3 subjects (biology, mechanical engineering, business administration) from 20 HEIs	• Didactic training of educators at 20 HEIs and respective networks for didactic training in HE	
	• Federal and state laws			
	• Federal, regional rectors' conferences (HRK/LRK)			
	• Target agreements of all states with HEI			
	• Education reports			
	• Student associations			
	• HEI self-governance (e.g., mission statements, reports, strategies, statutes) from 20 HEIs			

- | | |
|--|--|
| <p>1. Education for Sustainable Development</p> <ul style="list-style-type: none"> • Education for Sustainable Development • Education as Sustainable Development • ESD / EFS* (German & English) <p>3. Perspectives on and from ESD</p> <ul style="list-style-type: none"> • Global Action Programme, GAP • ESD for 2030*, ESD2030* • National Action Plan* • Whole Institution Approach • Whole School Approach • SDG, Agenda 2030 • Global goal • Intergenerational / Future generation • Planetary Boundar / Guardrail • Global development | <p>2. Sustainability / Sustainable Development</p> <ul style="list-style-type: none"> • Sustainability • Sustainable Development • sustain (German & English) <p>4. Related educational concepts</p> <ul style="list-style-type: none"> • Gestaltungskompetenz (Shaping competency) • Transformative learning / education • Global citizenship education • Climate education • Global learning • Learning in global contexts • Development policy education • Environmental education / pedagogy • Nature education / pedagogy • Ecological education |
|--|--|

FIGURE 2 Conceptual keywords used for lexical search (translated from German, different forms for singular/plural as well as different suffixes were included); based on Holst et al. (2020). Keywords which were included in this study for the first time are marked with.

TABLE 2 Experts involved in the external expert evaluation with institutional affiliation and context of expertise.

Expert	Institutional affiliation	Context of expertise
Prof. Dr. Inka Bormann	Freie Universität Berlin	Professor of General Education
Prof. Dr. Johannes Hartig	Leibniz Institute for Research and Information in Education	Professor of Educational Measurement
Prof. Dr. Werner Kuhlmeier	University of Hamburg	Professor of Vocational Education
Prof. Dr. Armin Lude	Ludwigsburg University of Education	Professor of Biology and Biology Education
Prof. Dr. Heike Molitor	Eberswalde University for Sustainable Development	Professor of Environmental Education and Education for Sustainable Development
Prof. Dr. Marco Rieckmann	University of Vechta	Professor of Higher Education Development

Holst, 2022). Abstracts, evaluations and recommendations were removed to better ensure an unbiased and independent evaluation by the experts. The descriptive reports were divided into five PDFs (introduction and methods, one PDF for each sub-indicator of SDG 4.7.1) and provided to the experts with the template. The following Tables 3 and 4 are part of the template and were provided to the experts as the predefined category system for assessment. First, Table 3 introduces the category system used to evaluate the quality and depth of ESD implementation. Table 4 subsequently introduces the category system used to evaluate speed of change.

Importantly, the rating of both categories (depth/quality, speed) refers to the predominant pattern of anchoring, which means that individual references are less important in the evaluation than the larger patterns. During the evaluation, all document groups were evaluated

individually and an aggregated assessment was made for each sub-indicator. After the six expert evaluations had been collected, the mean and modus were calculated for each document group and sub-indicator.

4 | RESULTS

Section 4.1 provides a descriptive overview of the main results of the document analysis for each area of education. These serve as the data for the evaluation of SDG 4.7.1. The results of the expert evaluation are reported in section 4.2.

4.1 | Implementation of ESD and related concepts in Germany: Descriptive overview

Before presenting the results for each area of education, it is important to note that, under the German constitution, education in Germany is the responsibility of the 16 federal states. This means that the federal government only has direct influence on some parts of the education system (e.g., parts of vocational education) and that most data are reported for the 16 states.

4.1.1 | Early childhood education (ECE)

Early childhood education in Germany is primarily organized by independent institutions. Municipalities and states support daycare places, and in recent years the federal government has provided funding for overall quality development. At the level of **education policy** (state laws), there is a slight trend toward the inclusion of ESD compared to the previous study, with 4 state laws (2019: 1) referring to sustainability or ESD. The supporting associations, which are united in the Child and Youth Welfare Association (AGJ), have also taken a position on ESD.¹ Position papers of the Standing Conference of the Ministers of Education and Cultural Affairs (KMK) on the training of early childhood education specialists and support staff have provided a basis for

TABLE 3 Category system for quality and depth of ESD implementation with descriptions and further elaborations for the categories “Redesign”, “Substantial Integration”, “Partial Integration”, “Add-On”, “Isolated Mentioning” and “No Mentioning”.

Category	Description	Further elaboration
Redesign	<u>Comprehensive redesign or reorganization of the fundamental orientation of documents/document groups toward sustainability/ESD (paradigm/lived culture of sustainability).</u>	Understanding of ESD as a central, continuous and binding part of the educational mission in the sense of a whole institution and ultimately a whole-system approach, which in turn corresponds to a fundamentally changed educational paradigm/a lived culture of sustainability (cf. also Sterling, 2003). The orientation toward sustainability restructures the goals and paths of the educational sector / institution in question.
Substantial Integration	<u>Deep and cross-sectional integration of sustainability/ESD in the various documents/document groups; high quantity and quality (substantial integration) of references on ESD and sustainability.</u>	An ambitious and binding conceptual understanding of ESD is consistently applied to the content of the respective documents (e.g., curriculum or resolution).
Partial Integration	<u>Predominantly high content quality of the references to ESD/sustainability in the sense of substantial integration in several documents/document groups (e.g., in several, but not all federal states) with differences between or within the documents/document groups.</u>	An ambitious and binding conceptual understanding of ESD is applied in several documents of a document group or in several federal states, subjects, or at several locations with high content quality in the sense of substantial integration (see above).
Add-on	<u>References to ESD/sustainability are predominantly of medium to low content quality, often as a supplement to otherwise frequently unchanged requirements/objectives/explanations.</u>	For example, naming the concept of ESD in curricula, but without describing goals, content, methods/media, and organizational implementation as substantially oriented toward ESD/sustainability.
Isolated mentioning	<u>Isolated references in individual documents (groups of documents) that are not further contextualized and/or taken up in the rest of the document.</u>	Isolated references to for example, sustainability, ESD or related concepts.
No mentioning	<u>No mentioning of sustainability, ESD or related concepts.</u>	

TABLE 4 Category system for speed of change of ESD-implementation with descriptions for the categories “Strong Increase”, “Medium Increase”, “Small Increase”, “No Increase” and “Decrease”.

Category	Description
Strong increase	A <u>very strong/rapid increase</u> in references to ESD/sustainability in the respective documents (groups) compared to usual publication/revision times.
Medium increase	A <u>significant increase</u> in references to ESD/sustainability in the respective documents (groups) compared to usual publication/revision times.
Small increase	A <u>slow increase</u> in references to ESD/sustainability in the respective documents (groups) compared to usual publication/revision times, recognizable by sporadically increasing references.
No change	<u>No change</u> is discernible over time.
Decrease	A <u>reduction of references</u> to sustainability/ESD can be observed in the periods under consideration.

strengthening ESD in training (see below). ESD has not been included in education reporting. Regarding the **curricula**, there are no binding documents for young children up to the age of 6. However, by the end of 2021, 9 of the 16 educational plans of the federal states explicitly referred to ESD (2017: 6; 2019: 8). A clear trend can therefore be

observed, which applies in particular to the recently revised educational plans. Early childhood **educators** follow one of two training paths: traditional dual educator training (see section on Vocational Education and Training (VET) below) or an early education/childhood study program at higher education institutions. An increase of references to ESD or related concepts was found in documents related to study programs (3% of documents with references in 2017 to 5% in 2021). Specifically, this means that references to ESD could be found on about one in 31 analyzed pages (2017: 1/139 pages), and references to sustainability on about one in 45 pages (2017: 1/256 pages). There is also an increase in the proportion of ESD in relation to other sustainability-related educational concepts. An even clearer trend is evident in VET for early childhood educators: starting from comparatively few references in the baseline analysis (2017: 1 reference every 280 pages, $n = 292$), ESD is more frequently integrated in more recent documents (2019: 1 reference every 43 pages, $n = 44$; 2021: 1 reference every 24 pages, $n = 72$). No ECE documents exist that could be analyzed in the area of **student assessments**.

4.1.2 | School education (SE)

In Germany, SE laws, curricula and examination questions differ from state to state. The Standing Conference of the Ministers of Education and Cultural Affairs (KMK) therefore wields considerable influence as the joint consulting body of the federal states. A review of the

different **education policies** adopted in each state shows that no change has occurred in the education laws of the 16 federal states since 2019. Four laws explicitly refer to ESD and another four mention sustainability. The recommendations and resolutions issued by the KMK since 2019 only refer to ESD in one thematically relevant document on consumer education. ESD is not referred to in documents that focus on the overarching design of the school system. The analysis of **curricula** continues to show that references to ESD and SD differ greatly across federal states and subjects. Looking first at all curricula valid at the time of data collection ($n = 422$), four federal states included at least some explicit references to ESD in more than 50% of all curricula assessed. However, the curricula documents from eight states included ESD in less than 20% of the documents analyzed. There is a strong tendency to include references in subjects that are thematically close to SD, which limits the cross-cutting implementation of ESD. In a few federal states, ESD has been implemented across different subjects (e.g., Baden-Württemberg, North Rhine-Westphalia, Saxony). ESD is rarely – 6% of all documents – integrated in training course handbooks and course/examination regulations for the **training of educators**, whereas ESD-relevant terms, including related concepts, appear in 14% of the documents. Documents that contain references to (E)SD focus primarily on specific universities and, again, on specific subjects (e.g., biology, geography). In 5 out of 20 of the largest teacher training institutions in Germany, ESD did not appear in any document. Within the category of **student assessment**, thematic references to the ecological dimension of SD were analyzed based on dimensions of the planetary boundary concept (Steffen et al., 2015). The number of text segments has increased over the past years, especially those related to climate change and, less frequently, biodiversity. Strong differences were also found between subjects. For instance, 78% of geography exams referred to SD, and 46% to climate change. In business administration, 41% referred to SD and around one third (28%) to climate. There were far fewer references to SD in other subjects, such as most natural sciences, German, history, or arts, with a maximum of 3% of all exams in each subject referring to SD-related issues.

4.1.3 | Vocational education and training (VET)

In Germany, VET is organized in a dual system, in which vocational schools cooperate with companies to combine both theoretical and practical perspectives. While a programmatic discourse on sustainability in VET was observed in the last assessment in 2019, the concrete integration of ESD was described as slower and less dynamic (Holst et al., 2020). In contrast, the present analysis shows significant trends toward embedding sustainability in the German VET system between 2019 and 2021. Regarding VET-related **education policies**, the concept of sustainability (not ESD) has been included in the standard training elements (“Standardberufsbildpositionen”) by the Federal Institute for VET (BIBB), and the contribution to SD has been included by the KMK in the corresponding agreement as a task of vocational schools. No major changes were observed with regard to laws and

educational reporting. In particular, the inclusion of sustainability in the standard training elements and the KMK's curriculum development guidebook has led to a sharp increase in the number of text segments in **curricula** (training regulations, school curricula) that refer to sustainability. As of 2021, all new or updated documents include references to sustainability (not to ESD, which could only be expected in school curricula). So far, this only affects a comparatively small number of vocations (e.g., 5 training regulations in 2021), in which the number of references to sustainability has increased (e.g., in training regulations, from an average of 4.5 to 10.8 mentions per document). In terms of depth, references are frequently overarching VET requirements or closely follow the wording of the standard training element. The concrete meaning of sustainability for a specific vocational context is only defined in individual cases. Regarding the **training of educators** (teacher training in universities), the longitudinal data show an increase in the relevant text segments based on an overall low anchorage in 2017 and 2019 (Holst et al., 2020). However, these references focus primarily on single HEIs and individual courses (1% of all text segments at four out of 16 HEIs). Further, the respective sections on **student assessment** in all training regulations published between 2015 and 2021 were analyzed: Out of a total of 66 vocations, 6 training regulations (9%) referred to sustainability. Although the standard training elements should legally be part of all assessments, this is not yet reflected in the data since 2020.

4.1.4 | Higher education (HE)

In HE, the category of **education policy** includes state-policies (including agreements between federal states and HEIs) and the documents produced by self-governing HEIs. Continuing a trend described in Holst et al. (2020), the data shows that sustainability – and to some extent ESD – is increasingly included in target agreements between state ministries and HEIs. In 2021, 12 of the 16 federal states mentioned sustainability at least once in >50% of their agreements with HEIs (7/16 for ESD). At the same time, frequency and qualitative depth vary strongly between states and among HEIs. In contrast to earlier observations, significant dynamic can be observed in state laws, with 10 of the 16 states mentioning sustainability as a core mission of HEIs (2017: 5, 2019: 6). In addition, from 2022 onwards, two states explicitly designate ESD as a compulsory objective (Hesse, Bavaria). In contrast to state policies, there are far fewer references to ESD and sustainability in documents in the self-governance documents of HEIs (e.g., mission statements, strategies, statutes) and in the positions formulated by the federal and regional rectors' conferences. A slowly increasing number of individual references to sustainability were found in **curricula** (module guides; e.g., in biology, business administration, mechanical engineering) at almost all of the 20 HEIs surveyed, albeit with a low frequency (2021: approx. one reference every 14.8 pages, 2017: 19.3, 2019: 25.7). The majority of references are concentrated in individual HEIs and within individual study programs and modules (82% of all references at 5 out of 20 HEIs). Overall, the data do not show a comprehensive horizontal integration of

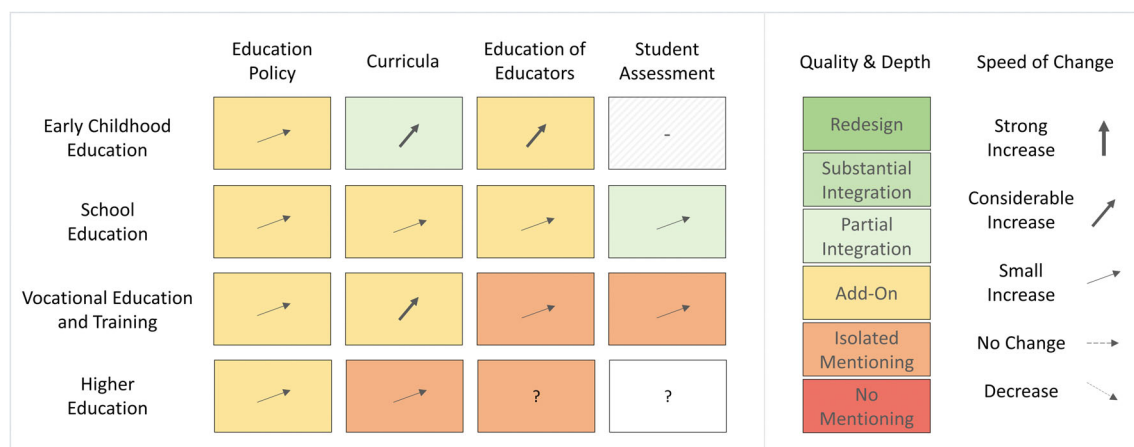


FIGURE 3 The status of and progress with the implementation of Education for Sustainable Development (ESD) in the German education system. Colors and arrows refer to the rounded mean external expert evaluations (see Table 5) of quality and depth of implementation as well as speed of change. No data exists for student assessment in Early Childhood Education (ECE) and no data was assessed for student assessment in Higher Education (HE). Speed of change could not be evaluated for training of educators and student assessment in HE due to a lack of appropriate data (indicated with a question mark).

sustainability or ESD in the analyzed curricula. Bearing in mind their importance in enhancing the quality of training in the **training of educators**, assessments were carried out on programs for further training in higher education didactics. Of the 126 documents from the 20 assessed HEIs and related networks (2020, 2021), 6 documents (5 modules) referred to ESD and sustainability in individual modules at 7 of the 20 HEIs. The data did not show structural that is, systematic, cross-sectional and comprehensive embedding of ESD, sustainability and related concepts. As exams in HE are mostly created individually by each lecturer and are therefore highly heterogeneous, no data on **student assessment** in HE could be assessed.

4.2 | External expert evaluation on SDG 4.7.1

As part of the external evaluation, six experts in ESD and educational monitoring evaluated the descriptive results in terms of both depth and quality of implementation as well as speed of change. Figure 3 and Table 5 show their evaluation of the status and progress of ESD implementation in Germany across all formal areas of education and sub-indicators for SDG 4.7. Figure 3 provides a graphical overview of both quality and depth (background colors) and speed of change (arrows). The same result is presented in descriptive form (means and distributions for the ratings of each sub-indicator) in Table 4 below. Across all sub-indicators and areas of education, the mean expert-evaluations are concentrated on and spread around the “Add-on”-pattern of implementation (indicated in yellow in Figure 3). This pattern describes a medium to low overall quality of integration, where implementation usually involves adding ESD to a mostly unchanged main body of content. The evaluations by the experts range from isolated mentions of sustainability, ESD and related concepts (curricula in HE, training of educators in VET and HE, student assessment in VET, orange in Figure 3) to partial integration, which

describes a high quality of implementation in several but not the majority of documents or document groups (curricula in ECE, student assessment in SE; light green in Figure 3). Of the sub-indicators, the training of educators is currently the lowest ranked sub-indicator in Germany with two areas of education rated as “Isolated Mentioning” (VET, HE), and two as “Add-On” (ECE, SE). No sub-indicator scored within the lowest and highest categories of “No Mentioning” and “Substantial Integration” or “Redesign” respectively. Even one aggregation level below sub-indicators, within the specific document groups, none of the 34 document groups were rated by the experts as fitting into the categories of “Substantial Integration” or “Redesign”. Two were rated as not mentioning sustainability, ESD or related concepts at all (National Education Reports, Ordinance on Trainer Aptitude in VET (AEVO)).

In terms of the speed of change, the experts evaluated the increases in implementation since the last assessment to be small for most of the sub-indicators (30° upward pointing arrows in Figure 3). For the sub-indicators on ECE and VET curricula and on ECE educator training, all three of which started from a comparatively low level of implementation in the previous evaluation (Holst et al., 2020), the increases were rated as medium/significant (60° upward pointing arrows in Figure 3). None of the sub-indicators were considered by the experts to have increased significantly, and none was judged to have decreased or not changed at all. Looking at the individual document groups, considerable increases were seen in nine of the 34 document groups. These include laws and target agreements in HE, different types of curricula (ECE, VET), documents of the Standing Committee of the Federal Institute for Vocational Education and Training (BIBB-Hauptausschuss) in VET and positions formulated by the Child and Youth Welfare Association (AGJ) in ECE.

With regard to the variance of the responses (Table 5) it is worth noting that, with the exception of one sub-indicator (curricula in VET), the responses scatter around a maximum of three assessment

TABLE 5 Expert evaluations of quality/depth and speed of ESD implementation in documents of the German education system (mean, distribution in brackets) for all four subdomains of target 4.7.1 of the Sustainable Development Goals (mainstreaming of ESD in education policy, curricula, training of educators and student assessment). Results are shown for early childhood education (ECE), school education (SE), vocational education and training (VET) and higher education (HE). Scale for quality: 0 = No Mentioning, 1 = Isolated Mentioning, 2 = Add-On, 3 = Partial Integration, 4 = Substantial Integration, 5 = Redesign. Scale for speed: -1 = Decrease, 0 = No Change, 1 = Small Increase, 2 = Considerable Increase, 3 = Strong Increase. nR = No Response.

		Education policy	Curricula	Training of educators	Student assessment
Early childhood education	Quality	1,7 (1***, 2**, 3*)	2,8 (2*, 3*****)	1,8 (1**, 2***, 3*)	-
	Speed	1,0 (1*****)	1,5 (1***, 2***)	1,8 (1*, 2*****)	-
School education	Quality	1,7 (1***, 2**, 3*)	2,3 (1*, 2**, 3***)	1,7 (1**, 2*****)	2,5 (2***, 3***)
	Speed	0,5 (0***, 1***)	1,0 (1*****)	0,8 (0*, 1****, nR*)	1,2 (1****, 2*, nR*)
Vocational education and training	Quality	1,8 (1**, 2***, 3*)	2,3 (1*, 2***, 3*, 4*)	1,0 (1*****)	1,2 (1****, 2*)
	Speed	1,2 (1****, 2*)	1,8 (1**, 2***, 3*)	1,0 (1*****)	0,8 (0*, 1****)
Higher education	Quality	2,2 (1*, 2***, 3**)	1,2 (1****, 2*)	1,0 (1*****)	-
	Speed	1,0 (1*****)	1,0 (0*, 1***, 2*, nR*)	-	-

categories and in most cases the mode matches the mean. Focusing on the differences in the evaluations of all 34 individual document groups (one aggregation level below the sub-indicators), the highest mean score of the expert evaluation on depth of implementation is 3.3 (“Partial Integration”) for the most recent documents from the BIBB-Hauptausschuss (part of education policies in VET), which issued an update to the standard training elements (“Standardberufsbildpositionen”) in 2020 to include sustainability as a focus for all training programs in VET. This score is considerably higher than the scores for the document groups in the sub-indicator for education policies in VET (e.g., laws, documents by the KMK which focus primarily on the school side of the dual VET system in Germany). A further finding specific to the area of HE is that policy documents are evaluated differently depending on whether they are the responsibility of state actors (laws, target agreements) or students (publications by state student councils) on the one hand, or the direct responsibility of autonomous HE institutions on the other. While state and student-driven documents were generally evaluated as “Partial Integration” and as increasing considerably (e.g., target agreements ($M_{\text{Quality}} = 2.8$) or documents by State Student Councils ($M_{\text{Quality}} = 3.0$)), most documents produced by HE institutions and their representative bodies were categorized as “Isolated Mentioning” and sometimes “Add-On” with little or no increase. In ECE, the documents of the Child and Youth Welfare Association (AGJ) were evaluated as of higher quality ($M = 2.3$) with a considerably faster speed of change ($M = 1.8$) than policy documents from the federal states or the minister conferences.

5 | DISCUSSION: DEVELOPMENT OF INPUT-INDICATOR FOR ESD IN LINE WITH SDG 4.7 AND ILLUSTRATIVE ASSESSMENT IN GERMANY

The development of concrete, measurable and facilitative indicators is crucial to support evidence-based governance of the integration of sustainability into all levels of education (on SDG indicators generally,

Håk et al., 2016; Biermann et al., 2017; Kim, 2023). However, most international SDG assessments do not focus on the implementation of ESD and sustainability in education (SDG 4.7). Instead, SDG assessments to date have tended to refer to general developments in education. As an example, the SDG-mid-term report includes data on participation rates in pre-primary learning, primary-, secondary school enrollment and literacy rates (Sachs et al., 2023). Other assessments measure SDG 4 according to school enrollment rates, literacy rates, or gender parity index of school enrolment among others (e.g., Campagnolo et al., 2018; Huan et al., 2021). The input-indicator framework presented in this article differs from these analyses in that it focuses explicitly on the depth and speed of ESD integration, which is critical to the quality with which sustainable development is implemented and practiced in education. While the importance of ESD for high quality education has often been proclaimed and indicators for ESD have been discussed for over 15 years (e.g., Tilbury, 2007), monitoring of SDG 4.7 specifically has to date mostly relied upon country self-reporting using a binary (yes/no) scheme (UNESCO, 2019a, 2019b). With the proposed framework we respond to this by offering a procedure to increase the validity, reliability and reproducibility of input-assessments of SDG 4.7.1.

The framework can be used to evaluate the status and development of ESD implementation in documents at the level of countries and federal states, as well as in the context of international frameworks and education partnerships (e.g., UN, UNESCO, OECD, and others). The operationalization is two-dimensional. It includes the quality and depth of ESD implementation as well as speed of change and combines lexical document analysis with structured external expert evaluation. The reliability of assessments is increased by proposing clearly structured categories for the evaluation of quality (6 categories) and speed of change (5 categories) of implementation of ESD and related concepts in documents. This allows for a more concise and comparable understanding of the different levels of monitoring and mainstreaming of ESD (see Brent Edwards et al., 2020; Gallwey, 2016). As the literature-based conceptual framework beneath the category system provides a condensed understanding of

the different degrees of quality of integration and depth, the framework itself also contributes to increased assessment validity. By providing clear methodological steps, the framework allows for reproducibility and comparability across diverse research contexts and time periods. By broadening the knowledge base for future evaluations, the framework might also bridge approaches between international large-scale assessments and less quantitative evaluations of cross-cutting educational topics such as ESD (e.g., Sinnes & Eriksen, 2016). In addition, by minimizing the risk of author or self-reporting bias, external expert evaluation increases the objectivity of evaluations.

The framework could be used in future assessments in two ways:

1. First, the use of independent scientific analyses with external expert evaluation is proposed as a complement to country self-reporting. Depending on the resources and data available, assessments can either focus solely on current quality and depth, or – if longitudinal data are available – also include speed of change. The commissioning of independent assessments would allow for countries to assess the current situation as well as shortcomings and trends and would provide an empirical basis for informed policy making.
2. Second, the conceptual framework can be used as part of self-assessments: The quality of self-assessments could be enhanced by complementing reporting on thematic indicators (e.g., on the integration of human rights, gender equality, peace and non-violence) with a structured and critical self-evaluation of the patterns of quality and depth of ESD implementation (0: No Mentioning, 1: Isolated Mentioning, 2: Add-On, 3: Partial Integration, 4: Substantial Integration, 5: Redesign) as well as speed of change in the domains of SDG 4.7.1 (–1: Decrease, 0: No Change, 1: Small Increase, 2: Medium Increase, 3: Strong Increase).

The quality of the data evaluated is critical to the validity of the results for both pathways (scientific assessments, self-assessments). The documents assessed must be representative of the total set of documents (e.g., no showcasing of best practices; focus not only on latest, but on all currently valid documents). It is moreover important for external evaluation purposes to involve external experts from the specific region who have considerable contextualized field knowledge of the different educational areas and, ideally, of educational monitoring in general.

5.1 | Assessment in Germany: From add-on to substantial integration?

The conceptual and methodological framework for assessing SDG 4.7.1 was applied in this study to the German context. The experts on ESD and educational measurement evaluated most 4.7.1 sub-indicators in the “Add-On” category. This describes the implementation of ESD and sustainability content as predominantly of medium to low quality, often as an addition to otherwise unchanged educational

objectives or explanations (also Sterling, 2003). Evaluations ranged around the “Add-On” category from isolated mentioning of ESD-related concepts in the training of educators (VET, HE), curricula (HE) and student assessment (VET) to partial integration in curricula of ECE and student assessment in SE. Across the four sub-domains, educator training is still the lowest ranked sub-indicator, which is in line with previous studies (Grund & Brock, 2020; Holst et al., 2020) and international studies on ESD (De Haan 2021; Fischer et al., 2022; Gough, 2016). In the area of education policy, we found that in many cases there are policies on ESD, but they are often non-binding and often address ESD as an “add-on” instead of a central point of reference. Particularly within curricula, but also across all other domains, we found strong foci of textual references within specific states, subjects, organizations (e.g., HEIs) and modules. Overall, based on the conceptual framework presented in this study, it is not yet apparent that ESD has been comprehensively integrated (in a cross-cutting way) into documents of the German education system. While the “No Mentioning” category was not used at all, which means that ESD has its place in all areas of education and all sub-domains of SDG 4.7.1 in Germany, the same is currently true for the “Substantial Integration” and “Redesign” categories. In terms of speed of change, the German data clearly show a dynamic of implementation (all sub-indicators were evaluated as increasing). However, the experts rated the increases as mostly small or, in some sub-indicators and areas of education, as considerable. It is important to note here that the evaluation of the speed of change is related both to the revision cycles of documents (e.g., curricula are only revised every 10 to 20 years) and the speed of change required to achieve the objective set in SDG 4.7 – enabling all to contribute to sustainability by 2030. While the current implementation might be considered dynamic compared to (a) past timescales of substantial changes in education systems and (b) the low implementation status reported in the first analysis in 2017 (Brock et al., 2018; Singer-Brodowski et al., 2019), this dynamic is still too slow given the ambition of SDG 4.7.

5.1.1 | Methodological strengths and limitations

In addition to the contributions of the presented framework to enhancing the reliability, validity and objectivity of ESD assessments at the input level, further methodological strengths and limitations require discussion. First, the data set containing over 11,000 documents from over 30 document groups is very heterogeneous. This implies that both the initial analysis and the external evaluation required considerable system-specific knowledge on the part of the researchers and external experts involved. The analysis presented here therefore needed time and resources, which may not be available in every context. However, one strength of the approach lies in its scalability, that is, the same procedure can be applied to a much smaller dataset, as long as the selection of documents accurately represents the total set of documents (e.g., a document analysis for one federal state in one area of education, see Krah et al., 2021) or other educational concepts (e.g., Global Citizenship Education). For regional

adaptation, we suggest involving key stakeholders from civil society, educational practice, administration and academia in the selection of document groups to be assessed. Regarding the keywords used for lexical analysis, we deliberately focused on conceptual keywords (e.g., ESD, sustainability/SD, related educational concepts and perspectives). Naturally, thematic references to sustainability and ESD (e.g., to sustainability-related topics) can be found more frequently across the set of documents than conceptual keywords. However, assessing a wide range of conceptual keywords gives a broader impression not only of the topics but also of the objectives, methods and approaches associated with the educational concept of ESD (e.g., Brundiers et al., 2021; De Haan, 2010; Rieckmann et al., 2017). Also, SDG 4.7.1 specifically focuses on the “mainstreaming” of ESD. Here we argue again that this is best operationalized by focusing on the relevant key concepts. Lastly, while a wide range of data was included in the present study, not all sub-indicators could be covered equally: No data are available for student assessment in ECE (there are no assessments in ECE) and no data were collected in HE, where data might theoretically exist, but in practice are very difficult to acquire as exams in HE are very diverse and mostly created by the individual lecturers themselves.

6 | CONCLUSIONS & OUTLOOK

In light of the ambition articulated in SDG 4.7 – to enable all to contribute to SD until 2030 – the Declaration from the recent UNESCO World Conference on ESD calls on all countries to “[e]nsure that ESD is a foundational element of our education systems at all levels” (UNESCO, 2021, p. 2). If the practice of sustainability in education is to live up to the call for ESD to become a “key enabler of all the other SDGs” (United Nations General Assembly, 2017), it is necessary that its structural integration into education systems matches this ambition. Clearly, individuals cannot be expected to act consistently in a sustainable manner if the norms around them – as formalized in documents – treat sustainability as an isolated issue or “add-on”. Although integration in structures involves more than anchoring in documents (e.g., mental structures), these formalizations set a frame for human action, provide orientation and are therefore an important lever for changing practice. For this reason, it is crucial that reliable assessments are made of the status and progress on SDG 4.7. The proposed framework adds validity, reliability, and comparability to country reporting and scientific assessments (Brent Edwards et al., 2020; Giangrande et al., 2019). Furthermore, the categories introduced can also be a means for policymakers, administrators, and practitioners to reflect on their actions in relation to sustainability in education.

With regard to further developments, future research may focus particularly on understanding the processes of policy development and policy mobility (McKenzie et al., 2015) which lead to ESD implementation in line with a pattern of integration or even redesign. In this vein of public policy-making, it would be critical to explore how administrative stakeholders in particular can overcome status-quo

biases (e.g., thinking ESD in an “add-on”-mode). We further argue that while stocktaking through input assessments is critical to understanding the status and progress of structural implementation, integrative monitoring approaches may go further and include indicators also across the levels of educational processes, outputs and outcomes (e.g., Holst et al., *in review*; Marron & Naughton, 2019; Unterhalter, 2019). Regarding monitoring, internationally agreed-upon indicators (e.g., on 4.7) may be complemented with context-specific indicators to foster participation and generation of policy-relevant knowledge, e.g., at sub-national levels (also Brockwell et al., 2022; Gallwey, 2016). Finally, while there is a tendency to focus on what is easy to measure using existing data, we join various other scholars in arguing that it is critical to aim for assessments that actually measure what is important for achieving the targets set (e.g., Brockwell et al., 2022; McCool & Stankey, 2004). Ultimately, consistently linking education with sustainability in times of mounting unsustainability crises is closely connected to what education is fundamentally about: to empower learners to understand and address the key epochal problems of any given time (Klafki, 1996; Kvamme, 2021).

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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ENDNOTE

¹ https://www.agj.de/fileadmin/files/positionen/2021/AGJ-Discussion_Paper_How_dare_you.pdf.

REFERENCES

- Abson, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., von Wehrden, H., Abernethy, P., Ives, C. D., Jager, N. W., & Lang, D. J. (2017). Leverage points for sustainability transformation. *Ambio*, 46(1), 30–39. <https://doi.org/10.1007/s13280-016-0800-y>
- Agbedahin, A. V. (2019). Sustainable development, education for sustainable development and the 2030 agenda for sustainable development: Emergence, efficacy, eminence, and future. *Sustainable Development*, 27(4), 669–680. <https://doi.org/10.1002/sd.1931>

- Beveridge, D., McKenzie, M., Aikens, K., & Strobbe, K. M. (2019). A National Census of sustainability in K-12 education policy: Implications for international monitoring, evaluation, and research. *Canadian Journal of Educational Administration and Policy*, 188, 36–52.
- Biermann, F., Hickmann, T., S  nit, C.-A., Beisheim, M., Bernstein, S., Chasek, P., Grob, L., Kim, R. E., Kotz  , L. J., Nilsson, M., Ordo  ez Llanos, A., Okereke, C., Pradhan, P., Raven, R., Sun, Y., Vijge, M. J., van Vuuren, D., & Wicke, B. (2022). Scientific evidence on the political impact of the sustainable development goals. *Nature Sustainability*, 5(9), 795–800. <https://doi.org/10.1038/s41893-022-00909-5>
- Biermann, F., Kanie, N., & Kim, R. E. (2017). Global governance by goal-setting: The novel approach of the UN sustainable development goals. *Current Opinion in Environmental Sustainability*, 26–27, 26–31. <https://doi.org/10.1016/j.cosust.2017.01.010>
- Bormann, I., & Nikel, J. (2017). How education for sustainable development is implemented in Germany: Looking through the lens of educational governance theory. *International Review of Education*, 63(6), 793–809. <https://doi.org/10.1007/s11159-017-9683-9>
- Brent Edwards, D., Sustarsic, M., Chiba, M., McCormick, M., Goo, M., & Perriton, S. (2020). Achieving and monitoring education for sustainable development and global citizenship: A systematic review of the literature. *Sustainability*, 12(4), 1–57. <https://doi.org/10.3390/su12041383>
- Brock, A., De Haan, G., Etzkorn, N., & Singer-Brodowski, M. (Eds.). (2018). *Wegmarken zur Transformation—Nationales Monitoring von Bildung f  r nachhaltige Entwicklung in Deutschland*. Verlag Barbara Budrich.
- Brock, A., & Holst, J. (2022). Schl  ssel zu Nachhaltigkeit und BNE in der Schule: Ausbildung von Lehrenden, Verankerung in der Breite des F  cherkanons und jenseits der Vorworte. Kurzbericht des Nationalen Monitorings zu Bildung f  r nachhaltige Entwicklung (BNE). Freie Universit  t Berlin. <https://doi.org/10.17169/refubium-36094>
- Brockwell, A. J., Mochizuki, Y., & Sprague, T. (2022). Designing indicators and assessment tools for SDG target 4.7: A critique of the current approach and a proposal for an ‘Inside-out’ strategy. *Compare: A Journal of Comparative and International Education*, 1–19. <https://doi.org/10.1080/03057925.2022.2129957>
- Brundiers, K., Barth, M., Cebri  n, G., Cohen, M., Diaz, L., Doucette-Remington, S., Dripps, W. R., Habron, G., Harre, N., Jarchow, M. E., Losch, K., Michel, J., Mochizuki, Y., Rieckmann, M., Parnell, R. A., Walker, P., & Zint, M. (2021). Key competencies in sustainability in higher education—Toward an agreed-upon reference framework. *Sustainability Science*, 16(1), 13–29. <https://doi.org/10.1007/s11625-020-00838-2>
- Buckler, C., & Creech, H. (2014). *Shaping the future we want: UN decade of education for sustainable development (2005-2014). Final report*. UNESCO.
- Campagnolo, L., Eboli, F., Farnia, L., & Carraro, C. (2018). Supporting the UN SDGs transition: Methodology for sustainability assessment and current worldwide ranking. *Economics*, 12(1), 1–31. <https://doi.org/10.5018/economics-ejournal.ja.2018-10>
- Coburn, C. E. (2003). Rethinking scale: Moving beyond numbers to deep and lasting change. *Educational Researcher*, 32(6), 3–12. <https://doi.org/10.3102/0013189X032006003>
- Dalampira, E.-S., & Nastis, S. A. (2020). Mapping sustainable development goals: A network analysis framework. *Sustainable Development*, 28(1), 46–55. <https://doi.org/10.1002/sd.1964>
- De Haan, G. (2010). The development of ESD-related competencies in supportive institutional frameworks. *International Review of Education*, 56(2–3), 315–328. <https://doi.org/10.1007/s11159-010-9157-9>
- De Haan, G. (2021). Bildung f  r nachhaltige Entwicklung in Luxemburg: Eine Bestandsaufnahme. In LUCET & SCRIPT (Eds.), *Nationaler Bildungsbericht Luxemburg 2021* (pp. 211–225). Imprimerie Centrale.
- Destatis. (2023). Integration von ‘Global Citizenship Education’ und, Bildung f  r nachhaltige Entwicklung’ im Bildungswesen. Retrieved from <https://sdg-indikatoren.de/4-7-1/>
- Fischer, D., King, J., Rieckmann, M., Barth, M., B  ssing, A., Hemmer, I., & Lindau-Bank, D. (2022). Teacher education for sustainable development: A review of an emerging research field. *Journal of Teacher Education*, 73(5), 509–524. <https://doi.org/10.1177/00224871221105784>
- Fonseca, L. M., Domingues, J. P., & Dima, A. M. (2020). Mapping the sustainable development goals relationships. *Sustainability*, 12(8), 3359. <https://doi.org/10.3390/su12083359>
- Fredriksson, U., Kusanagi, N., Gougoulakis, P., Matsuda, Y., & Kitamura, Y. (2020). A comparative study of curriculums for education for sustainable development (ESD) in Sweden and Japan. *Sustainability*, 12(3), 1123. <https://doi.org/10.3390/su12031123>
- Gallwey, S. (2016). Capturing transformative change in education: The challenge of tracking Progress towards SDG target 4.7. *Policy and Practice: A Development Education Review*, 23, 124–138.
- Giangrande, N., White, R. M., East, M., Jackson, R., Clarke, T., Saloff Coste, M., & Penha-Lopes, G. (2019). A competency framework to assess and activate education for sustainable development: Addressing the UN sustainable development goals 4.7 challenge. *Sustainability*, 11(10), 2832. <https://doi.org/10.3390/su11102832>
- Gough, A. (2016). Teacher education for sustainable development: Past, present and future. In W. Leal Filho & P. Pace (Eds.), *World sustainability series. Teaching education for sustainable development at university level* (pp. 109–122). Springer International Publishing. https://doi.org/10.1007/978-3-319-32928-4_8
- Grund, J., & Brock, A. (2020). Education for sustainable development in Germany: Not just desired but also effective for transformative action. *Sustainability*, 12(2838), 1–20. <https://doi.org/10.3390/su12072838>
- H  k, T., Janou  skov  , S., & Moldan, B. (2016). Sustainable development goals: A need for relevant indicators. *Ecological Indicators*, 60, 565–573. <https://doi.org/10.1016/j.ecolind.2015.08.003>
- Hickel, J. (2019). The contradiction of the sustainable development goals: Growth versus ecology on a finite planet. *Sustainable Development*, 27(5), 873–884. <https://doi.org/10.1002/sd.1947>
- Holden, E., Linnerud, K., & Banister, D. (2017). The imperatives of sustainable development. *Sustainable Development*, 25(3), 213–226. <https://doi.org/10.1002/sd.1647>
- Holst, J. (2022). Nachhaltigkeit & BNE in der Beruflichen Bildung: Dynamik in Ordnungsmitteln, Potentiale bei Berufen, Lernorten und in der Qualifizierung von Auszubildenden. Kurzbericht des Nationalen Monitorings zu Bildung f  r nachhaltige Entwicklung (BNE). Freie Universit  t Berlin. <https://doi.org/10.17169/refubium-35827>
- Holst, J. (2023). Towards coherence on sustainability in education: A systematic review of whole institution approaches. *Sustainability Science*, 18(2), 1015–1030. <https://doi.org/10.1007/s11625-022-01226-8>
- Holst, J., Brock, A., Singer-Brodowski, M., & de Haan, G. (2020). Monitoring progress of change: Implementation of Education for Sustainable Development (ESD) within documents of the German education system. *Sustainability*, 12(10), 4306. <https://doi.org/10.3390/su12104306>
- Holst, J., Grund, J., & Brock, A. (in review). *Whole Institution Approach: Measurable and highly effective in empowering learners and educators for sustainability*.
- Holst, J., & Singer-Brodowski, M. (2022). Nachhaltigkeit & BNE im Hochschulsystem: St  rkung in Gesetzen und Zielvereinbarungen, ungenutzte Potentiale bei Curricula und Selbstverwaltung. Kurzbericht des Nationalen Monitorings zu Bildung f  r nachhaltige Entwicklung (BNE). Freie Universit  t Berlin. <https://doi.org/10.17169/refubium-35828>
- Huan, Y., Liang, T., Li, H., & Zhang, C. (2021). A systematic method for assessing progress of achieving sustainable development goals: A case study of 15 countries. *The Science of the Total Environment*, 752, 141875. <https://doi.org/10.1016/j.scitotenv.2020.141875>
- Ioannidou, A. (2010). Educational monitoring and reporting as governance instruments for evidence-based education policy. In S. K. Amos (Ed.), *International perspectives on education and society* (Vol. 12, pp. 155–172). Emerald. [https://doi.org/10.1108/S1479-3679\(2010\)0000012011](https://doi.org/10.1108/S1479-3679(2010)0000012011)

- Kim, R. E. (2023). Augment the SDG indicator framework. *Environmental Science & Policy*, 142, 62–67. <https://doi.org/10.1016/j.envsci.2023.02.004>
- Kioui, V., & Voulvoulis, N. (2019). Education for sustainable development: A systemic framework for connecting the SDGs to educational outcomes. *Sustainability*, 11(21), 6104. <https://doi.org/10.3390/su11216104>
- Klafki, W. (1996). *Neue Studien zur Bildungstheorie und Didaktik: Zeitgemäße Allgemeinbildung und kritisch-konstruktive Didaktik*. Beltz Verlag.
- Kolmos, A., Hadgraft, R. G., & Holgaard, J. E. (2016). Response strategies for curriculum change in engineering. *International Journal of Technology and Design Education*, 26(3), 391–411. <https://doi.org/10.1007/s10798-015-9319-y>
- Krah, J. M., Reimann, J., & Molitor, H. (2021). Sustainability in Brandenburg study programs. Perspectives for anchoring sustainability in higher education curricula. *Sustainability*, 13(7), 3958. <https://doi.org/10.3390/su13073958>
- Kvamme, O. A. (2021). Rethinking Bildung in the Anthropocene: The case of Wolfgang Klafki. *HTS Theologies Studies/Theological Studies*, 77(3), 1–9. <https://doi.org/10.4102/hts.v77i3.6807>
- Lingard, B. (2013). The impact of research on education policy in an era of evidence-based policy. *Critical Studies in Education*, 54(2), 113–131. <https://doi.org/10.1080/17508487.2013.781515>
- Marron, R. K., & Naughton, D. (2019). Monitoring Progress Towards SDG Target 4.7 in Europe: Proposed Framework and Tools.
- McCool, S. F., & Stankey, G. H. (2004). Indicators of sustainability: Challenges and opportunities at the interface of science and policy. *Environmental Management*, 33(3), 294–305. <https://doi.org/10.1007/s00267-003-0084-4>
- McKenzie, M., Bieler, A., & McNeil, R. (2015). Education policy mobility: Reimagining sustainability in neoliberal times. *Environmental Education Research*, 21(3), 319–337. <https://doi.org/10.1080/13504622.2014.993934>
- Meadows, D. H. (1997). Places to intervene in a system. *Whole Earth*, 91(1), 78–84.
- Nationale Plattform BNE c/o BMBF. (2017). Nationaler Aktionsplan Bildung für nachhaltige Entwicklung: Der deutsche Beitrag zum UNESCO-Weltaktionsprogramm. Retrieved from https://www.bmbf.de/bmbf/shareddocs/downloads/files/nationaler_aktionsplan_bildung_fuer_nachhaltige_entwicklung.pdf?__blob=publicationFile&v=2
- Nazir, J., Pedretti, E., Wallace, J., Montemurro, D., & Inwood, H. (2011). Reflections on the Canadian experience with education for climate change and sustainable development. *Canadian Journal of Science, Mathematics and Technology Education*, 11(4), 365–380. <https://doi.org/10.1080/14926156.2011.624673>
- Otto, I. M., Donges, J. F., Cremades, R., Bhowmik, A., Hewitt, R. J., Lucht, W., Rockström, J., Allerberger, F., McCaffrey, M., Doe, S. S. P., Lenferna, A., Morán, N., van Vuuren, D. P., & Schellnhuber, H. J. (2020). Social tipping dynamics for stabilizing Earth's climate by 2050. *Proceedings of the National Academy of Sciences of the United States of America*, 117(5), 2354–2365. <https://doi.org/10.1073/pnas.1900577117>
- Pham-Truffert, M., Metz, F., Fischer, M., Rueff, H., & Messerli, P. (2020). Interactions among sustainable development goals: Knowledge for identifying multipliers and virtuous cycles. *Sustainable Development*, 28(5), 1236–1250. <https://doi.org/10.1002/sd.2073>
- Richardson, K., Steffen, W., Lucht, W., Bendtsen, J., Cornell, S. E., Donges, J. F., Drüke, M., Fetzer, I., Bala, G., von Bloh, W., Feulner, G., Fiedler, S., Gerten, D., Gleeson, T., Hofmann, M., Huiskamp, W., Kumm, M., Mohan, C., Nogués-Bravo, D., et al. (2023). Earth beyond six of nine planetary boundaries. *Science Advances*, 9(37), adh2458. <https://doi.org/10.1126/sciadv.adh2458>
- Rieckmann, M., Mindt, L., & Gardiner, S. (2017). *Education for sustainable development goals: Learning objectives*. UNESCO.
- Rockström, J., Gupta, J., Qin, D., Lade, S. J., Abrams, J. F., Andersen, L. S., & Zhang, X. (2023). Safe and just earth system boundaries. *Nature*, 619(7968), 102–111. <https://doi.org/10.1038/s41586-023-06083-8>
- Sachs, J. D., Lafortune, G., Fuller, G., & Drumm, E. (2023). Implementing the SDG stimulus. In *Sustainable development report 2023*. Dublin University Press. <https://doi.org/10.25546/102924>
- Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., & Rockström, J. (2019). Six transformations to achieve the sustainable development goals. *Nature Sustainability*, 2(9), 805–814. <https://doi.org/10.1038/s41893-019-0352-9>
- Singer-Brodowski, M., Brock, A., Etzkorn, N., & Otte, I. (2019). Monitoring of education for sustainable development in Germany – insights from early childhood education, school and higher education. *Environmental Education Research*, 25(4), 492–507. <https://doi.org/10.1080/13504622.2018.1440380>
- Singer-Brodowski, M., von Seggern, J., Duveneck, A., & Etzkorn, N. (2020). Moving (Reflexively within) structures. *The Governance of Education for Sustainable Development in Germany*. *Sustainability*, 12(7), 2778. <https://doi.org/10.3390/su12072778>
- Singer-Brodowski, M., & Holst, J. (2022). Nachhaltigkeit & BNE in der Frühen Bildung: Chancen durch Partizipation und ökologische Kinderrechte, Bedarfe bei der Ausbildung von Fachkräften. Kurzbericht des Nationalen Monitorings zu Bildung für nachhaltige Entwicklung. <https://doi.org/10.17169/refubium-35735>
- Sinnes, A. T., & Eriksen, C. C. (2016). Education for sustainable development and international student assessments: Governing education in times of climate change. *Global Policy*, 7(1), 46–55. <https://doi.org/10.1111/1758-5899.12256>
- Spall, S. (1998). Peer debriefing in qualitative research: Emerging operational models. *Qualitative Inquiry*, 4(2), 280–292. <https://doi.org/10.1177/107780049800400208>
- Spangenberg, J. H. (2017). Hot air or comprehensive Progress? A critical assessment of the SDGs. *Sustainable Development*, 25(4), 311–321. <https://doi.org/10.1002/sd.1657>
- Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Ingo, F., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 348(6240), 1217–c. <https://doi.org/10.1126/science.aaa9629>
- Stepanek Lockhart, A. (2018). Monitoring ESD: Lessons learned and ways forward. In A. Leicht, J. Heiss, & W. J. Byun (Eds.), *Issues and trends in education for sustainable development* (pp. 215–231). United Nations Educational, Scientific and Cultural Organization.
- Sterling, S. (2003). *Whole systems thinking as a basis for paradigm change in education: Explorations in the context of sustainability* (PhD). University of Bath.
- Sterling, S. (2016). A commentary on education and sustainable development goals. *Journal of Education for Sustainable Development*, 10(2), 208–213. <https://doi.org/10.1177/0973408216661886>
- Tilbury, D. (2007). Monitoring and evaluation during the UN decade of education for sustainable development. *Journal of Education for Sustainable Development*, 1(2), 239–254. <https://doi.org/10.1177/097340820700100214>
- UNECE. (2005). *Indicators for education for sustainable development*. Progress report on the work of the Expert Group Retrieved from <https://unece.org/fileadmin/DAM/env/documents/2005/cep/ac.13/cep.ac.13.2005.9.e.pdf>
- UNECE. (2009). Learning from each other: The UNECE Strategy for Education for Sustainable Development ECE/CEP/159. Retrieved from <https://sdgs.un.org/sites/default/files/publications/798ece5.pdf>
- UNECE. (2022). Implementation of the UNECE strategy for ESD across the ECE region (2015–2018). Retrieved from https://unece.org/sites/default/files/2022-09/Implementation%20of%20the%20UNECE%20Strategy_web_final_05.09.2022.pdf

- UNESCO. (2017). Measurement Strategy for SDG Target 4.7: Proposal by GAML Task Force 4.7. Retrieved from GAML4/17 website: <http://uis.unesco.org/sites/default/files/documents/gaml4-measurement-strategy-sdg-target4.7.pdf>
- UNESCO. (2019a). Proposal for monitoring of SDG indicators 4.7.1, 12.8.1 and 13.3.1. TCG6/REF/14. Retrieved from United Nations Educational, Scientific and Cultural Organization website: <https://tcg.uis.unesco.org/wp-content/uploads/sites/4/2019/08/TCG6-REF-14-Proposal-for-monitoring-of-SDG-indicators-4.7.1-12.8.1-and-13.3.1.pdf>
- UNESCO. (2019b). TCG6/REF/4. SDG indicator 4.7.1: Proposal for a measurement strategy. Retrieved from United Nations Educational, Scientific and Cultural Organization website: <https://tcg.uis.unesco.org/wp-content/uploads/sites/4/2019/08/TCG6-REF-4-4.7.1-Proposal-for-measurement-strategy.pdf>
- UNESCO. (2020). *Education for sustainable development. A roadmap*. UNESCO.
- UNESCO. (2021). *Berlin declaration on education for sustainable development*. UNESCO.
- United Nations General Assembly. (2015). 70/1. Transforming Our World: The 2030 Agenda for Sustainable Development. Retrieved from http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E
- United Nations General Assembly. (2017). Education for sustainable development in the framework of the 2030 Agenda for Sustainable Development: Resolution 72/222.
- United Nations General Assembly. (2023). Political declaration of the high-level political forum on sustainable development convened under the auspices of the General Assembly A/HLPF/2023/L.1. Retrieved from https://hlpf.un.org/sites/default/files/2023-09/A%20HLPF%202023%20L1.pdf?_gl=1*krm5r*_ga*Mjc5NDQ5NDA4LjE2MDMxNDUzNDU.*_ga_TK9BQL5X7Z*MTY5NjM0NTIzNi4xMjEuMS4xNjk2MzQ3Nzk1LjAuMC4w
- Unterhalter, E. (2019). The many meanings of quality education: Politics of targets and indicators in SDG 4. *Global Policy*, 10(S1), 39–51. <https://doi.org/10.1111/1758-5899.12591>
- Van Poeck, K., Östman, L., & Block, T. (2020). Opening up the black box of learning-by-doing in sustainability transitions. *Environmental Innovation and Societal Transitions*, 34, 298–310. <https://doi.org/10.1016/j.eist.2018.12.006>
- Vladimirova, K., & Le Blanc, D. (2016). Exploring links between education and sustainable development goals through the lens of UN flagship reports. *Sustainable Development*, 24(4), 254–271. <https://doi.org/10.1002/sd.1626>
- Wals, A. E. J., & Benavot, A. (2017). Can we meet the sustainability challenges? The role of education and lifelong learning. *European Journal of Education*, 52(4), 1–10. <https://doi.org/10.1111/ejed.12250>
- Weiss, M., Barth, M., & von Wehrden, H. (2021). The patterns of curriculum change processes that embed sustainability in higher education institutions. *Sustainability Science*, 16(5), 1579–1593. <https://doi.org/10.1007/s11625-021-00984-1>
- Xiao, H., Liu, Y., & Ren, J. (2023). Synergies and trade-offs across sustainable development goals: A novel method incorporating indirect interactions analysis. *Sustainable Development*, 31(2), 1135–1148. <https://doi.org/10.1002/sd.2446>

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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8.1.2. Article 2: Holst (2023)

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Supplementary Material:

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Towards coherence on sustainability in education: a systematic review of Whole Institution Approaches

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Abstract

Orienting societies towards sustainability requires comprehensive learning of how to think, act and live within a safe and just space for humanity. Approaching sustainability as a core paradigm of quality education in the twenty-first century, Education for Sustainable Development necessitates an integrated view on learning. For educational organizations, Whole Institution Approaches (WIAs) to sustainability emphasize that all learning is embedded within its socio-physical contexts. Although the core objective—to “walk the talk” on sustainability—is theoretically well established, questions remain regarding its specific conceptualizations. Based on a systematic qualitative analysis of 104 international documents from scientific and grey literature, this article offers a conceptual synthesis of the core elements of WIAs to sustainability in education. Based on the literature analysis, WIAs are described as continuous and participative organizational learning processes aimed at institutional coherence on sustainability, consistently linking the formal and informal (hidden) curricula. While specific pathways are necessary for diverse organizations, the article synthesizes a joint framework. Key characteristics of WIAs are clustered within five core principles (*coherence, continuous learning, participation, responsibility, long-term commitment*), seven highly integrated areas of action (*governance, curriculum, campus, community, research, communication, capacity building*), the underlying organizational culture, and critical conditions for successful implementation. As becomes clear from the synthesis, following a WIA means to collaboratively switch the default mode of all rules-in-use to sustainability. The concept of WIAs may thus both be approached as an instrument for consistent organizational development in light of (un-)sustainability and as a keystone of integrated high-quality sustainability learning.

Keywords Whole institution approach · Whole school approach · Education for sustainable development · Institutional coherence · Hidden curriculum · Sustainability

Introduction

Rapidly accelerating changes in the Earth system (e.g. Steffen et al. 2015) have resulted in an unprecedented need for humanity to change its course of action. As Sterling (2016, p. 212) points out, a deeply rooted transformation towards sustainability—as aimed for in the Sustainable Development Goals (SDGs)—implies “an unprecedented and huge learning challenge at every level”. Aiming to empower *everyone*

with competencies, knowledge and values required to co-create a sustainable future (UNESCO 2014, 2021), Education for Sustainable Development (ESD) addresses this learning challenge. Responding to the imperative to rethink education systems in ways that empower people to navigate through the challenges of our time, a systemic implementation of ESD requires a redesign of policies, curricula and funding (*macro-level*), rethinking of goals, contents and didactics of learning situations (*micro-level*) as well as a transformation of learning environments within local communities and networks (*meso-level*). Specifically addressed in SDG 4.7, UNESCO describes ESD as “an integral element of the ambitious SDGs”, connecting “SDG 4 with all other SDGs” (UNESCO 2020, p. 14). In practice however, ESD is often approached as an “add-on” to other educational tasks (e.g. Benavot 2014; Wals and Benavot 2017), falling short of its transformative and cross-disciplinary ambition.

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One reason for this is that, while much attention has been focused on the development of competencies (e.g. Brundiers et al. 2021; Haan 2010; Rieckmann 2012) as well as the integration of ESD in education policy (e.g. in Germany, Singer-Brodowski et al. 2019; Holst et al. 2020), the consistent transfer of ESD into learning environments through whole system approaches within specific educational organizations remains a considerable challenge.

Acknowledging the critical importance of socio-physical environments for learning, UNESCO (2014, p. 18) dedicated a “Priority Action Area” of the Global Action Programme on ESD and its follow-up programme “ESD for 2030” to “Transforming learning and training environments”, calling for “whole-institution approaches to ESD in schools and all other learning and training settings”. Connecting the socio-physical contexts of learning with the learning processes, Whole Institution Approaches (WIAs) “encompass mainstreaming sustainability into all aspects of the learning environment” (Buckler and Creech 2014, p. 30). This means that aligning all functional components of educational organizations (e.g. campus management, curriculum design, or community partnerships) with sustainability becomes a core objective of organizational development. In terms of learning processes, WIAs directly link to the notion of “hidden” curricula, referring to “the divergence between what is overtly taught in educational institutions and what students actually learn” (Winter and Cotton 2012, p. 785 with reference to Jackson 1968). Such informal learning occurs, for example, through self-directed, unintended, and tacit learning outside of curricular planning (Livingstone 2001; Schugurensky 2000), e.g. when learners experience or co-shape the daily (un-)sustainable practices at an educational organization (see e.g. Hopkinson et al. 2008; Gramatakos and Lavau 2019).

Early references to WIAs can be found among others by Sterling (2003, p. 344), who describes sustainable institutions as institutions “attempting to be a reflective ‘microcosm of a sustainable society’”. While Sterling relates this to a general paradigm shift in education (e.g. Sterling 2001, 2003), Henderson and Tilbury (2004) take a pragmatic approach in systematizing approaches by certification programmes for eco-schools, highlighting key components in school education (SE), e.g. curriculum links, funding and management, partnerships, or professional development (ibid.). Related discourses can also be found in other areas of education (e.g. on higher education (HE), McMillin and Dyball 2009; Kohl et al. 2021), which are jointly referred to here as WIAs. Yet, though the main objective of WIAs—“living what we learn” (Buckler and Creech 2014, p. 89)—is well established as one of the core concepts in ESD, it is repeatedly being diagnosed that organizations who systematically follow a WIA are still scarce (e.g. Wals 2012; Hargreaves 2008) and, that compartmentalized

approaches—i.e. developing only specific parts of educational organizations in line with sustainability—are often preferred to more holistic and integrative approaches (in HE, McMillin and Dyball 2009; Lozano et al. 2015). Moreover, the term “WIA” is used in a variety of ways (e.g. in guidelines, reports, or articles) across all areas of education (from early childhood and school education to vocational and higher education and non-formal/informal learning). At present, no systematic conceptual synthesis of the core characteristics of the approaches in-use across these different contexts seems to exist. As such, there is a lack of clarity on whether the concepts in-use are convergent and, what policy decisions and further research would be useful to strengthen WIAs in practice. Keeping in mind that organizations require context-specific pathways towards sustainability, this review responds to this gap: in systematically assessing the international literature on WIAs, the article provides an overview of the conceptual debate on WIAs, and synthesizes core characteristics as well as conditions for successful implementation in a joint framework.

Materials and methods: systematic qualitative literature analysis

Literature search

The inclusion of documents for systematic analysis was carried out in five steps. First, a standardized literature search was conducted, using a Boolean operator to identify sources from *Web of Science* (206 results) and *ERIC* (Education Resources Information Center; 119 results) (November 2020): “ALL=((“whole school” OR “whole-school*” OR “whole institution” OR “whole-institution*” OR “whole System” OR “whole-system*”) AND (“education”) AND (“sustainable” OR “sustainability”))”. Secondly, doubles were deleted and two mutually inclusive content-related criteria were applied during abstract screening: (i) *content related to sustainability* and (ii) *content related to design and/or development of educational organizations*. 71 articles fulfilled both criteria, of which 65 were digitally available (formal criterion due to the digital analysis). Thirdly, an online search was conducted (Google) to screen for grey and further relevant scientific literature, using two sets of keywords: “Whole Institution Approach Education for Sustainable Development” and “Whole School Approach Education for Sustainable Development”, resulting in an addition of 36 documents (first three result-pages, archived). During analysis, 16 documents were fourthly added based on in-text citations, and 13 sources were excluded in a fifth step as they did not fulfil the above-mentioned criteria in the full texts or, because they constituted specific action plans. In total, 104 documents were analysed (65 + 36 + 16 – 13). As

only documents in English were considered due to language constraints, further research may focus on how WIAs are referred to differently across the globe. A list of all documents with further information is provided in the supplementary material (S1).

Qualitative analysis

Tailoring the approach of qualitative content analysis (Kuckartz 2014, 2019) to the literature analysis, a rule-bound procedure was developed to systematically analyze the 104 retrieved documents, differentiating between three steps: preparation, inductive coding and clustering, and consolidation (Fig. 1). In preparation (1), units of analysis were defined, namely concepts related to implementing a WIA, which were assessed through identification and description of thematic categories (see Kuckartz 2014, 2019) at different levels. For analysis, all material was inductively coded (2), implying that codes in MAXQDA pool text segments referring to similar or the same concepts. Through clustering in different abstraction levels, a system of nested thematic categories results from the content analysis (e.g. categories for different areas of action/core principles of WIAs, facets and sub-facets therein). After coding and clustering, all text segments were reassessed, recoded and reorganized (3) to strengthen the internal conceptual consistency of the framework. As part of this second round of coding, also doubles were eliminated, and boundaries of categories defined. Definitions were developed based on the primary literature for each category representing a concept, which serve as the basis for reporting in the results section.

Expert review

While the literature analysis followed a systematic and rule-bound procedure, it was conducted by one researcher only. A written expert review (Olson 2010; Artino et al. 2014) was used to further substantiate the conceptual validity and comprehensiveness of the findings. Ten high-profile experts

on ESD and WIAs were invited to participate in the online survey (nine participated), representing different sectors from one exemplary national education system (Germany): politics, administration (ministries), education practice (secondary school, higher education), academia (researchers on ESD in school and higher education), and youth participation. While experts from Germany were consulted, the review followed the literature analysis in focusing on the overall concept of WIAs. For review, the concepts from the literature analysis were translated into 53 statements, each starting with “*At our educational organization, ...*”. Each statement was assessed by the experts using a five-point Likert scales on (1) how well it represents the underlying concept (*representativeness*) and (2) how relevant it is for WIAs and their assessment (*relevance*). Additionally, the experts were asked after each thematic category and at the end of the survey whether important aspects were missing (*comprehensiveness*). Across all 53 facets, the expert review showed very high mean scores for relevance (4.68; SD = 0.26) and representativeness (4.66; SD = 0.23). While the experts saw the relevant concepts covered and suggested no changes at the level of thematic categories (areas of action, core principles; see results), few facets were added based on the feedback (e.g. foci on inclusive communication, mental health). For details on the national context of the explorative expert review, the used scales, mean responses and the list of revised statements, see the supplementary material (S2).

Results: conceptual synthesis of Whole Institution Approaches

In the following, the conceptual synthesis of the literature on WIAs is reported upon, providing exemplary references. After a short descriptive overview of the data (“[International literature on WIAs: descriptive overview](#)”), a framework for WIAs is introduced (“[Towards organizational sustainability: introducing the WIA-framework](#)”) and laid out within

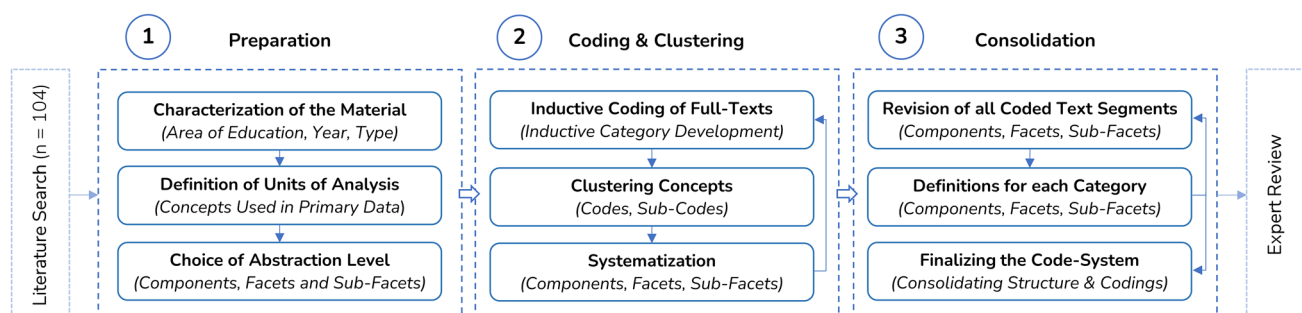


Fig. 1 Three steps of the systematic procedure for qualitative analysis of the international literature on whole institution approaches (based on Kuckartz 2014, 2019)

three main chapters on the core principles of WIAs (“[Core principles](#)”), organizational areas of action (“[Jointly towards sustainability: integrated organizational areas of action](#)”), and the underlying organizational culture (“[Organizational culture](#)”). Subsequently, critical conditions for successful WIAs are highlighted (“[External conditions: priority in policy, funding and access to expertise](#)”). The results end with a synthesis (“[Synthesis: conceptual framework for WIAs to sustainability](#)”), including an illustrative overview of the conceptual framework for WIAs.

International literature on WIAs: descriptive overview

Of the 104 assessed documents, 83 were classified as scientific literature (journal articles, chapters, project reports), and 21 as grey literature (reports, frameworks, guidelines, handbooks). Regarding areas of education, 50% primarily referred to SE, 34.6% to HE, and 12.5% set an overarching focus (e.g. UN reports). With one document each primarily focusing on early childhood education and non-formal education, and no documents with specific focus on vocational education and training, these areas of education seem under-represented in the current international discourse. While the numbers point to a strong concentration on SE and HE, it should also be noted that cross-references were made to other areas (e.g. non-formal organizations as partners) and that different wordings for WIAs may be used in different contexts (Didham and Ofefi-Manu 2018). Regarding date of publication (range 1999–2020), an overall increase was observed with over half (57.7%) of all documents having been published since the start of the Global Action Programme on ESD in 2015. In summary, the literature primarily focuses on SE and HE and, considering the increase in publications, some of the findings may be subject to change as the discourse evolves.

Towards organizational sustainability: introducing the WIA framework

As a starting point, it is recurrently described that WIAs aim at “mainstreaming sustainability into all aspects of the learning environment” (Buckler and Creech 2014, p. 30) through a systematic, strategic, and holistic process (similarly e.g. UNESCO 2017; Rieckmann et al. 2017; Henderson and Tilbury 2004; Hargreaves 2008; Ferreira et al. 2006). In approaching sustainability as a fundamental paradigm of education (Sterling 2003), organizations which implement a WIA seek to enhance the overall sustainability-related learning experience (e.g. Breiting et al. 2005; McMillin and Dyball 2009). Integrating the socio-physical context into sustainability learning, WIAs imply that particular attention is put on the informal learning processes within

organizations, regularly described as “non-formal”, “hidden”, “shadow”, or “living” curriculum (e.g. McMillin and Dyball 2009; Shallcross et al. 2006; Henderson and Tilbury 2004). Through WIAs, informal and formal learning is consistently connected within a sustainable organizational environment, both contributing to sustainable learning (process) and practice (output and impact). Described as processes of “whole system redesign” (Wals and Benavot 2017, p. 6, reference to Sterling), WIAs adopt a holistic approach to sustainability in organizational development (e.g. Mogren et al. 2019). In this sense, Birney and Reed (2009, p. 23) describe the practice in SE as “not about adding on to what they [schools] do already but about changing and reordering the relationships between learning, leadership and change that are being created for sustainability in pupils, schools and community”. In line with Sterling (e.g. 2003), WIAs may therefore be considered as the organizational manifestation of an integrative view on sustainability in education. In practice, this takes shape “in a variety of ways, differing from place to place” (UNESCO 2012, p. 46), given that every organization is grounded within specific social, cultural, environmental, and economic contexts.

Keeping in mind that various pathways are possible towards WIAs, the following sections provide an overview of the key characteristics highlighted in the international literature. Based on the nested system of thematic categories inductively developed as part of the content analysis and refined after the expert review, the characteristics of WIAs are clustered within five core principles, seven organizational areas of action, the underlying organizational culture, and conditions for successful WIAs. After the five core principles (coherence, continuous learning, participation, responsibility, long-term commitment) are introduced, the following seven organizational areas of action are laid out:

- Governance
- Curriculum and formal learning
- Operations and campus management
- Community and networks
- Research (in higher education)
- Human capacity building
- Communication

While an overview is provided for each component independently, it is important to note that their introduction follows no specific order given that in practice the boundaries are not sharp—instead, their overlaps and interactions are a key feature of WIAs. After each individual component of the framework is introduced, the last section of the results synthesizes the core results and provides an illustrative overview of the overall framework.

Core principles

Coherence

Referred to with various wordings, institutional *coherence* (to "walk the talk"/"live what is learned") may be considered as *the core* of WIAs (similarly, e.g. McKeown and Hopkins 2007; Mogren et al. 2019; UNESCO 2020; Whitby 2019; Ferreira et al. 2006). Implying that individuals learn "from the entire experience (...), not just from what is taught within the classroom-walls" (McMillin and Dyball 2009, p. 63), coherence relates to a process of consistently integrating the different subsystems, components or elements of institutions (e.g. Giesenbauer and Müller-Christ 2020; DCSF 2009). One way to describe this is to assess the interconnectedness of different components within educational organizations (e.g. Warner and Elser 2015). Among others, this includes consistency between formal, non-formal and informal sustainability learning inside and outside of classrooms (e.g. Shallcross et al. 2007; Shallcross and Robinson 1999; McMillin and Dyball 2009; UNESCO 2012; Birney and Reed 2009). Through this, it is suggested that "the institution itself functions as role model" (Rieckmann 2018, p. 46) for sustainability within all of its practices (e.g. McMillin and Dyball 2009; Shallcross et al. 2006; Whitby 2019; McKeown and Hopkins 2007; Gibb 2016).

Continuous learning

Implementing a WIA implies a *continuous learning process* for the organization and its internal and external stakeholders. As such, educational organizations are viewed as learning organizations (e.g. Shallcross and Robinson 1999; Sterling 2003; Breiting et al. 2005), learning communities (e.g. Potter 2007), dynamic (e.g. Koester et al. 2006; Beringer and AdomBent 2008) or living systems (e.g. Kensler 2012; Kensler and Uline 2019), and as facilitating learning for everyone (e.g. Birney and Reed 2009). Understanding sustainability as much as a process as an outcome (e.g. Bosevska and Kriewaldt 2020; Mathar 2013; Mogren et al. 2019), WIAs not only point to what an "institution does, but also what it is trying to become" (Scott 2015, p. 952). This implies continuous collaborative redesign, improvement (Gough 2006) and adaptation according to capacities and needs (Schröder et al. 2020) at a rate which considers an institution's inherent "ability to change" (Gough and Sharpley 2005, p. 12).

Participation (organizational capacity)

In terms of an organizational capacity, *participation* implies that an organization functions in a way that all individuals, regardless of their role, are "encouraged and enabled" (Fischer et al. 2015, p. 792) to participate in

design, decision-making, implementation, monitoring, and readjustment of sustainability-related efforts. In this, WIAs are described as aiming for an inclusive and equality-oriented learning environment (e.g. UNESCO 2020; SEdA 2007), providing a "welcoming atmosphere that values everyone's participation and contributions—irrespective of background, culture, age, religion or ability—and challenge[s] prejudice and injustice in all its forms" (DCSF 2009, p. 63). Apart from learners, this refers to teaching and non-teaching staff as well as families (e.g. in SE) and partners in the community. Regarding student participation, it implies sharing ownership over the process (Breiting et al. 2005), which empowers learners for agency (e.g. McMillin and Dyball 2009; O'Donoghue et al. 2018). Authentic participation thereby means both real opportunity for needs, interests and contributions (e.g. Schröder et al. 2020; Shallcross et al. 2007) and, at the same time, transparency and honesty about levels of power and responsibility to manage expectations and avoid frustrations (e.g. Gibb 2016).

Responsibility (of individuals)

While participation refers to the capacity of an organization to enable and encourage stakeholders to be part of a process of change, *responsibility* (of individuals) refers to the notion that engagement for sustainability is necessary not only by a single or a few individuals (e.g. a principle, engaged learners or educators), but by various actors within the organizational community (e.g. Henderson and Tilbury 2004; Birney and Reed 2009; Ferreira et al. 2006; UNESCO 2012; Whitby 2019). In this sense, responsibility can be viewed as an individual complement to the organizational capacity to facilitate participation by pointing out that, if an organization is to become sustainable, members of the organizational community also have a responsibility to jointly act for it.

Long-term commitment

Long-term commitment to change towards sustainability was synthesized from the literature as a fifth core principle (e.g. Pittman 2004; Koester et al. 2006; Goldman et al. 2018; Hargreaves 2008). While sustainability by definition requires committed long-term effort, WIAs are described not only to need time and patience, but also flexibility, creativity and, to some extent, risk-taking (Birney and Reed 2009). While transformative actions are required to trigger systemic changes at all levels, Davis and Ferreira (2009, p. 60) also argue that "deep and wide change is more likely to be evolutionary rather than revolutionary, taking into account the complexities of educational settings".

Jointly towards sustainability: integrated organizational areas of action

Reporting on the main conceptual clusters from the international literature, the following sections introduce seven different but highly integrated organizational areas of action for WIAs.

Governance

In terms of coordination, an active interplay between bottom-up change processes and supportive top-down structures is viewed critical for WIAs (e.g. Bohunovsky et al. 2020; Barrett et al. 2019; Shallcross et al. 2006). While top-down support and engagement is important for systemic change (e.g. Whitby 2019; Henderson and Tilbury 2004; Gough and Sharpley 2005), leadership and institutional agency may be distributed collaboratively and in decentral ways (e.g. Birney and Reed 2009), strengthening ownership and responsibility of stakeholders. In this, a participatory integration of mostly all relevant stakeholders is seen as vital to WIAs (e.g. Niedlich et al. 2020; Sterling 2003; UNESCO 2017; Gibb 2016). In fostering democratic and distributed decision-making (e.g. Henderson and Tilbury 2004; Higgs and McMillan 2006; Sterling 2003; Whitby 2019; Tilbury and Wortman 2005), organizations may cultivate a sense of participative leadership for SD and divide tasks across groups of stakeholders (e.g. Mathar 2016; Birney and Reed 2009). To organize this, multi-stakeholder SD steering bodies are suggested, including committees, working groups or councils (e.g. Birney and Reed 2009; Farinha et al. 2020; Ferreira et al. 2006; Henderson and Tilbury 2004; WWF 2011), which should ideally be supported by designated employees (e.g. coordinators, sustainability offices) as permanent facilitators (e.g. McMillin and Dyball 2009; Gibb 2016; Ferreira et al. 2006; Niedlich et al. 2020).

Governance instruments As an early milestone, organizations may anchor sustainability and ESD within their vision and mission statement (e.g. Lozano et al. 2015; Mogren and Gericke 2019; Breiting et al. 2005; DCSF 2009). According to the literature, such vision should ideally be jointly developed, agreed upon, and shared by and with as many stakeholders as possible (e.g. UNESCO 2014; Birney and Reed 2009; WWF 2011; Henderson and Tilbury 2004), among others, to make sure it becomes context specific to the "history, culture and needs" of an organization and its community (Gibb 2016, p. 5). Likewise, an integration of sustainability is suggested within various further institutional policies such as strategic, improvement or development plans (Gibb 2016; WWF 2011; DCSF 2009; SEdA 2007), declarations and public statements (e.g. Pittman 2004; Lozano et al. 2015; Aleixo et al. 2018) or guidelines and codes of conduct (e.g. Aleixo et al. 2018; Gibb 2016),

ideally with binding character (Niedlich et al. 2020). Outlining "commitment to sustainability goals and direct areas for action" (Henderson and Tilbury 2004, p. 36), such policies may have both internal ("motive for reflection and innovation") and external effects ("clear future-oriented profile") (Breiting et al. 2005, p. 34 on SE). Also, comprehensive sustainability audits play a critical role (e.g. UNESCO 2017; Henderson and Tilbury 2004; WWF 2011; Tilbury and Wortman 2005), providing a valuable basis for goal-setting and future evaluations, and may ideally be performed collaboratively (e.g. Birney and Reed 2009; Breiting et al. 2005). Sustainability plans and action plans are suggested to organize the process of comprehensively integrating SD and ESD (e.g. Gibb 2016; Henderson and Tilbury 2004; WWF 2011; UNESCO 2017). Lastly, critical collaborative internal as well as external monitoring and evaluation of goals and activities are important for WIAs (e.g. Mathar 2016; Henderson and Tilbury 2004; O'Donoghue et al. 2018), enabling organizations to reflect on actions, review on-going progress, celebrate successes and derive new goals.

Curriculum and formal learning

For consistent sustainability learning, *curricula* need to reflect "knowledge, skills, perspectives and values related to sustainability" (UNESCO 2012, p. 46). While national curricula are typically not influenced by individual organizations, they have (varying) degrees of freedom regarding institutional curricula. Instead of approaching ESD as an "add-on" or "bolt-on" to some subjects or courses (see Benavot 2014), the literature on WIAs calls for a cross-cutting and cross-disciplinary integration of ESD (e.g. Laurie et al. 2016; Shallcross et al. 2007; Hargreaves 2008; Henderson and Tilbury 2004; SEdA 2007; DCSF 2009), strengthening also the interconnectedness between disciplines (e.g. Warner and Elser 2015; Breiting et al. 2005; Shallcross and Robinson 1999). Fostering real-world and place-based sustainability learning, organizations following a WIA attempt to link learning to all other activities, e.g. campus management, community engagement, research (in HE), or governance (e.g. McMillin and Dyball 2009; Simovska and Prøsch 2016; Buckler and Creech 2014; Wals and Benavot 2017). In terms of participation, some authors also view institutional curricula as an opportunity for co-design with learners (examples in Block et al. 2016; Shallcross et al. 2007), non-teaching staff and community partners.

Learning processes As the educational concept of ESD is elaborated upon elsewhere (e.g. Vare and Scott 2007; Rieckmann et al. 2017; Leicht et al. 2018), this section solely focuses on aspects highlighted in the literature on WIAs. Among others, learning is here described as holistic (e.g. Mogren et al. 2019), e.g. implying that it is consistently embedded within the socio-physical context (hidden

curriculum) and, that the different cognitive, emotional and social aspects of learning are viewed as integrated (e.g. Badjanova and Iliško 2015). Offering a place of experimental and engaged learning *as* sustainable development (e.g. Buckler and Creech 2014; McMillin and Dyball 2009; Rieckmann 2018), organizations act as a facilitating environment for transformative learning. As an action-oriented (e.g. O'Donoghue et al. 2018; Rieckmann 2018) and situated process (e.g. O'Donoghue et al. 2018; Shallcross et al. 2006), learning in WIAs is implanted in contexts familiar to the learners (O'Donoghue et al. 2018), building upon practical real-world experiences (e.g. UNESCO 2012; DCSF 2009) as well as local and place-based sustainability issues (e.g. Birney and Reed 2009; Shallcross and Robinson 1999). As such, it involves problem and project-based learning (Kensler and Uline 2019; Warner and Elser 2015), in which learners may instigate real-world changes (e.g. Lewis et al. 2014; Shallcross et al. 2007; Potter 2007). Highlighting the role of participation (Sterling 2003; Potter 2007; Rieckmann et al. 2017; Henderson and Tilbury 2004), learning itself is viewed as co-designed between learners and educators, implying a shift "from doing to students, to doing with students" (Kensler and Uline 2019, p. 1202). In this, instruction is "replaced by co-construction between students, teachers, parents, partner and experts from outside schools" (Mathar 2013, p. 1). The educator takes on a role of a facilitator (e.g. UNESCO 2020), acting as a "mediator of co-engaged learning" (O'Donoghue et al. 2018, p. 118), requiring a close learner–educator relationship (e.g. Higgs and McMillan 2006), in which "learners and educators jointly figure out and address solutions together" (O'Donoghue et al. 2018, p. 131).

Operations and campus management

For operations and campus management, WIAs imply strongly reducing the use of resources (e.g. waste, water, energy) (e.g. Henderson and Tilbury 2004; Lozano et al. 2015; Gough and Sharpley 2005; Gibb 2016; Whitby 2019) by means of sufficiency, efficiency and consistency, including both changes in behaviour and the use of sustainable technologies and materials. To reach targets such as net-zero emissions, sustainability in operations and campus management spans across all fields of action (e.g. buildings, grounds, mobility, procurement). Aside from drastically reducing the environmental footprint, it includes social aspects, e.g. to foster inclusiveness, diversity and equality (Lozano et al. 2015), as well as physical and psychological well-being (e.g. Posch 1999; Kensler 2012; DCSF 2009). As an example, sustainable procurement (e.g. Fischer et al. 2015; Sterling 2003; SEdA 2007) implies a consequent use of socially and environmentally responsible products (e.g. eco, fair trade, local, see e.g. Aleixo et al. 2018, UNESCO

2012, 2020, Gibb 2016, Buckler and Creech 2014), and overall reduced consumption.

Given that the "learning experience of students is influenced by more than what is taught in the classroom" (McMillin and Dyball 2009, p. 58) and that educational organizations have a socializing effect on learners through informal learning (e.g. Barth et al. 2012), the socio-physical environment of learning is critical for coherent sustainability learning. Therefore, organizational structures can be considered as "facilities that teach sustainability practices" (SEdA 2007, p. 4), offering a learning laboratory for sustainability (e.g. McMillin and Dyball 2009; Gibb 2016). In the context of HE, McMillin and Dyball (2009) suggest linking the curriculum with research and operations as a way to engage students as stakeholders, who take ownership over the process of learning sustainability. Similarly, other authors suggest that learners may directly be involved in or even to some extent in charge of sustainable operations (Higgs and McMillan 2006; Shallcross et al. 2007; McMillin and Dyball 2009). In short, operational activities are described in the literature as an opportunity for real-world sustainability learning.

Community and networks

Realizing WIAs, educational organizations actively engage in partnerships and networks with diverse (cross-)regional stakeholders (e.g. NGOs, businesses, authorities, individuals), involving "members of the community and their enthusiasms in situated real-world issues" (Sterling 2003, p. 343). Through such embeddedness, communities may become co-learning grounds for sustainability (e.g. Gibb 2016; Shallcross et al. 2006), allowing for learners to develop both "meaningful relationships with their immediate environment" and "the skills to design and implement solutions to the problems they may encounter there" (McMillin and Dyball 2009, p. 62; ref. to Orr 1992). Organizations following a WIA are considered "active in the society" and "recognized as relevant stakeholders in the development of the community" (Breiting et al. 2005, p. 42). Not only referring to solely educational collaboration, but also transfer activities in HE (e.g. Nölting et al. 2020), community cooperation is described as two-way engagement and co-learning (e.g. Henderson and Tilbury 2004; Tilbury and Wortman 2005). Such learning and contribution implies a reciprocal process (e.g. Warner and Elser 2015; Nölting et al. 2020) based on dialogue and focused on real-life action along real-world challenges (e.g. Gibb 2016; Rieckmann et al. 2017; Whitby 2019; Rieckmann 2018). Often manifested through collaborative projects (e.g. Koester et al. 2006; Mathar 2016), two-way collaboration may also lead to shared visioning (e.g. Henderson and Tilbury 2004; Rieckmann 2018). While Davis and Ferreira (2009) and Ballantyne and Packer (2006)

recognize the role of external programs, both suggest that network-based approaches (power-sharing, capacity-building, integration into institutional curricula) would be beneficial to holistic ESD. From a bird's-eye perspective, this may be described as a learning network (e.g. O'Donoghue et al. 2018), which facilitates practice-based co-learning, empowering learners and partners as agents of change (Rieckmann et al. 2017). Using similar terminology, Mathar (2016, p. 403) refers to "local learning landscape[s]", where learning is situated outside the boundaries of the organization (Henderson and Tilbury 2004). Here, networks are not only viewed as vital support structures for organizations in "navigating their way through change" (Shallcross et al. 2006, p. 295), but also help to avoid duplication of resources, or open up access to new ones (e.g. Davis and Ferreira 2009; Gough and Sharpley 2005; Henderson and Tilbury 2004). Also, networks with other organizations of the same type (e.g. schools, universities) are described as essential (e.g. Giesenbauer and Müller-Christ 2020; Kahle et al. 2018; Henderson and Tilbury 2004), among others, for mutual support, peer-to-peer learning, and to expand the visibility of WIAs "as a model for adaptation" (UNESCO 2014, p. 35).

Research (in higher education)

As Sterling (2003, p. 343) puts it, HE institutions following a WIA aim to "develop an ethical and responsible research agenda", considering sustainability as an important factor in research projects, publications, and the way in which knowledge is generated. Vogt and Weber (2020, p. 17) even argue that it is the responsibility of free and autonomous science to act as agents of change towards sustainability, given that "universities are part of the problem and part of the solution" (ibid.). In practice, a focus on sustainability in research requires structural changes (e.g. in funding, departments, incentives), and often involves new collaborations and partnerships (Fischer et al. 2015; Lozano et al. 2015; Aleixo et al. 2018). Apart from approaching sustainability as a cross-disciplinary compass, HE institutions may actively conduct research activities on sustainability and ESD (e.g. Bohunovsky et al. 2020; Fischer et al. 2015) and, for example, set up new research units to institutionalize these efforts (e.g. Aleixo et al. 2018; Lozano et al. 2015). Given the complex embeddedness of SD into social processes, inter- and transdisciplinary approaches are particularly described as fundamental for SD (e.g. Aleixo et al. 2018; Giesenbauer and Müller-Christ 2020). Yet, Giesenbauer and Müller-Christ (2020, p. 12) also point out that "not all subsystems have to embrace complexity and transdisciplinary research", stressing that different types of research require different

approaches. Regarding the integration of research and learning, it is widely suggested to more strongly involve students within research processes (e.g. McMillin and Dyball 2009; Giesenbauer and Müller-Christ 2020).

Human capacity building

Having designated a priority action area of the global ESD programs on building capacity of educators, UNESCO (2020, p. 30) stresses that "[e]ducators remain key actors in facilitating learners' transition to sustainable ways of life". Yet, they themselves "need to be empowered and equipped with the knowledge, skills, values and behaviours that are required for this transition" (ibid.). While professional development of staff and leadership on ESD and SD is considered decisive (e.g. Kadji-Beltran et al. 2014; Henderson and Tilbury 2004; Shallcross et al. 2006; Rieckmann 2018; Mathar 2016; SEa 2007), many have not yet been involved in such training (e.g. Amado et al. 2017; Rieckmann et al. 2017) and systematic provision of professional development programs on ESD is still lacking globally (e.g. Gough 2016). Such training focuses particularly on competencies, knowledge and attitudes as well as practical experience with regard to ESD (e.g. UNECE 2012; UNESCO 2020; Rieckmann et al. 2017), enabling educators to transfer (E)SD into practice (e.g. DCSF 2009; Ferreira et al. 2006; Henderson and Tilbury 2004). Aside from cognitive skills, emphasis may be put on emotional competencies, which are fundamental to facilitate a motivational and empowering institutional climate (e.g. Schröder et al. 2020). Also, programmes may focus on facilitating active reflection on pedagogical practices and self-conceptions (e.g. Ferreira et al. 2006; UNECE 2012), given that educators act as role models (e.g. Higgs and McMillan 2006), coaches and/or change agents (e.g. Laurie et al. 2016; Henderson and Tilbury 2004), empowering learners to become agents of change themselves (e.g. Shallcross et al. 2006; Wals 2012). For such professional development, sufficient time needs to be allocated (e.g. Henderson and Tilbury 2004; Amado et al. 2017), and organization-specific trainings are suggested for context-specific learning (e.g. in SE, Shallcross et al. 2006). Yet, exchange between practitioners is also referred to as critical for collaborative peer-to-peer learning (e.g. Kadji-Beltran et al. 2014; UNESCO 2020), e.g. through mentoring-systems (Kadji-Beltran et al. 2014) or in networks (e.g. Ferreira et al. 2006; Wals 2012).

Aside from professional development, the literature addresses various aspects related to the management of human resources (HR). For example, SEa (2007, p. 2) summarizes: (i) integration of ESD-competencies in appraisals and hiring, (ii) development of HR policies that "support

ESD capacity building, mentoring, collaborative and life-long learning”, (iii) celebration of diversity and (iv) recognition for staff who show leadership with regard to (E)SD. While these aspects target either individuals outside (to be hired) or inside an institution (e.g. staff support, recognition), Gibb (2016) also mentions the importance to involve recently hired staff into the process. Moreover, WIAs also imply a deliberate focus on social sustainability, e.g. through support systems and initiatives for healthy lifestyles (e.g. Aleixo et al. 2018). Regarding quality working conditions, the literature addresses the availability of high-quality teaching materials and guides (e.g. Mathar 2013; SEdA 2007; Buckler and Creech 2014), and sufficient space and time for reflection and clarification (e.g. Gibb 2016; Breiting et al. 2005; Warner and Elser 2015) as well as support for educators (e.g. Warner and Elser 2015; Henderson and Tilbury 2004).

Communication

Communication is considered a critical and highly integrated cornerstone of WIAs. For example, Awuzie and Abuzeinab (2019, p. 14) conclude from assessing the relationship between organizational factors in HE that “the absence of the effective communication of SD will serve to undermine all the other efforts”. Yet in practice, communication within organizations and towards the outside faces various difficulties. Based on a case study in HE, Djordjevic and Cotton (2011, p. 386) point to a number of issues such as contested definitions of sustainability, conflicts with the organizations mission, and resistance towards change as well as different values, needs, and expectations. Grounded in a review of literature, the authors recommend that communication on SD (i) “must be clear, precise and coherent, yet tailored to the different contexts of recipients”, providing and following a “working definition of sustainability”, (ii) requires high-level support, yet at the same time follows a dialogical and democratic approach and (iii) should be “highly consistent” and supportive for the specific change processes at a given institution (ibid.:392). Also, as pointed out during the expert review, organizations following a WIA may put attention to inclusive communication (e.g. gender neutral, simple language). Practically, it is highlighted in the literature across different areas of education that organizations who follow a WIA foster visibility and transparency of SD activities (e.g. Bauer et al. 2020; Higgs and McMillan 2006; Lozano et al. 2015), both internally and towards the public. Such visibility, i.e. showing sustainability as a core feature of an organization (e.g. Niedlich et al. 2020) not only attracts partners and students (e.g. Bauer et al. 2020), but the sharing of results and lessons learned is also suggested

to foster participation and awareness (Bauer et al. 2020), build accountability, bring about commitment (Awuzie and Abuzeinab 2019), and motivate further action (Gibb 2016). In terms of active interaction with stakeholders, Breiting et al. (2005, p. 37) suggest on SE that it is “important that all the members of the school community are aware of their mission and their contribution”, pointing to their importance for sustainability practice. Aside from sharing vision and progress (e.g. Gough and Sharpley 2005; Henderson and Tilbury 2004; SEdA 2007), this involves strengthening effective internal communication (e.g. Djordjevic and Cotton 2011; Warner and Elser 2015).

Organizational culture

Strongly affected by and affecting all core principles (“Core principles”) and areas of action (“Jointly towards sustainability: integrated organizational areas of action”), aligning the organizational culture (shared beliefs and values, social rules-in-use) with sustainability is at the core of WIAs. Yet though various authors refer to its importance for WIAs (Warner and Elser 2015; Pittman 2004; Roos et al. 2020; Ferreira et al. 2006), fewer sources address specific dispositions of an organizational culture in line with sustainability (e.g. for HE, Bauer et al. 2020; Niedlich et al. 2019). In the context of WIAs, organizational culture is decisive in at least two ways: firstly, existing culture manifests through informal procedures and rules-in-use, which may act as drivers or hurdles (e.g. Warner and Elser 2015). Secondly, the continuous process of co-designing and co-implementing WIAs may lead to cultural shifts within the organizational community (e.g. Henderson and Tilbury 2004; Niedlich et al. 2019), implying that a culture of sustainability can also be considered part of the process, and an overarching output of a WIA. Considering this iterative and integrating double-role, organizational culture may be viewed as a critical proxy for the extent to which an organization is practically living sustainability.

Constituting the hidden profile of an organization, culture refers to the shared values and rule-systems that act as a “collective ‘memory’” (Breiting et al. 2005, p. 35), which is the basis for the “way people interact, discuss and do things” (ibid.). As such, aligning organizational culture with SD strongly ties to developing a sustainability ethos (UNESCO 2012; Wals 2012) and, to addressing organizations as models practicing sustainability (e.g. Higgs and McMillan 2006). As Shallcross et al. (2007, p. 73) state, WIAs “are education as a way of life in which sustainable actions become second nature—culturally intuitive normative responses”. Yet, as Bauer et al. (2020, p. 17) point out, “sustainability processes are no ‘optimized production lines’; they are

instead complex social processes", implying that there are various cultural orientations which, dependent on contexts, may or may not contribute to sustainability learning. At the same time, the authors argue that this "is precisely why consideration of organizational cultures is so relevant and why it is worth attempting to identify patterns hampering or supporting fundamental change" (ibid.). Among the patterns of cultural dispositions frequently referred to in the literature on WIAs, integration and holism describe a culture of comprehensively viewing sustainability as an intertwined field of action for all parts of an organization (e.g. Bauer et al. 2020; Niedlich et al. 2019), manifesting, e.g. in what an organization does (e.g. Higgs and McMillan 2006), how its organizational climate develops (e.g. Breiting et al. 2005), and how it perceives itself as part of a greater change process (e.g. Niedlich et al. 2019). Aside from this consistency-oriented perspective, various authors refer to a culture of collective learning (e.g. Sterling 2003; Niedlich et al. 2019; Bauer et al. 2020), in which space is provided for reflection and reflexivity (e.g. Giesenbauer and Müller-Christ 2020; Henderson and Tilbury 2004; Sterling 2003). Viewing "sustainability not as an externally defined goal, but as an open search process" (Vogt and Weber 2020, p. 17), this also implies a culture of complexity (e.g. Breiting et al. 2005; Mathar 2013), in which individuals critically reflect upon assumptions, values, and actions. Relatedly, various authors describe a culture of co-design and collaborative actions (e.g. Bauer et al. 2020; Shallcross et al. 2006, 2007; UNESCO 2020). Lastly, the literature refers to the importance of social interaction by facilitating and living solidarity (e.g. UNESCO 2020), diversity (e.g. Wals 2012; SEDa 2007), inclusiveness (e.g. UNESCO 2020; Sterling 2003), and care (e.g. DCSF 2009; Mathar 2016; Sterling 2003) as well as respect and mutual recognition (e.g. Posch 1999), emphasizing emotional and physical well-being (e.g. DCSF 2009).

External conditions: priority in policy, funding and access to expertise

While there are many ways through which organizations can autonomously develop towards sustainability, the literature also points to contextual factors which may foster or hinder WIAs. As a first, prioritization within regional, national and international policies is decisive (e.g. Wals and Benavot 2017; UNESCO 2020; Henderson and Tilbury 2004). As such, UNESCO (2020, p. 28) calls on policymakers to "create enabling environments for educators to integrate the whole-institution approach on ESD". According to UNESCO, this "includes, for example, placing emphasis on ESD among other competing priorities, allowing more flexibility, facilitating partnership, and

reflecting the whole-institution approach to ESD in the performance of learning institutions" (ibid.). Secondly, availability of sufficient and long-term funding is essential. Mentioned by Henderson and Tilbury (2004, p. 6) as one of several "critical success factors", significant funding (e.g. UNESCO 2014) is important, for example, to redesign the campus or buildings, to facilitate high-quality in-service professional development or to designate specific staff as facilitators for the process. As a third, access to expertise on ESD through external support (e.g. in multi-stakeholder networks, see Tilbury and Wortman 2005) and pre-service education of educators on ESD is fundamental (e.g. Henderson and Tilbury 2004; UNESCO 2014; Gibb 2016). As various authors point out, transformative change within education not only requires in-service training and support, but also considerable changes in pre-service education of educators (e.g. Ferreira et al. 2006, 2007; Gough 2016; Gibb 2016; Henderson and Tilbury 2004; UNESCO 2020). Though this is widely acknowledged, Gough (2016, p. 109) describes an "almost universal lack of success in introducing coherent or consistent programs of EE [environmental education]/ESD into teacher education courses". Given that educators are "key actors in facilitating learners' transition to sustainable ways of life" (UNESCO 2020, p. 30), a systematic integration of sustainability and ESD in pre-service education of all leaders, educators and non-teaching staff is critical also for WIAs to sustainability.

Synthesis: conceptual framework for WIAs to sustainability

In a nutshell, WIAs are described in the international literature as continuous individual and institutional learning processes to coherently mainstream sustainability as a fundamental principle within all activities of an educational organization. Through WIAs, all formal and informal learning *as* and *for* sustainability is embedded within its socio-physical surrounding, implying that both social processes (e.g. governance, communication) and physical contexts (built and natural environment) consistently practice sustainability. Such an orientation of both the visible and the hidden curriculum towards sustainability aims to link formal and informal learning, ideally creating an authentic sustainable learning environment in which *everyone* involved is empowered with the abilities to design and create sustainable futures. While different organizations may follow different pathways towards sustainability in their specific context, a joint framework could be synthesized for WIAs from the international literature (for an illustrative overview, see Fig. 2). On the operational level, the framework consists of a set of core principles (*coherence, continuous learning,*

Whole Institution Approaches to Sustainability in Education

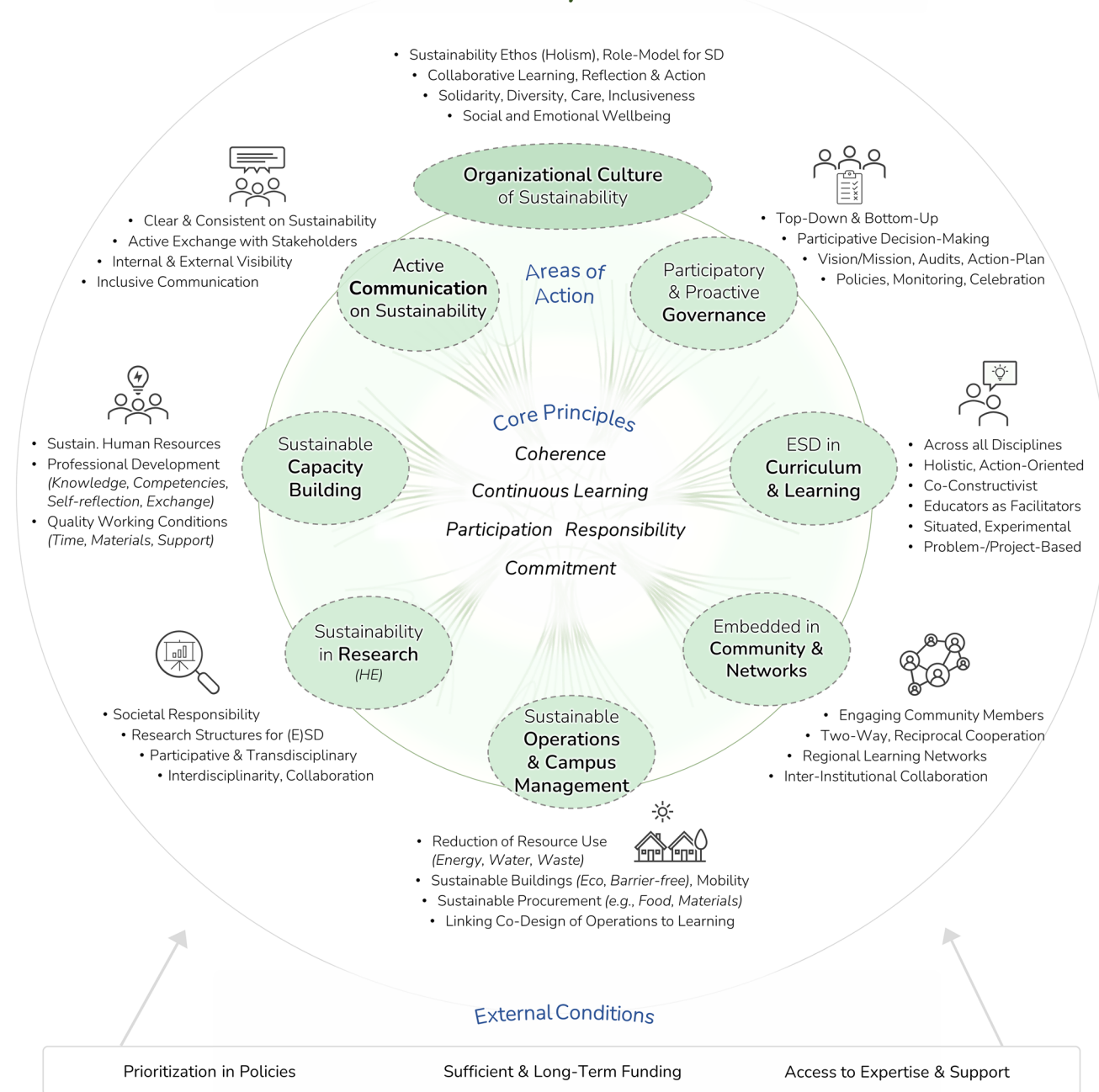


Fig. 2 Illustrative framework for whole institution approaches (WIAs) to sustainability in education, containing core principles (coherence, continuous learning, participation, responsibility, long-term commitment), seven integrated areas of action (governance, curriculum, community and networks, operations and campus management, research (in higher education (he)), capacity building, communication), organizational culture and external conditions

for successful WIAs. Areas of action are displayed in order of their introduction in the chapter “Jointly towards sustainability: integrated organizational areas of action”. Key defining concepts from the literature analysis are clustered in the outer circle (for organizational culture, areas of action). *ESD*: Education for Sustainable Development, *SD*: sustainable development

participation, responsibility, long-term commitment), and seven highly integrated areas of action, including:

- an integrative and participative **governance** that proactively supports and empowers an institutional (re-)orientation towards sustainability driven by individuals at all levels,
- an encompassing and cross-disciplinary orientation of **curriculum** and **learning** towards sustainability, following a holistic, emancipatory, situated and action-oriented approach to pedagogy,
- a process of (re-)designing **operations** and **campus management** in line with sustainability, providing an opportunity to collaboratively learn how to live sustainably,
- a strong embeddedness within the surrounding **communities**, regional educational landscapes and inter-organizational **networks**,
- in HE, a strong and institutionalized emphasis on sustainability in **research**, including an active involvement of learners,
- fostering of competencies, knowledge, attitudes and practical experience of educators and non-educating staff on sustainability and ESD through **capacity building**, as well as
- clear and consistent internal and external **communication** on SD.

Underlying all areas of action, **organizational culture** refers to the shared values and social rules-in-use within an organizational community. It is thus critical for WIAs as a condition (driver, or hurdle), characteristic of the process (e.g. collaboration, holism), and as overarching output (“Culture of Sustainability”). Notably, WIAs are about consistency in co-shaping sustainability in the different yet interacting parts of the organization. To foster such an integrative approach, the literature points to high prioritization in policy, adequate long-term funding, and availability of expertise, including a consequent integration of sustainability into the training of educators.

Discussion: towards coherence on sustainability in education

In light of the critical importance of socio-physical environments for sustainability learning, the here presented systematic literature review offers a synthesis of the key concepts that characterize WIAs. Overarchingly, WIAs are described as participatory and integrative processes of learning how to live, act, and co-create sustainability within and around educational organizations. In viewing sustainability as a defining paradigm of quality education (Sterling 2003), WIAs move beyond a compartmentalized integration of sustainability

(“cherry-picking”) (see Lozano et al. 2015; McMillin and Dyball 2009), in which sustainability learning is frequently approached as an “add-on” or “bolt-on” (Benavot 2014; Wals and Benavot 2017). Instead, WIAs call for whole-system approaches, which—in essence—are not limited to education organizations but may also be applied to various other institutional arrangements (e.g. NGOs, businesses). Building on core results of the analysis, the following sections reflect upon the methods used for analysis, gaps in our current understanding of WIAs, and opportunities for further research.

As the literature analysis shows, core characteristics of the concept of WIAs (core principles, organizational areas of action, organizational culture) converge across the literature from different areas of education. At the same time, the practical implementation requires specific pathways and adaptations according to age groups, social, cultural and environmental contexts. Also, it was found that the current literature on WIAs puts a considerable focus on school and higher education. Acknowledging that other wordings may also be in-use here, future studies could put additional emphasis on WIAs in vocational education and training, early childhood education and non-formal learning. Regarding publication dates, a considerable increase was observed since 2015, implying that the analysis characterizes a status, and that the concepts under debate are expected to further evolve. As the literature analysis was limited to English, and the expert review was conducted within one exemplary education system (Germany), further context-specific studies on both conceptual understanding and practical implementation of WIAs across the globe are moreover viewed as an important field for further research. Regarding the qualitative content analysis, conducting the analysis as a single researcher implied the methodological challenge to mediate potential researcher biases. Aside from following a rigorous systematic and rule-bound procedure, the exemplary cross-sectoral expert review was conducted to further substantiate the findings.

Concerning the key concepts that characterize WIAs in the international literature, the analysis points to a need to better understand the specific ways in which the hidden curriculum affects learning, e.g. through socializing effects of informal communication or (co-)design of learning environments (on HE, Winter and Cotton 2012; Hopkinson et al. 2008; Gramatakis and Lavau 2019). Particularly, the fields of organizational culture and communication are repeatedly referred to as critical to WIAs (e.g. Niedlich et al. 2020; Roos and Guenther 2020; Shallcross et al. 2007), yet relatively few studies offer precise operationalizations and in-depth analyses of the related learning processes. Also, interactions between the organizational areas of action require further attention, given that they constitute important intermediate spaces for social learning and transformative action. In terms of assessing the implementation of WIAs, various self-evaluation tools exist, yet little non-self-reporting biased data is currently available.

Moreover, future research may put additional emphasis on patterns of organization-specific pathways towards sustainability (e.g. Weiss et al. 2021), both identifying positive examples and highlighting inherent challenges and tensions in organizational change processes (e.g. Hoover and Harder 2015).

Conclusion

As becomes clear from the synthesis, following a WIA means to collaboratively switch the default mode of all social rules-in-use to sustainability. WIAs may thus be approached both as an instrument for coherent organizational development in light of (un-)sustainability, and as a keystone of integrated high-quality sustainability learning.

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Declarations

Conflict of interest The author declares that there is no conflict of interest.

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References

Aleixo AM, Azeiteiro U, Leal S (2018) The implementation of sustainability practices in Portuguese higher education institutions. *Int J Sustain Higher Educ* 19(1):146–178

- Amado A, Dalelo A, Adomßent M, Fischer D (2017) Engaging teacher educators with the sustainability agenda. *Int J Sustain Higher Educ* 18(5):715–737
- Artino AR, La Rochelle JS, Dezee KJ, Gehlbach H (2014) Developing questionnaires for educational research: AMEE Guide No. 87. *Med Teacher* 36(6):463–474
- Awuzie BO, Abuzeinab A (2019) Modelling organisational factors influencing sustainable development implementation performance in higher education institutions: an Interpretative structural modelling (ISM) approach. *Sustainability* 11(16):1–18
- Badjanova J, Iliško D (2015) Holistic approach as viewed by the basic school teachers in Latvia. *Discourse Commun Sustain Educ* 6(1):132–140
- Ballantyne R, Packer J (2006) Promoting learning for sustainability: principals' perceptions of the role of Outdoor and Environmental Education Centres. *Aust J Environ Educ* 22(1):15–29
- Barrett M, Bunds KS, Casper JM, Edwards MB, Showalter DS, Jones GJ (2019) 'A nut we have officially yet to crack': forcing the attention of athletic departments toward sustainability through shared governance. *Sustainability* 11(19):5198
- Barth M, Fischer D, Michelsen G, Nemnich C, Rode H (2012) Tackling the knowledge-action gap in sustainable consumption: insights from a Participatory School Programme. *J Educ Sustain Dev* 6(2):301–312
- Bauer M, Niedlich S, Rieckmann M, Bormann I, Jaeger L (2020) Interdependencies of culture and functions of sustainability governance at higher education institutions. *Sustainability* 12(2780):1–21
- Benavot A (2014) Education for sustainable development in primary and secondary education. Background paper prepared for the DESD unit at UNESCO headquarters, Paris, France
- Beringer A, Adomßent M (2008) Sustainable university research and development: inspecting sustainability in higher education research. *Environ Educ Res* 14(6):607–623
- Birney A, Reed J (2009) Sustainability and renewal: findings from the Leading Sustainable Schools research project. A research study highlighting the characteristics of sustainable schools and the leadership qualities required to develop sustainable schools. Nottingham
- Block M, Brassler M, Orth V, Riecke M, Rodriguez Lopez JM, Perino G, Tan W-H, Lamparter M (2016) Dies Oecologicus-how to foster a whole institutional change with a student-led project as tipping point for sustainable development at universities. In: Leal Filho W, Pace P (eds) *Teaching education for sustainable development at university level*. Springer International Publishing, Switzerland, pp 341–355
- Bohunovsky L, Radinger-Peer V, Penker M (2020) Alliances of change pushing organizational transformation towards sustainability across 13 universities. *Sustainability* 12(7):1–20
- Bosevska J, Kriewaldt J (2020) Fostering a whole-school approach to sustainability: learning from one school's journey towards sustainable education. *Int Res Geogr Environ Educ* 29(1):55–73
- Breiting S, Mayer M, Mogensen F (2005) Quality criteria for ESD-schools. Guidelines to enhance the quality of Education for Sustainable Development
- Brundiers K, Barth M, Cebrián G, Cohen M, Diaz L, Doucette-Remington S, Dripps W, Habron G, Harré N, Jarchow M, Losch K, Michel J, Mochizuki Y, Rieckmann M, Parnell R, Walker P, Zint M (2021) Key competencies in sustainability in higher education—toward an agreed-upon reference framework. *Sustain Sci* 16(1):13–29
- Buckler C, Creech H (2014) Shaping the future we want: UN decade of education for sustainable development (2005–2014). Final Report, Paris 07 SP, France
- Davis JM, Ferreira J-A (2009) Creating cultural change in education: a proposal for a continuum for evaluating the effectiveness of

- sustainable schools implementation strategies in Australia. *Austr J Environ Educ* 25(1):59–70
- DCSF (2009) s3: sustainable school self-evaluation. Driving school improvement through sustainable development. Nottingham
- de Haan G (2010) The development of ESD-related competencies in supportive institutional frameworks. *Int Rev Educ* 56(2):315–328
- Didham RJ, Ofei-Manu P (2018). In: Leicht A, Heiss J, Byun WJ (eds) Issues and trends in education for sustainable development. United Nations Educational, Scientific and Cultural Organization, Paris, pp 87–110
- Djordjevic A, Cotton D (2011) Communicating the sustainability message in higher education institutions. *Int J Sustain Higher Educ* 12(4):381–394
- Farinha CS, Caeiro SS, Azeiteiro U (2020) Universities speak up regarding the implementation of sustainable development challenges the case of Portugal. *Int J Sustain High Educ* 21(3):465–506
- Ferreira J-A, Ryan L, Tilbury D (2006) Whole-school approaches to sustainability: a review of models for professional development in pre-service teacher education. Australian Government Department of the Environment and Heritage and the Australian Research Institute in Education for Sustainability (ARIES), Canberra
- Ferreira J-A, Ryan L, Tilbury D (2007) Mainstreaming education for sustainable development in initial teacher education in Australia: a review of existing professional development models. *J Educ Teach* 33(2):225–239
- Fischer D, Jenssen S, Tappeser V (2015) Getting an empirical hold of the sustainable university: a comparative analysis of evaluation frameworks across 12 contemporary sustainability assessment tools. *Assess Eval High Educ* 40(6):785–800
- Gibb N (2016) Getting climate-ready: a guide for schools on climate action. United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris
- Giesenbauer B, Müller-Christ G (2020) University 4.0: promoting the transformation of higher education institutions toward Sustainable Development. *Sustainability* 12(8):1–27
- Goldman D, Ayalon O, Baum D, Weiss B (2018) Influence of “green school certification” on students’ environmental literacy and adoption of sustainable practice by schools. *J Clean Prod* 183:1300–1313
- Gough A (2006) Sustainable schools in the UN decade of education for sustainable development: meeting the challenge? *South Afr J Environ Educ* 23(1):48–63
- Gough A (2016) Teacher education for sustainable development: past, present and future. In: Leal Filho W, Pace P (eds) Teaching education for sustainable development at university level. Springer International Publishing, Switzerland, pp 109–122
- Gough A, Sharpley B (2005) Educating for a sustainable future. A National Environmental Education Statement for Australian Schools. Australian Government. Department of the Environment and Heritage
- Gramatakis AL, Lavau S (2019) Informal learning for sustainability in higher education institutions. *Int J Sustain Higher Educ* 20(2):378–392
- Hargreaves LG (2008) The whole-school approach to education for sustainable development: from pilot projects to systemic change. In: Coriddi J (ed) Policy and practice. A development education review, pp 69–74
- Henderson K, Tilbury D (2004) Whole-school approaches to sustainability: an international review of sustainable school programs. A report prepared by the Australian Research Institute in Education for Sustainability (ARIES) for The Department of the Environment and Heritage, Australian Government
- Higgs AL, McMillan VM (2006) Teaching through modeling: four schools’ experiences in sustainability education. *J Environ Educ* 38(1):39–53
- Holst J, Brock A, Singer-Brodowski M, de Haan G (2020) Monitoring progress of change: implementation of education for sustainable development (ESD) within documents of the German Education System. *Sustainability* 12(10):4306
- Hoover E, Harder MK (2015) What lies beneath the surface? The hidden complexities of organizational change for sustainability in higher education. *J Clean Prod* 106:175–188
- Hopkinson P, Hughes P, Layer G (2008) Sustainable graduates: linking formal, informal and campus curricula to embed education for sustainable development in the student learning experience. *Environ Educ Res* 14(4):435–454
- Jackson PW (1968) *Life in classrooms*. Holt, Rinehart and Winston, New York
- Kadji-Beltran C, Zachariou A, Liarakou G, Flogaitis E (2014) Mentoring as a strategy for empowering education for sustainable development in schools. *Prof Dev Educ* 40(5):717–739
- Kahle J, Risch K, Wanke A, Lang DJ (2018) Strategic networking for sustainability: lessons learned from two case studies in higher education. *Sustainability* 10(12):1–24
- Kensler LAW (2012) Ecology, democracy, and green schools: an integrated framework. *J School Leadersh* 22(4):789–814
- Kensler LAW, Uline CL (2019) Educational restoration: a foundational model inspired by ecological restoration. *Int J Educ Manag* 33(6):1198–1218
- Koester RJ, Eflin J, Vann J (2006) Greening of the campus: a whole-systems approach. *J Clean Prod* 14(9–11):769–779
- Kohl K, Hopkins C, Barth M, Michelsen G, Dlouhá J, Razak DA, Abidin Bin Sanusi Z, Toman I (2021) A whole-institution approach towards sustainability: a crucial aspect of higher education’s individual and collective engagement with the SDGs and beyond. *Int J Sustain Higher Educ (ahead-of-print)*
- Kuckartz U (2014) *Qualitative text analysis: a guide to methods, practice and using software*. SAGE Publications Ltd, London
- Kuckartz U (2019) *Qualitative text analysis: a systematic approach*. In: Kaiser G, Presmeg N (eds) *Compendium for early career researchers in mathematics education*. Springer International Publishing, Cham, pp 181–197
- Laurie R, Nonoyama-Tarumi Y, McKeown R, Hopkins C (2016) Contributions of education for sustainable development (ESD) to quality education: a synthesis of research. *J Educ Sustain Dev* 10(2):226–242
- Leicht A, Heiss J, Byun WJ (eds) (2018) *Issues and trends in education for sustainable development*. United Nations Educational, Scientific and Cultural Organization, Paris
- Lewis E, Mansfield C, Baudains C (2014) Ten Tonne Plan: education for sustainability from a whole systems thinking perspective. *Appl Environ Educ Commun* 13(2):128–141
- Livingstone DW (2001) Adults’ informal learning: definitions, findings, gaps and future research. *WALL Working Paper* (21)
- Lozano R, Ceulemans K, Alonso-Almeida M, Huisinigh D, Lozano FJ, Waas T, Lambrechts W, Lukman R, Hugé J (2015) A review of commitment and implementation of sustainable development in higher education: results from a worldwide survey. *J Clean Prod* 108:1–18
- Mathar R (2013) The concept of the whole school approach—a platform for school development with focus on sustainable development. Concept paper. ESD Expert Network. Schools for Sustainability—a Resource Toolkit for Teacher Training
- Mathar R (2016) Global development education/ESD—a task for the whole school. In: Schreiber J-R, Siege H (eds) *Curriculum framework education for sustainable development*, 2nd edn. Engagement Global gGmbH, Bonn

- McKeown R, Hopkins C (2007) Moving beyond the EE and ESD disciplinary debate in formal education. *J Educ Sustain Dev* 1(1):17–26
- McMillin J, Dyball R (2009) Developing a whole-of-university approach to educating for sustainability. *J Educ Sustain Dev* 3(1):55–64
- Mogren A, Gericke N (2019) School leaders' experiences of implementing education for sustainable development—anchoring the transformative perspective. *Sustainability* 11(12):3343
- Mogren A, Gericke N, Scherp H-A (2019) Whole school approaches to education for sustainable development: a model that links to school improvement. *Environ Educ Res* 25(4):508–531
- Niedlich S, Kummer B, Bauer M, Rieckmann M, Bormann I (2019) Cultures of sustainability governance in higher education institutions: a multi-case study of dimensions and implications. *Higher Educ Q* 74:373–390
- Niedlich S, Bauer M, Doneliene M, Jaeger L, Rieckmann M, Bormann I (2020) Assessment of sustainability governance in Higher Education Institutions—a systemic tool using a governance equalizer. *Sustainability* 12(5):181
- Nölting B, Molitor H, Reimann J, Skroblin J-H, Dembski N (2020) Transfer for sustainable development at higher education Institutions—untapped potential for education for sustainable development and for societal transformation. *Sustainability* 12(2925):1–21
- O'Donoghue R, Taylor J, Vente V (2018) Chapter 5: How are learning and training environments transforming with ESD? In: Leicht A, Heiss J, Byun WJ (eds) *Issues and trends in education for sustainable development*. United Nations Educational, Scientific and Cultural Organization, Paris, pp 111–132
- Olson K (2010) An examination of questionnaire evaluation by expert reviewers. *Field Methods* 22(4):295–318
- Orr DW (1992) *Ecological literacy*. Education and the transition to a postmodern world. SUNY series in constructive postmodern thought. State University of New York Press, Albany
- Pittman J (2004) Living sustainably through higher education: a whole systems design approach to organizational change. In: Corcoran PB, Wals AEJ (eds) *Higher education and the challenge of sustainability*. Springer, Dordrecht, pp 199–212
- Posch P (1999) The ecologisation of schools and its implications for educational policy. *Camb J Educ* 29(3):341–348
- Potter S (2007) Rock hopping, yoga and student empowerment: a case study of a sustainable school. *Aust J Environ Educ* 23(1):13–21
- Rieckmann M (2012) Future-oriented higher education: which key competencies should be fostered through university teaching and learning? *Futures* 44(2):127–135
- Rieckmann M (2018) Chapter 2: learning to transform the world: key competencies in ESD. In: Leicht A, Heiss J, Byun WJ (eds) *Issues and trends in education for sustainable development*. United Nations Educational, Scientific and Cultural Organization, Paris, pp 39–60
- Rieckmann M, Mindt L, Gardiner S (2017) *Education for sustainable development goals: learning objectives*. UNESCO, Paris
- Roos N, Guenther E (2020) Sustainability management control systems in higher education institutions from measurement to management. *Int J Sustain High Educ* 21(1):144–160
- Roos N, Heinicke X, Guenther E, Guenther TW (2020) The role of environmental management performance in higher education institutions. *Sustainability* 12(2):1–17
- Schröder L-MU, Wals AEJ, van Koppen CSA (2020) Analysing the state of student participation in two Eco-Schools using Engeström's Second Generation Activity Systems Model. *Environ Educ Res* 26(8):1088–1111
- Schugurensky D (2000) The forms of informal learning: towards a conceptualization of the field. *WALL Working Paper* (19)
- Scott WAH (2015) Exploring a transformative orientation to sustainability in universities: a question of loose and tight framings. *Environ Educ Res* 21(6):943–953
- SEdA (2007) Domain framework for whole system approach to ESD
- Shallcross T, Robinson J (1999) A model of participation in continuing professional development and evaluation through action research in educating for sustainability. *J in-Serv Educ* 25(3):403–422
- Shallcross T, Loubser C, Le Roux C, O'Donoghue R, Lupele J (2006) Promoting sustainable development through whole school approaches: an international, intercultural teacher education research and development project. *J Educ Teach* 32(3):283–301
- Shallcross T, Robinson J, Pace P, Tamoutseli K (2007) The role of students' voices and their influence on adults in creating more sustainable environments in three schools. *Improve Schools* 10(1):72–85
- Simovska V, Prøsch ÅK (2016) Global social issues in the curriculum: perspectives of school principals. *J Curric Stud* 48(5):630–649
- Singer-Brodowski M, Etzkorn N, von Seggern J (2019) One transformation path does not fit all—insights into the diffusion processes of education for sustainable development in different educational areas in Germany. *Sustainability* 11(1):1–17
- Steffen W, Broadgate W, Deutsch L, Gaffney O, Ludwig C (2015) The trajectory of the anthropocene: the great acceleration. *Anthr Rev* 2(1):81–98
- Sterling S (2001) *Sustainable education. Re-visioning learning and change*. Schumacher briefing, vol 6. Green Books for the Schumacher Society, Totnes
- Sterling S (2003) *Whole systems thinking as a basis for paradigm change in education: explorations in the context of sustainability*. PhD, University of Bath
- Sterling S (2016) A commentary on Education and Sustainable Development goals. *J Educ Sustain Dev* 10(2):208–213
- Tilbury D, Wortman D (2005) Whole school approaches to sustainability. *Geogr Educ* 18:22–30
- UNECE (2012) *Learning for the future: competences in education for sustainable development*, Schweiz
- UNESCO (2012) *Education for sustainable development: sourcebook. Education for sustainable development in action. Learning and Training Tools*, Paris
- UNESCO (2014) *UNESCO roadmap for implementing the Global Action Programme on education for sustainable development*, Paris
- UNESCO (2017) *Implementing the whole-school approach under the Global Action Programme on education for sustainable development. Information Note for National Coordinators of UNESCO's Associated Schools Project Network* (23.03.2017), Paris
- UNESCO (2020) *Education for sustainable development. A roadmap*, Paris
- UNESCO (2021) *Berlin declaration on education for sustainable development*, Berlin
- Vare P, Scott W (2007) Learning for a change: exploring the relationship between Education and Sustainable Development. *J Educ Sustain Dev* 1(2):191–198
- Vogt M, Weber C (2020) The role of universities in a Sustainable Society. Why value-free research is neither possible nor desirable. *Sustainability* 12(2811):1–21
- Wals AEJ (2012) *Shaping the education of tomorrow: 2012 full-length report on the UN decade of education for sustainable development. DESD monitoring and evaluation—2012*, Paris
- Wals AEJ, Benavot A (2017) Can we meet the sustainability challenges? The role of education and lifelong learning. *Eur J Educ* 52(4):1–10
- Warner BP, Elser M (2015) How do sustainable schools integrate sustainability education? An assessment of certified sustainable K-12 Schools in the United States. *J Environ Educ* 46(1):1–22

- Weiss M, Barth M, von Wehrden H (2021) The patterns of curriculum change processes that embed sustainability in higher education institutions. *Sustain Sci* 16(5):1579–1593
- Whitby A (2019) Advancing education for sustainable development. Key success factors for policy and practice, Hamburg
- Winter J, Cotton D (2012) Making the hidden curriculum visible: sustainability literacy in higher education. *Environ Educ Res* 18(6):783–796
- WWF (2011) Pathways: to education for sustainable development. A practical tool for planning a whole school approach, United Kingdom
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8.1.3. Article 3: Holst, Grund & Brock (2024)

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Abbreviations:

JH: Jorrit Holst

JG: Dr. Julius Grund

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Whole Institution Approach: measurable and highly effective in empowering learners and educators for sustainability

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Abstract

Whole Institution Approaches (WIAs) to sustainability in education emphasize the strong link between the socio-physical environment and the learning processes and outcomes. However, there has been a lack of instruments for quantifying the implementation of WIAs based on the experience of learners and educators. In this article, we present the systematic development, pretesting, validation and first application of a novel WIA-Scale (learners: 13 items, educators: 15 items). As part of a large-scale assessment in Germany (school education, vocational education and higher education; $n = 2,985$), we apply the WIA-Scale and assess how WIAs are related to the effectiveness of sustainability learning. Based on extensive validation, the scale quality was evaluated as high. The application showed that young people who experience more sustainability in line with the WIA feel strongly more motivated and empowered by their educational institution to contribute to sustainability. Also, regression modeling revealed that WIA implementation is the strongest of various predictors of how sustainable learners act beyond the educational institution. Further, educators who experience more sustainability in line with the WIA feel considerably more motivated and report more sustainable behavior. They also view Education for Sustainable Development (ESD) as more relevant and participate more frequently in training on ESD. For future use, we provide the WIA-Scale in its original version, a 7/8-item variant and a one-item proxy. The scale may be used as a process indicator for high-quality sustainability education and as part of organizational development. Overall, the study shows that experienced WIAs are measurable and highly effective for quality sustainability learning.

Keywords Whole Institution Approach (WIA) · Whole School Approach (WSA) · Sustainability learning · Education for Sustainable Development (ESD) · Scale development · Process indicator

Introduction

What kind of education is appropriate to effectively enable learners to contribute to sustainability? Considering that education is frequently framed as a “key enabler” for the achievement of all Sustainable Development Goals (SDGs, Rieckmann et al. 2017; UNESCO 2020; United Nations General Assembly 2017), answering this question is essential not only for *Quality Education* (SDG 4), but also for sustainability transitions in general (e.g., Abson et al. 2017;

Otto et al. 2020). In the final 2021 declaration of the UNESCO World Conference on Education for Sustainable Development (ESD), the participating UNESCO member states acknowledge that “urgent action is needed to address the dramatic interrelated challenges the world is facing” (UNESCO 2021, p. 1) and therefore call for a comprehensive reorientation of education systems toward sustainability.

In educational practice, however, sustainability often tends to be approached as an “add-on” or “bolt-on”, not as a core component of quality education (e.g., Holst et al. 2024; Sterling 2003; Wals and Benavot 2017; Wals and Mathie 2022). In contrast, the idea of a whole system approach emphasizes that effective and coherent sustainability learning would require sustainability to be substantially integrated and practiced across all levels of education systems (e.g., in policies, administration, learning landscapes and communities, organizations and specific learning situations). As a coherent part of a whole system approach to sustainability in

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education, the terms Whole Institution Approach (WIA, all areas of education), Whole School Approach (for schools) and Whole-of-University Approach (for higher education institutions) address educational institutions and their surroundings, calling for schools, universities, kindergartens and other places of learning to “walk the talk” by mainstreaming sustainability within all activities (e.g., Buckler and Creech 2014; Henderson and Tilbury 2004; Holst 2023; McMillin and Dyball 2009; Mogren et al. 2019; Rieckmann et al. 2017; Sterling 2003; Wals and Mathie 2022). In the words of the UNESCO declaration, this implies that “institutions become living laboratories for participation and active citizenship” on sustainability, “allowing learners to learn what they live and live what they learn” (UNESCO 2021, p. 3). These appeals are supported by a wide range of scientific literature which suggests that the extent to which sustainability is experienced on a day-to-day basis within educational institutions (WIA) is strongly linked with the effectiveness of sustainability learning (e.g., Buckler and Creech 2014; Henderson and Tilbury 2004; Sterling 2003). The idea of WIAs (hereafter used as a generic term for all areas of education) thereby aims at a double objective: the continuous co-creation of coherent and empowering sustainability learning for all members of educational institutions, and at the same time, real-world impact for more sustainable societies (e.g., manifesting in less climate impact, protection of biodiversity, inclusivity).

While calls for WIAs as high-quality ESD have become a cornerstone of the international discourse on coherent education in times of (un-)sustainability over the past years (e.g., Bautista-Puig and Sanz-Casado 2021; Hargreaves 2008; Henderson and Tilbury 2004; Holst 2023; Lozano et al. 2015; Rieckmann et al. 2017; Tilbury and Galvin 2022; UNESCO 2020, 2021; Wals 2012), we are not aware of large-scale studies on (a) the degree to which sustainability is experienced in educational organizations (e.g., schools, higher education institutions) across all domains of WIAs and (b) how this relates to the effectiveness of sustainability learning. As Kohl et al. (2022, p. 229), among others, point out in the exemplary context of higher education, “more empirical research (...) is needed to fully understand the effectiveness and efficiency of the WIA”. To date, most international studies on the effects of WIAs have either relied on self-reporting data collected from educational leaders, which is prone to bias toward positive reporting (e.g., Nazir et al. 2011; Warner and Elser 2015), or have compared certified organizations with uncertified ones (e.g., Olsson et al. 2016). Particularly in the context of eco-school programs, the available evidence on differences between certified and non-certified organizations (e.g., on behavioral changes in learners) is mixed (Barratt Hacking et al. 2010; Boeve-de Pauw and van Petegem 2013; Goldman et al. 2018; Olsson et al. 2019). Both in school and higher education,

tools for (self-)assessments of sustainability performance exist and are used by a range of institutions for reporting and organizational development (e.g., CRUE 2023; DCSF 2009; Fischer et al. 2015; Larrán Jorge et al. 2016; Urbanski and Filho 2015). Interestingly, few attempts have been made to systematically ask those who experience the practices and rules-in-use at their educational institution on a daily basis—learners and educators—about their experiences with regard to sustainability across the different dimensions of WIAs (an exception for educators: Mogren et al. 2019; a focus on perceived participation: Torsdottir et al. 2023). However, considering the double objective of coherent and effective sustainability learning and real-world impact, we argue that WIAs can only be viewed as fully implemented if sustainability is coherently practiced across all areas of action and if this practice is experienced by those within the organization, i.e., by learners and educators. Therefore, this article has a twofold objective in addressing the following research questions:

- A. How can the WIA be operationalized for quantitative assessments focusing on the experiences of those within educational institutions (learners, educators)?
- B. To what extent is the experience of sustainability at educational institutions (WIAs) related to key aspects of effective sustainability learning (e.g., empowerment, behavior, knowledge)?

In response to the first question, we present a systematically tested and validated instrument (WIA-Scale) in different lengths that can be used as a process indicator for high-quality sustainability learning. Regarding the second question, we present data from a first large-scale application of the WIA-Scale in Germany. As part of this, we provide data on the implementation in Germany as well as insights into the relationship between the WIA and various constructs related to effective sustainability learning. Among others, these constructs include learners' feeling of empowerment to contribute to sustainability (SDG 4.7, Rieckmann 2018; UNESCO 2020; United Nations General Assembly 2015), motivation to contribute to sustainability (e.g., Brundiers et al. 2021; Grund and Brock 2019; Haan 2010; Hickman et al. 2021), as well as knowledge and behaviors (e.g., Brundiers et al. 2021; Rieckmann et al. 2017; Sass et al. 2023; UNESCO 2020).

As a conceptual basis for operationalization, the following first section introduces core characteristics and components of WIAs to sustainability in education on the basis of international literature. In the methods section, we lay out our approach to the systematic development, pretesting and first large-scale application of the WIA-Scale. In the results, we report on the application of the WIA-Scale with 2,985 learners and educators from school education,

vocational education, and higher education in Germany. In this, we report on quality criteria (e.g., validity, reliability), descriptive statistics and on relationships between the WIA-Scale and other scales related to sustainability learning. Last, we discuss the results and their main implications for further research, practice and policymaking.

Conceptual basis: Whole Institution Approaches to sustainability in education

By deliberately emphasizing the socializing effect of learners' experiences in everyday life (e.g., Barth et al. 2012), the idea of WIAs extends the learning and experience space of an educational institution beyond the learning content and the classroom into all areas of experience and action (e.g., campus, community, governance; for an overview, see Gericke 2022; Holst 2023; Tilbury and Galvin 2022; Wals and Mathie 2022). In doing so, the concept of WIAs links the socio-physical context of learning to sustainability-related learning objectives, thus calling for organizations and their members to rethink and redesign what may be considered their standard way of acting. Sterling (2003, p. 344) describes such an integrative orientation as an attempt by educational institutions to function as “a reflective ‘microcosm of a sustainable society’” in which space is provided for collaborative learning along the challenges and opportunities of co-designing sustainability (Buckler and Creech 2014; Gericke 2022; McMillin and Dyball 2009; Rieckmann 2018). As part of a recent systematic review, WIAs were described as “continuous and participative organizational learning processes aimed at institutional coherence on sustainability, consistently linking the formal and informal (hidden) curricula” (Holst 2023, p. 1015). In this process, educational institutions attempt to “mainstream sustainability as a fundamental principle within all activities” and in doing so, to “collaboratively switch the default mode of all social rules-in-use to sustainability” (Holst 2023, p. 1026f.). Conceptually, WIAs are thus closely linked to the frequently suggested importance of informal learning and the hidden curriculum—i.e., the interaction with the social and physical contexts of learning—for learning outcomes (e.g., Gramatakos and Lavau 2019; Hopkinson et al. 2008; Orr 2004; Winter and Cotton 2012). This holistic perspective on learning environments is consistent with latest theories on cognition, in which material environments are not only viewed as distant or passive external factors for cognitive processes, but also as much more directly and actively involved in learning and memorizing processes. In this vein, the perspectives of, e.g., “embodied cognition” (e.g., Fugate et al. 2019), “grounded cognition” (Barsalou 2008) and “tacit knowledge” (Kaaronen 2018; Polanyi 1966, 2009) strongly emphasize the role of material environments

for learning (in its application to ESD, see Brock 2022). Findings in this context also show that learning is more effective when material learning environments are consistent with the learning content (Fugate et al. 2019). It is therefore adequate to understand material environments as direct co-constituents of learning processes instead of mere external influencing factors (Brock 2022).

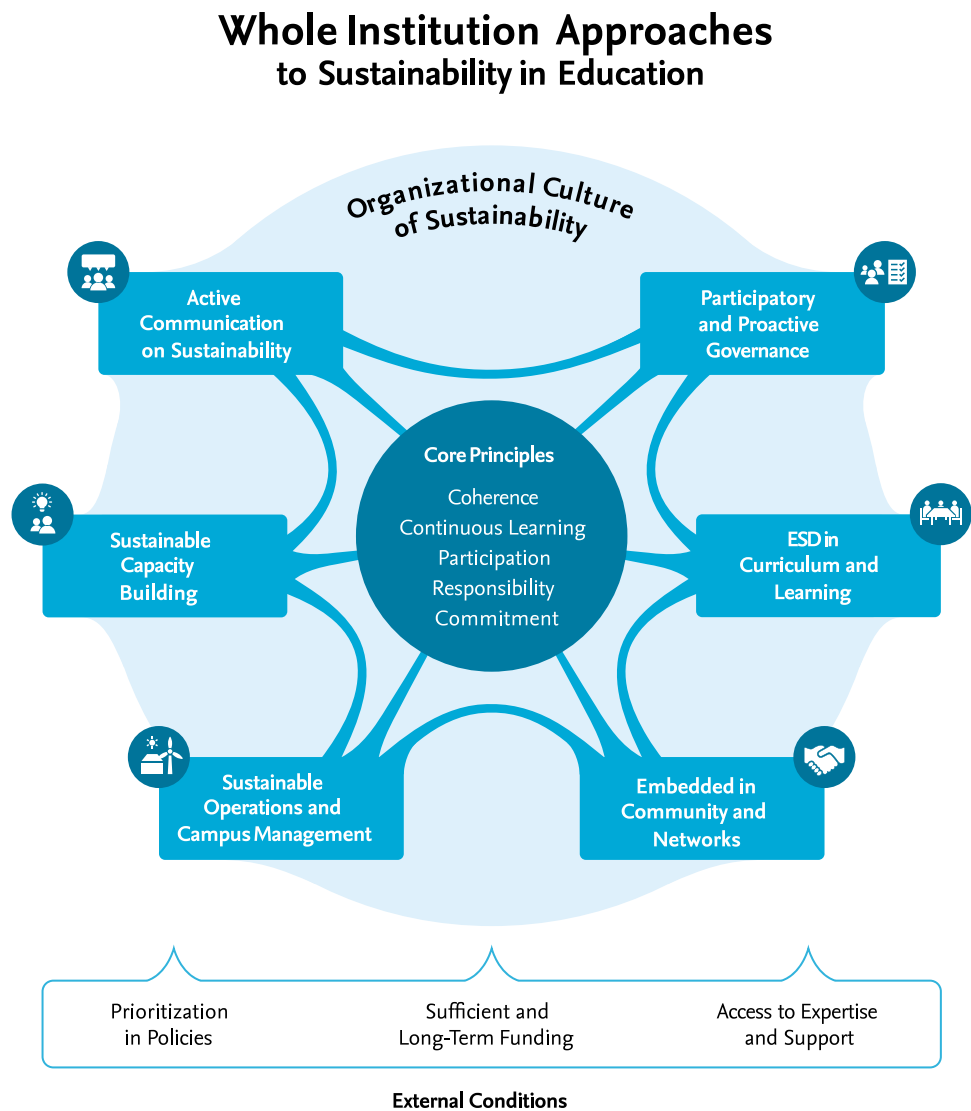
As the conceptual foundation for the operationalization of WIAs within a quantitative scale, we build upon a recent systematic review of the international literature on WIAs to sustainability, in which 104 scientific articles, reports, frameworks and guidebooks were synthesized and a joint framework was developed to characterize WIAs across the different areas of education (Holst 2023).¹ The WIA-framework consists of a set of five core principles, six concrete areas of action² and the underlying and interconnected culture of organizations (Fig. 1). As a first principle, institutional **coherence** is described in the literature as the central core of WIAs, referring to consistency between what is intended to be learned and what is practically lived (e.g., Mogren et al. 2019; UNESCO 2020). The second principle, **continuous learning**, points to the notion that a WIA is not a destination, but a continuous process of co-designing sustainability between the different stakeholders of an organization (e.g., Mathar 2013; Scott 2015). This links directly to the third principle of **participation**, which is described as the capacity of an organization to encourage and empower all stakeholders to take part in the process. At the same time, such capacity for participation involves the **responsibility** of individuals within the organizational community for taking on the challenging task of practicing sustainability (Ferreira et al. 2006; Henderson and Tilbury 2004). The fifth core principle refers to **long-term commitment**, pointing out that changes within educational organizations are often gradual, and thus require long-term efforts and a certain degree of flexibility and creativity. Together, these five principles describe the foundation of WIAs, which is put into practice within the different organizational areas of action (see Fig. 1):

- (1) participative and proactive **governance** and leadership, which empowers and supports a process of continuous institutional development in line with the principles of sustainable development (SD), involving the relevant

¹ As part of the systematic review, the international literature (in English) was analyzed. Data were collected via Web of Science, ERIC, an online search and an in-text citation analysis. For details, see Holst (2023).

² In higher education, alignment of the research agenda with sustainable development and active involvement of learners into such research processes is considered a seventh area of action.

Fig. 1 Overview of the Whole Institution Approach concept (adapted from Holst 2023). The framework includes a set of five core principles, six interconnected organizational areas of action, the underlying organizational culture (“Organizational Culture of Sustainability”) as well as critical external conditions. In higher education, research constitutes a seventh area of action, which is not displayed as it does not relate to all areas of education. *ESD* Education for Sustainable Development



- stakeholders from all parts of the organizational community;
- (2) cross-disciplinary integration of ESD as an action-oriented, situated, holistic and emancipatory approach to **curriculum and learning**, in which social-emotional and cognitive learning are equally considered;
- (3) sustainability-oriented **operations and campus management** (e.g., buildings, campus, materials, food and drink, mobility), which provide real-world opportunities for collaborative sustainability learning;
- (4) close and reciprocally engaged embeddedness in local **communities** and inter-organizational **networks** as collaborative real-world learning grounds;
- (5) active **capacity building** for educators and non-teaching staff by fostering sustainability and ESD competencies, building support structures and prioritizing sustainability within human resource management; as well as

- (6) clear, consistent and active **communication** on (un-) sustainability both within the organization and toward the outside.

Importantly, the areas of action are viewed as intertwined and interdependent. Connecting all areas of action, the **organizational culture** describes the shared beliefs, values and meanings that underlie the system of rules-in-use within any given organization and is therefore viewed as of critical importance for WIAs. Lastly, the international literature points to several external conditions for successful WIAs (prioritization in policies, sufficient and long-term funding, access to expertise and support; e.g., Henderson and Tilbury 2004; UNESCO 2020; Wals and Benavot 2017).

As part of the systematic literature analysis, the conceptual categories derived from the international literature were used to develop a set of 53 items (Holst 2023), which served as the conceptual basis for the operationalization in

this article. Considering that it is the core of WIAs to live sustainability within every fiber of an educational institution, we view the real-world experiences of those who learn, teach and spend their everyday lives on site—learners and educators—as a central source of reliable information on the actual implementation of WIAs. While many assessments of WIAs primarily focus on self-reporting by organizational leaders and the collection of “objectifiable” data (e.g., emissions), we argue that if nobody in an educational organization actually notices that it is in fact climate neutral, some degree of organizational sustainability may exist, but it should not be considered a WIA to sustainability education. In other words, a WIA to sustainability education can only be considered realized if individual and ideally collective sustainability learning takes place. This is in line with Luhmann (1989), who argued that environmental problems only have social relevance if social resonance arises through communication. Therefore, as an addition to the collection and evaluation of data on the de facto ecological and social footprint of educational organizations, the WIA-Scale introduced in this article focuses on the degree to which learners and educators actually experience sustainability in practice.

Materials and methods

The following sections introduce the development of the WIA-Scale (conceptual basis, qualitative and quantitative pretesting) for the assessment of experienced WIA implementation from the perspective of learners and educators and the study setup for a first systematic assessment in Germany (see Fig. 2). As part of the large-scale assessment with learners and educators from school education, vocational

education and higher education ($n=2,985$), the scale’s quality was tested (e.g., internal consistency, validity), descriptive statistics are reported and explorative correlation as well as regression analyses were conducted with other relevant scales (e.g., self-reported sustainability-related behavior, subjective knowledge regarding SD or perceived empowerment to solve sustainability issues).

WIA-Scale: instrument development

The following sections provide an overview of the steps in the development and systematic pretesting of the WIA-Scale (on the process of pretesting, see Campanelli 2008; Collins 2003). After considering the conceptual basis of the scale in terms of its validity, the sections on qualitative and quantitative pretesting describe the measures taken to ensure high-scale quality.

Systematic literature analysis: conceptual foundation

The systematic analysis of the international literature on WIAs introduced above served as the conceptual basis for operationalization. As part of the literature analysis, the definitions for the identified facets and sub-facets of WIAs were translated into 53 items (see Holst 2023), which were refined on the basis of a written expert review of the representativeness of the items for the underlying constructs, relevance of the constructs within future assessments of WIAs and comprehensiveness (Olson 2010). In basing the scale development on a systematic literature analysis, high content validity can be assumed with regard to the thematic categories used for operationalization.

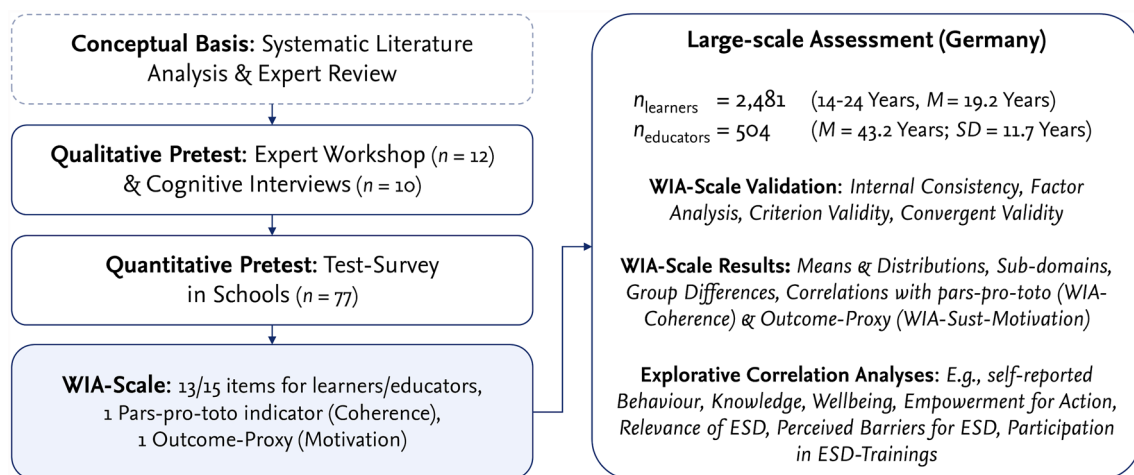


Fig. 2 Overview of the methods used for development, pretesting, validation and first large-scale application of the WIA-Scale. The conceptual basis for operationalization comes from a recent system-

atic literature review on Whole Institution Approaches (see Holst 2023). WIA Whole Institution Approach, ESD Education for Sustainable Development

Qualitative pretesting: consolidation and comprehensiveness

The first list of items was consolidated in several iterative rounds. First, an explorative expert workshop was conducted with twelve participants from research on WIAs, educational practice, policy and administration, civil society organizations and youth participation as well as co-researchers on the prioritization of facets for assessment (Artino et al. 2014; Gehlbach and Brinkworth 2011). The items were then pretested in two rounds of cognitive interviews (Collins 2003; Willis 1999) with five learners and five educators from different types of schools and higher education institutions. To ensure that the vast majority of respondents are able to fully comprehend the questions, retrieve all necessary information, judge the specific concepts and have fitting options to voice their responses (e.g., Faulbaum et al. 2009), the focus was on participants who were likely to have had little prior knowledge of sustainability, as well as younger participants and participants from non-selective secondary schools and comprehensive schools. As part of the cognitive interviews, thinking aloud as well as paraphrasing and probing with additional questions on comprehensiveness were used (Collins 2003; Weichbold 2014). Items were left out which were found (i) not to link sufficiently to the real-world experiences of most learners and/or educators (e.g., on the development of action plans), (ii) to be conceptually too complex to translate into easy-to-comprehend statements (e.g., on a culture of solidarity and care) and (iii) to show considerable overlaps with other items (e.g., there were originally two items for internal and external visibility). The scale has been consolidated through this process and, at this point, consisted of 21 items for learners and 24 items for educators, which are both relevant and representative for all areas of WIAs and ratable for learners and educators.

Quantitative pretesting: demarcation of conceptual categories, scale improvement

To further demarcate the conceptual categories, assess correlations between items and adjust item difficulties based on the range of responses and their spread (e.g., Campanelli 2008; Weichbold 2014), the scale was subsequently pretested in a small-scale quantitative assessment with 48 learners and 29 educators from school education. In cooperation with the Ministry of Education in the federal state of Schleswig–Holstein (Germany), the scale was distributed among comprehensive schools as well as non-selective secondary schools. The quantitative pretest was conducted in schools instead of higher education or vocational education institutions to make sure that the scale also functions well with the youngest possible participants. The quantitative

pretest showed that educators and learners used all response options (Range = 5) for most items, despite the relatively small sample. In addition, most mean values were between 2.5 and 3.5 with standard deviations of just over 1, indicating appropriate item difficulty and good differentiation between participants. None of the learners stated that they had a poor understanding of the questionnaire and even at this stage the scale showed a high internal consistency ($\alpha_{\text{Learners}} = 0.903$; due to the small sample size for educators, no calculation was made here). Individual items showed a much lower selectivity than others and were therefore excluded.

Finalization of the WIA-Scale

The final WIA-Scale consists of 13 items for learners and 15 items for educators (Table 1), which correspond to the six areas of actions (two for Curriculum and Learning, Management, Community, Governance, Communication and Capacity Building (only educators), respectively), as well as two items on Organizational Culture and one item on Participation. These items integrate both the need for practical usability (number of items) and content validity (comprehensiveness, high relevance and representativeness for WIAs). In terms of the different levels of indicators, all items can be regarded as process indicators, although some are also linked to other levels, such as input, output or outcome.

In addition to the main WIA-Scale, the item selection presented in Table 1 contains two complementary items: “WIA-Coherence” as a possible one-item indicator for the WIA-Scale and “WIA-Sust-Motivation” to offer an outcome indicator on the effects of the everyday experience on learners motivation to act for sustainability. As part of the first large-scale application, correlations between the WIA-Scale and these complementary items were tested (see below).

Large-scale assessment in Germany

The final scale was used in a large-scale quantitative survey in Germany. The sample used for the final validation as well as the methodological approach to the exploratory analyses and the additional instruments used are presented below.

Study setup

The study was conducted as part of the German national monitoring on ESD. In total, 2481 learners (aged 14–24, $M = 19.2$ years; $SD = 2.7$ years) and 504 educators ($M = 43.2$ years, $SD = 11.7$ years) were questioned from all federal states via an online-access-panel (73 participants were previously excluded due to socially desirable response behavior; see Bundesamt für Naturschutz 2017; Winkler et al. 2006).

Table 1 Overview of the WIA-Scale for learners and educators sorted by constructs and sub-constructs

Constructs and sub-constructs	Learners	Educators
Learning 1: Action orientation/link to practical activities	At my educational institution... ... learning about sustainability involves practical activities (e.g., in <i>our building, on the grounds, ...</i>).	... I link teaching about sustainability with practical activities (e.g., in <i>our building, on the grounds, ...</i>).
Learning 2: Educators as facilitators	... teachers not only pass on knowledge to me, they also help and support me on my own learning pathway.	... I not only pass on knowledge to learners, I also support and help them on their own learning pathway.
Community 1: Involvement of community members	... we also learn about sustainability by meeting people from outside our educational institution (e.g., <i>we invite speakers, go on excursions in the region, ...</i>).	... we also learn about sustainability by meeting people from outside our educational institution (e.g., <i>we invite speakers, go on excursions in the region, ...</i>).
Community 2: Service to the community	... direct contributions are made to making the surrounding region more sustainable (e.g., <i>through voluntary work, projects, ...</i>).	... direct contributions are made to making the surrounding region more sustainable (e.g., <i>through voluntary work, projects, ...</i>).
Management 1: Reduction of resource use	... care is taken to use as few resources as possible (e.g., <i>low energy consumption, avoiding food waste, ...</i>).	... care is taken to use as few resources as possible (e.g., <i>low energy consumption, avoiding food waste, ...</i>).
Management 2: Sustainable purchasing	... the sustainability of materials, food and other products is really important (e.g., <i>organic, regional, fair trade, recycling, ...</i>).	... the sustainability of materials, food and other products is really important (e.g., <i>organic, regional, fair trade, recycling, ...</i>).
Governance 1: Coordination and leadership (top-down)	... sustainability is actively strengthened and promoted by the people in charge (e.g., <i>by the management/principal/principal</i>).	... sustainability is actively strengthened and promoted by the people in charge (e.g., <i>by the management/principal/principal</i>).
Governance 2: Critical (self-)evaluation	... there is critical evaluation of what is done for sustainability at our institution.	... there is critical evaluation of what is done for sustainability at our institution.
Capacity building 1: Recognition for (E)SD engagement from leadership	(Only educators)	... the engagement of employees for sustainability is valued by those in charge.
Capacity building 2: Staff development on (E)SD	(Only educators)	... I am given support in gaining the skills and knowledge I need to teach sustainability.
Communication 1: Expression of SD through the design of buildings/campus	... the way buildings and the grounds are designed gives me the impression that sustainability is being put into practice.	... the way buildings and the grounds are designed gives me the impression that sustainability is being put into practice.
Communication 2: Internal and external visibility	... making sustainability a visible issue is really important (e.g., <i>on the website, on posters, ...</i>).	... making sustainability a visible issue is really important (e.g., <i>on the website, on posters, ...</i>).
Culture 1: Role model for sustainability	... I see the teachers as role models for sustainability.	... I experience my colleagues as role models for sustainability.
Culture 2: Topic for conversations outside of class	... sustainability is an important issue in conversations outside the classroom/courses.	... sustainability is an important issue in conversations outside the classroom/courses.
Participation	... I am encouraged and supported to take part in important decisions (e.g., <i>what and how we learn, how we design the grounds, ...</i>).	... I am encouraged and supported to take part in important decisions.
Pais-pro-toto (WIA-Coherence)	... sustainability is put into practice across the different areas of the school/higher education institution.	... sustainability is put into practice across the different areas of the school/higher education institution.
Outcome indicator (WIA-Sust-Motivation)	... day to day life motivates me to do more for sustainability.	... day to day life motivates me to do more for sustainability.

The scale was translated from German to English using the TRAPD method (parallel translation by a professional translator and the research team, joint review and adjustment, see Harkness 2003). The original WIA-Scale in German can be found in the supplementary material (S 2)

WIA Whole Institution Approach

The number of participants by federal state corresponds approximately to the population distribution in Germany. With regard to gender, the sample for educators is representative for the group (65.7% female, 34.3% male). Among young people, female participants are overrepresented (75.3% female, 23.6% male, 1.1% diverse/others). Learners were included from school education (47.3%), vocational education and training (15.5%) and higher education (37.2%), and educators from school education (82.3%) and vocational education (17.7%). On average, the educators in the sample have 14.5 years of work experience ($SD = 11.1$).

Statistical methods for testing quality criteria

The range, measures of central tendency (mean, mode and median) and standard deviation of all items as well as the overall scale were determined to describe the basic *distributional characteristics* of the scale. In addition, all items as well as the total scale were examined for normal distribution using graphical methods (histograms, Q–Q plots), numerical methods (skewness, kurtosis indices) and formal normality tests (Shapiro–Wilk; Razali and Wah 2011). The *discriminatory power* of individual items was determined using the corrected item–total correlation, and internal consistency (as an indicator of *reliability*) of the scale was assessed using Cronbach's alpha. All correlation analyses (e.g., to determine *convergent validity* with the help of frequency of contact with sustainability in a respondent's own educational institution, correlating the one-item indicator with the overall scale) were determined using the nonparametric Spearman's rank correlation coefficient due to partially missing normal distribution of the variables. To determine the extent to which participants from schools and higher education institutions with a focus or profile on sustainability score higher on the WIA scale than participants from schools without a sustainability focus (*criterion validity*), the Mann–Whitney U test was used (again, a non-parametric test was chosen because not all variables are normally distributed). A confirmatory factor analysis was conducted to determine *factorial validity* using the cutoff values proposed by Hu and Bentler (1995) for CFI and TLI (> 0.95).

Statistical methods for exploratory analyses

Non-parametric statistical procedures were also used for the exploratory analyses due to partially missing normal distribution. Consequently, Spearman's rank correlation coefficient was used for the correlation analyses between the WIA-Scale and other relevant sustainability- and ESD-related constructs (e.g., perceived empowerment to make important contributions to the solving of sustainability issues, sustainable behavior, emotions regarding

sustainability, well-being, subjective knowledge, perceived relevance of ESD (educators) and participation in ESD-related training (educators) (see instrument descriptions below).

As a last step, multiple regression analysis was calculated for the prediction of sustainable behavior of learners, replicating the analysis by Grund and Brock (2020) using the WIA-Scale instead of the ESD scale by Boeve-de Pauw et al. (2015), which focuses specifically on ESD (holism, pluralism) within class (examination of statistical requirements attached in the supplemental material).³ Other predictors included in the model were: emotions and attitudes regarding sustainability, connectedness with nature and humanity, ecological problem awareness, age, gender and money at one's disposal (for more details on the procedure and scale descriptions, see Grund and Brock 2020).

Further instruments used in validation and explorative analyses

In addition to the WIA-Scale and the measures used as part of the multiple regression analysis for the prediction of sustainable behavior (see above), further instruments are briefly described below.

Well-being was assessed using the WHO-5 questionnaire, which is widely used internationally (Topp et al. 2015). The five questions (6-point Likert scale) allow a time-efficient yet valid assessment of general well-being.

Perceived empowerment by one's educational institution to solve issues related to SD was assessed using one item (5-point Likert scale) that inquires about the extent to which participants agree with the following statement: "I feel that my school/university enables me to make an important contribution to solving sustainability problems (climate change, loss of biodiversity, social inequality, etc.)" (Grund and Brock 2022).

The *subjective knowledge* on SD (learners, educators) and ESD (educators) was assessed by asking participants to subjectively grade their knowledge of SD/ESD (1 = very good, 2 = good, 3 = satisfactory, 4 = sufficient, 5 = poor, 6 = insufficient). This scale was recoded for all statistical calculations so that higher values represent more knowledge.

In addition to the assessment of ecological problem awareness for the regression analysis (see above), the assessment of *problem awareness* was approached with the help of two items using 11-level sliders: first, participants

³ Self-reported sustainable behavior is the most widespread source of information on behavior currently obtainable via questionnaires. Yet, although social desirability has been accounted for in our analysis, the responses should be considered only as a limited representation of real-world actions.

were asked: “How big do you think are the sustainability problems in the world?” (0 = no sustainability problems, 10 = extremely large problems that severely threaten all of humanity and ecosystems). Second, participants were asked about their expectations: “How much will sustainability challenges, such as climate change, species loss and social inequalities affect your personal life in the coming decades?” (0 = no negative effects, 10 = massive negative effects).

The *frequency of contact with sustainability in the own educational institution* is an item from a scale that records points of contact with sustainability in different areas of life (friends, family, media, etc.). Participants rated on a five-point Likert scale the frequency (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always) with which they had encountered SD in their formal educational institution.

Educators were moreover asked about the *relevance of ESD* to teaching using a 10-level slider (1 = ESD has no relevance to my teaching practice, 10 = ESD is highly relevant to my teaching). The *number of training sessions on ESD in which educators participated* was captured for the last 5 years. In addition, *perceived barriers for ESD implementation* were assessed with the help of the item “What factors prevent you from integrating sustainability issues more strongly into your teaching?”. 12 possible hurdles were named (e.g., a lack of teaching materials, knowledge, further training) to which respondents could respond dichotomously (0 = does not apply, 1 = applies). A sum score was formed to determine the extent of the perceived hurdles.

Results

Quality criteria and scale description

Scale description

As in the pretest, responses on the WIA-Scale were distributed across the entire scale spectrum (Range = 5). Mean scores for all items ranged from 2.51 to 2.95 ($M_{\text{WIA-Scale}} = 2.71$) in the learners’ group and from 2.71 to 3.74 ($M_{\text{WIA-Scale}} = 3.00$) in the educators’ group (see Table 2; for more detailed analysis, see supplemental material). Except for two items in the teacher sample, the median and the mode of all individual items is 3. With one exception in each case, the standard deviations of each single item is above 1 for learners and above 0.95 for teachers. At the aggregated scale level, the values are lower, as is to be expected ($SD_{\text{WIA-Scale}} = 0.75$; $SD_{\text{WIA-Scale}} = 0.73$). These statistics indicate appropriate item difficulty as well as good differentiation between individuals. Nevertheless, the normal distribution indicators (graphical and statistical) show that a normal distribution cannot be assumed in the present sample

at the individual item level and at the scale level. Among learners, considerably more participants scored between 1 (“Fully disagree”) and 2 (“Disagree”) (19.1%) than between 4 (“Agree”) and 5 (“Fully agree”) (3.9%). Accordingly, the distribution is strongly right skewed ($z = 4.57^{***}$). In addition, the midpoint of the scale for learners seems slightly overrepresented (nevertheless, the statistical analysis indicates that there is no kurtosis [$z = 1.37$]). The statistical indicators for teachers do not point to skewness [$z = 0.52$] or kurtosis [$z = 0.12$].

Reliability

Internal consistency can be rated as excellent in both groups ($\alpha_{\text{Learners}} = 0.913$; $\alpha_{\text{Educators}} = 0.937$). This score cannot be further improved among learners by omitting an item. For the teachers, there would be a slight improvement in internal consistency to $\alpha = 0.940$ if the item on educators as facilitators was left out. The high internal consistency is also reflected in high corrected item–total correlations: these are all between 0.509 and 0.714 for the learners. Among educators, the item on educators as facilitators again stands out with an item–total correlation of 0.325, which nevertheless does not fall below conventional minimums. The item–total correlations of all other items among educators are between 0.557 and 0.799.

Validity

The convergent validity of the overall scale was determined using correlation with an item that measures the frequency of contact points with SD in formal education. It is $r = 0.493^{***}$ for learners and $r = 0.473^{***}$ for educators. Both values are conventionally almost in the large effect size range (Cohen 1988), which indicates existing construct validity. For criterion validity, the extent to which participants from schools and higher education institutions with a perceived focus on sustainability score higher on the WIA-Scale than participants from institutions without a sustainability focus was assessed. The Mann–Whitney U revealed statistically significant differences with a medium effect size for the learners ($d = 0.583$; $p < 0.001$) and large effect size for the educators ($d = 1.065$; $p < 0.001$). To determine factorial validity, a confirmatory factor analysis (CFA) was conducted for a one-factor model using the maximum-likelihood estimator. Chi-square is significant for both groups ($\chi^2[65] = 815.483$, $p < 0.001$ for learners; $\chi^2[90] = 629.421$, $p < 0.001$ for educators). The fit indices are (slightly) below the conventional cutoff values for good model fit (> 0.95 for CFI and TLI; $CFI_{\text{Learners}} = 0.947$, $TLI_{\text{Learners}} = 0.936$, $CFI_{\text{Educators}} = 0.885$, $TLI_{\text{Educators}} = 0.866$). However, given the finding that single-factor models produce substantially worse fit indices on average than other models (Bonifay and

Table 2 Means, standard deviations, item–scale correlation and Cronbach's alpha of the total WIA-Scale and all individual items based on the assessment of learners and educators in Germany ($n = 2985$)

Constructs and sub-constructs	Learners	Educators
WIA-Scale	$M = 2.707$ ($SD = 0.7495$) $\alpha = 0.913$	$M = 2.998$ ($SD = 0.7344$) $\alpha = 0.937$
Learning 1: Action-orientation/link to practical activities	$M = 2.51$ ($SD = 1.083$) $r_{\text{Item-Total}} = 0.610$	$M = 2.96$ ($SD = 0.972$) $r_{\text{Item-Total}} = 0.622$
Learning 2: Educators as facilitators	$M = 2.86$ ($SD = 1.025$) $r_{\text{Item-Total}} = 0.509$	$M = 3.74$ ($SD = 0.759$) $r_{\text{Item-Total}} = 0.325$
Community 1: Involvement of community members	$M = 2.56$ ($SD = 1.110$) $r_{\text{Item-Total}} = 0.639$	$M = 3.15$ ($SD = 1.022$) $r_{\text{Item-Total}} = 0.615$
Community 2: Service to the community	$M = 2.67$ ($SD = 1.133$) $r_{\text{Item-Total}} = 0.664$	$M = 2.98$ ($SD = 1.031$) $r_{\text{Item-Total}} = 0.698$
Management 1: Reduction of resource use	$M = 2.95$ ($SD = 1.063$) $r_{\text{Item-Total}} = 0.573$	$M = 3.50$ ($SD = 1.017$) $r_{\text{Item-Total}} = 0.557$
Management 2: Sustainable purchasing	$M = 2.79$ ($SD = 1.075$) $r_{\text{Item-Total}} = 0.636$	$M = 3.13$ ($SD = 1.058$) $r_{\text{Item-Total}} = 0.672$
Governance 1: Coordination and leadership (top-down)	$M = 2.78$ ($SD = 1.087$) $r_{\text{Item-Total}} = 0.714$	$M = 2.89$ ($SD = 1.077$) $r_{\text{Item-Total}} = 0.799$
Governance 2: Critical (self-)evaluation	$M = 2.64$ ($SD = 1.050$) $r_{\text{Item-Total}} = 0.702$	$M = 2.74$ ($SD = 0.994$) $r_{\text{Item-Total}} = 0.806$
Capacity Building 1: Recognition for (E)SD engagement from leadership	(Only educators)	$M = 2.91$ ($SD = 1.055$) $r_{\text{Item-Total}} = 0.750$
Capacity Building 2: Staff development on (E)SD	(Only educators)	$M = 2.85$ ($SD = 1.050$) $r_{\text{Item-Total}} = 0.714$
Communication 1: Communication through buildings/campus	$M = 2.62$ ($SD = 1.047$) $r_{\text{Item-Total}} = 0.669$	$M = 2.77$ ($SD = 1.021$) $r_{\text{Item-Total}} = 0.715$
Communication 2: Internal and external visibility	$M = 2.87$ ($SD = 1.097$) $r_{\text{Item-Total}} = 0.663$	$M = 2.81$ ($SD = 1.064$) $r_{\text{Item-Total}} = 0.758$
Culture 1: Role model for sustainability	$M = 2.64$ ($SD = 0.996$) $r_{\text{Item-Total}} = 0.642$	$M = 2.87$ ($SD = 0.962$) $r_{\text{Item-Total}} = 0.697$
Culture 2: Topic for conversations outside of class	$M = 2.64$ ($SD = 1.068$) $r_{\text{Item-Total}} = 0.601$	$M = 2.71$ ($SD = 0.979$) $r_{\text{Item-Total}} = 0.714$
Participation	$M = 2.67$ ($SD = 1.101$) $r_{\text{Item-Total}} = .644$	$M = 2.94$ ($SD = 1.035$) $r_{\text{Item-Total}} = .712$
Pars-pro-toto (WIA-Coherence)	$M = 2.69$ ($SD = 1.021$) $r_{\text{Item-WIA-Scale}} = 0.717^{***}$	$M = 2.91$ ($SD = 0.954$) $r_{\text{Item-WIA-Scale}} = 0.784^{***}$
Outcome indicator (WIA-Sust-Motivation)	$M = 2.74$ ($SD = 1.052$) $r_{\text{Item-WIA-Scale}} = 0.644^{***}$	$M = 3.11$ ($SD = 1.002$) $r_{\text{Item-WIA-Scale}} = 0.666^{***}$

WIA Whole Institution Approach

Cai 2017), the theoretically derived one-factor model can be considered empirically confirmed. A CFA with individual factors for each area of action was not calculated due to a lack of degrees of freedom when calculating with less than three items for each factor.

Descriptive group differences

When comparing the responses of learners and educators, it appears that, with the exception of one item (Communication 2: internal and external visibility), teachers describe slightly stronger implementation of a WIA in their educational institutions on average (Table 2). The difference in the overall mean between the groups ($M_{\text{Learners}} = 2.707$, $M_{\text{Educators}} = 2.998$) has

small effect size ($d = 0.39$). Among young people, male participants show a descriptively slightly higher overall mean score ($M = 2.779$) than female participants ($M = 2.683$). However, the effect size is so small ($d = 0.097$; $p = 0.017$) as to be practically negligible.

Strong correlation of pars-pro-toto indicator (WIA-Coherence) with WIA-Scale

Complementary to the WIA-Scale, a possible one-item indicator (pars-pro-toto) was developed (WIA-Coherence). For both learners and educators, strong correlations were found between WIA-Coherence and the WIA-Scale ($r_{\text{Learners}} = 0.717^{***}$; $r_{\text{Educators}} = 0.784^{***}$). In other terms,

the WIA-Coherence item explains 51.4% of the variance in the WIA-Scale for learners and 61.5% for educators.

Strong correlation between WIA-Scale and motivation to contribute to sustainability

A second complementary item was used which asks for the degree to which learners and educators feel motivated by their daily experience at the educational organization to do more for sustainability (outcome: WIA-Sust-Motivation). Correlations with strong effect sizes were found between the WIA-Scale and the motivational effect of everyday life at the organization to contribute to sustainability for both learners ($r = 0.644^{***}$) and educators ($r = 0.665^{***}$). In other terms, the WIA-Scale explains 41.4% of the variance within the item on motivation to act for learners and 44.2% for educators.

Relationships between the WIA-Scale and other scales related to sustainability learning

Small or no correlations between WIA-Scale and problem awareness

To check for a possible effect of participants' problem awareness on their responses on the WIA-Scale, correlation tests were conducted with three separate scales on problem awareness: (1) a one-item scale on the perceived problem size of unsustainability ($r_{\text{Learners}} = -0.052^{**}$, not significant for educators), (2) the expected future influence of unsustainability on one's own life ($r_{\text{Learners}} = 0.108^{***}$, not significant for educators) and (3) the perceived transgression of planetary boundaries (Steffen et al. 2015) for climate change ($r_{\text{Educators}} = 0.138^{**}$, not significant for learners) and biodiversity ($r_{\text{Learners}} = -0.067^{**}$, not significant for educators). Across

the three scales, correlations were either not significant or of small effect sizes with oppositional directions.

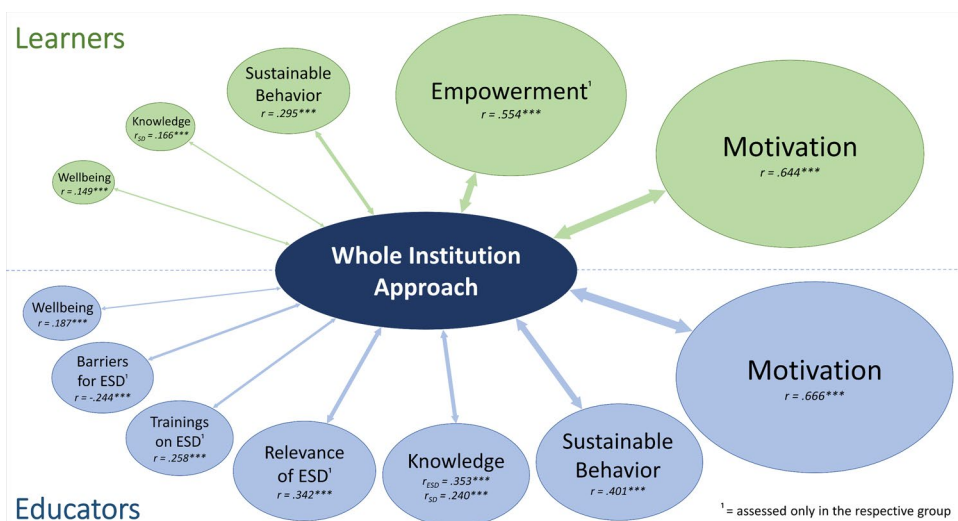
Positive correlations with perceived empowerment to make important contributions to the solving of sustainability issues, sustainable behavior, knowledge and well-being

The WIA-Scale strongly correlates with the perceived empowerment evoked by one's educational institution to make important contributions to the solving of sustainability issues ($r = 0.554^{***}$; for an overview of all significant correlations with $r > 0.1^{***}$, see Fig. 3). Also, a medium to strong correlation was recorded between the WIA-Scale and self-reported sustainable behavior ($r_{\text{Learners}} = 0.295^{***}$, $r_{\text{Educators}} = 0.401^{***}$). We further found for both learners and educators that higher scores on the WIA-Scale are associated with higher self-judgments for subjective knowledge on SD ($r_{\text{Learners}} = 0.166^{***}$; $r_{\text{Educators}} = 0.240^{***}$) and higher perceived well-being ($r_{\text{Learners}} = 0.149^{***}$; $r_{\text{Educators}} = 0.187^{***}$).

Experienced WIAs and educators: higher perceived relevance of ESD, more participation in ESD-training and fewer perceived barriers for ESD implementation

A correlation with moderate effect size was found between the WIA-Scale and the perceived relevance of ESD for educators ($r = 0.342^{***}$). Also, correlations were recorded with the number of training sessions on ESD in which educators participated ($r = 0.258^{***}$) and the responses on the scale were associated with higher self-judgment on subjective knowledge on ESD ($r_{\text{Educators}} = 0.353^{***}$) and fewer perceived barriers for ESD implementation ($r_{\text{Educators}} = -0.244^{***}$).

Fig. 3 Schematic overview of significant correlations between the WIA-Scale and other scales assessed as part of the explorative analysis with $r > 0.1^{***}$. Constructs indicated with ¹ were only assessed with one of the respective groups, i.e., learners or educators. SD Sustainable Development, ESD Education for Sustainable Development



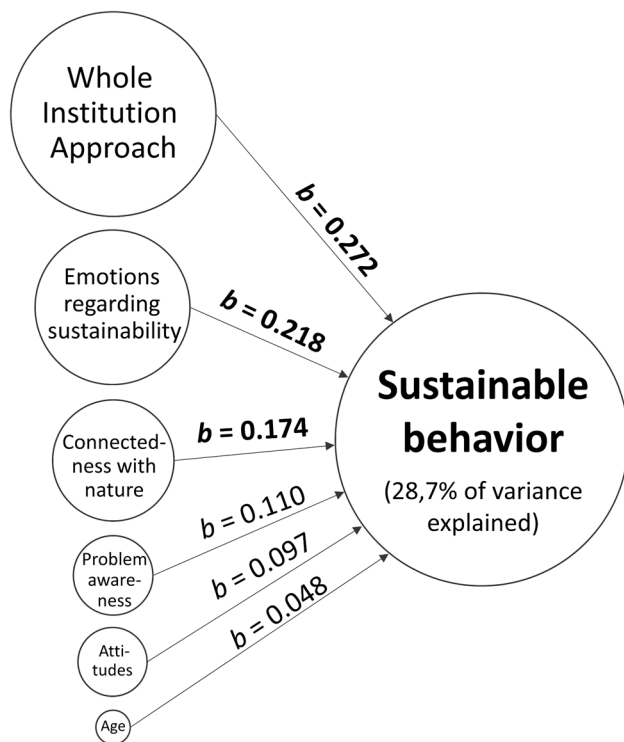


Fig. 4 Schematic representation of the multiple-regression analysis on sustainable behavior of learners ($n=2385$, 14–24 years; replication of the analysis by Grund and Brock (2020), including the WIA-Scale as a predictor). The model reveals that the degree to which learners experience sustainability in line with a Whole Institution Approach (WIA) is the strongest of various predictors of how sustainable learners act. Other significant predictors include emotions regarding sustainability, connectedness with nature, and ecological problem awareness as well as attitudes regarding sustainability and age of respondents

Sustainable behavior: WIA-Scale is the strongest predictor in regression model

The final part of the analysis replicated the multiple regression analysis of Grund and Brock (2020). While Grund and Brock operationalized ESD implementation through two facets of ESD practice (holism and pluralism, see Boeve-de Pauw et al. 2015), this study used the WIA-Scale instead. We found that experienced WIA implementation was the strongest predictor for self-reported sustainable behavior of learners ($b=0.272$) before sustainability-related emotions ($b=0.218$), connectedness to nature ($b=0.174$) and problem awareness ($b=0.110$) (Fig. 4). While the explanatory power of all other predictors remains largely unchanged when using the WIA-Scale instead of the ESD (holism and pluralism) scale, the overall predictive power of the model increases from 23.8 to 28.7%. As some of the items within the behavior scale could be interpreted by default as being part of daily experience at the educational organization, the model was calculated again to include only items which

overarchingly focused on activities outside the organization (informing others via social media, donating for charitable purposes, engagement in a group/organization for SD), resulting in an overall lower predictive power of the model (13,5%), in which the WIA-Scale remained the strongest predictor with an even higher b -value ($b=0.312$).

Discussion: Whole Institution Approach—measurable and effective for sustainability learning

A strong link between the extent to which sustainability is experienced on a day-to-day basis across all domains of educational institutions (WIA) and outcomes of sustainability learning has long been suspected (e.g., Buckler and Creech 2014; Kohl et al. 2022; McMillin and Dyball 2009; Sterling 2003; Tilbury and Galvin 2022). In this article, we presented the development, validation and first large-scale application of a quantitative WIA-Scale. The scale is able to systematically capture learners' and educators' perceptions of everyday sustainability in line with WIAs and can be used as a process indicator for high-quality sustainability learning. Among others, the findings provide strong indications that the degree to which a WIA to sustainability is experienced by learners and educators is indeed of substantial importance for effective sustainability learning. In the following, we

- (1) review the quality of the developed and validated WIA-Scale,
- (2) discuss the results of a first large-scale application in Germany,
- (3) reflect upon why WIAs are strongly related to effective sustainability learning and
- (4) consider opportunities for future use of the WIA-Scale in research and practice.

Measuring WIAs: scale development and validation

The WIA-Scale was developed based on a systematic review of the international literature on the characteristics of WIAs, which included an expert review on the relevance and comprehensiveness of the various facets (Holst 2023). High content validity of the scale can therefore be assumed. In several rounds of pretesting, the scale was refined to function both as a solid representation of WIAs (content quality) and as an easy-to-comprehend instrument for both learners from 14 to 24 years and educators across school education, vocational education and higher education. Its first large-scale application in Germany ($n=2,985$) showed good item difficulty and high internal consistency. Also, good convergent, factorial and criterion validity were determined as part of the validation process. Overall, a high

scale quality can be assumed on the basis of the presented first large-scale application. The observed skewness of the distribution (more individuals are at the low end of the scale than at the high end) can be seen as a strength of the scale, as it allows for high selectivity without ceiling effects, even if real WIA implementation is increased in the future. As the data was collected only once, test–retest reliability is still to be assessed.

Assessment of WIAs in Germany: first large-scale application of the WIA-Scale

With regard to the current implementation of WIAs in Germany, our results show that there are only very few learners (3.9%) and educators (8.9%) who, on average across the WIA-Scale, agree or strongly agree that sustainability is currently being practiced in their organization. In contrast, around one-fifth of the around 2,500 learners answered on average between “disagree” and “fully disagree”. This signals that at present, wide implementation of WIAs is rather an aspiration (e.g., Nationale Plattform BNE c/o BMBF 2017; Tilbury and Galvin 2022; UNESCO 2020, 2021) than lived practice. At the same time, the presented data indicates that different learners and educators already experience different degrees of sustainability in line with WIAs, which also underpins why it is important to approach the WIA as a continuous learning and development process rather than a specific status that is to be achieved (Bosevska and Kriewaldt 2020; Holst 2023; Mathar 2013; Shallcross et al. 2007). Also, each organization is likely to follow a very specific pathway toward a WIA (see Birney and Reed 2009; Bohunovsky et al. 2020; UNESCO 2012), which is why the WIA-Scale may, as an addition to critical assessments of sustainability across all activities of the organization, help to take stock and identify pathways for organizational development. Regarding differences between learners and educators, the analysis showed that educators tended to evaluate their educational organizations as more sustainable than learners. Although all data were controlled for social desirability, these differences were particularly present in areas of action where educators are directly involved (e.g., in curriculum and learning, community cooperation, operations and campus management).

In terms of the sampling strategy, the data presented is quasi-representative for Germany. While no norm data can be derived from the sample structure (by definition online access panels are not strictly representative for all subgroups of the population), the data is compiled along diversification criteria such as areas of education, federal states, age or job experience of teachers. One methodological limitation is that female learners are overrepresented due to the providers' panel composition. Interestingly, the medium to low mean

of the overall scale in Germany does not substantially differ between any of these subgroups. This may be explained by both the overall low implementation status and the sample structure, in which no full organizations were assessed but only individuals from various organizations. While the scale may be used within single institutions to deepen the perspective on specific cases, cross-institutional sampling such as the data presented here can contribute to WIA-data on more aggregated levels such as regions, nations or even at the international level. This sampling strategy may also help to explain the divergence between our findings (e.g., on the relationship between WIAs and motivation, empowerment and behavior) and studies that have compared certified with non-certified organizations and often found limited effects (e.g., Boeve-de Pauw and van Petegem 2013; Olsson et al. 2019; Spínola 2015). While these studies offer information on certifications, they mostly cannot address correlations between experienced WIAs in general across diverse institutions and measures for effective sustainability learning. In other words, while certificates may be important for promoting organizational development, the possession of a certificate does not necessarily mean that sustainability is actually practiced and experienced more coherently. As another effect of the cross-institutional sampling, we did not find strong mean differences between the six areas of action, which is likely due to cross-institutional variance, and more such differences could be expected when the scale is used within individual organizations.

Effectiveness of WIAs for sustainability learning: findings and probable explanations

As part of the first large-scale application in Germany, we assessed the relationship between experienced sustainability across all domains of WIAs and measures related to effective sustainability learning. In the following, we summarize the core findings and subsequently discuss explanations for the (likely causal) links between perceived WIA implementation and effective sustainability learning.

As the results indicate, there is a strong relationship between how sustainable learners and educators perceive their organization and how motivated they feel to act for sustainability as a result of their daily experiences there. Also, learners who respond higher on the WIA-Scale feel considerably more empowered by their organization to contribute to solving the sustainability issues of our times. Further, learners and educators who perceive their organization as more sustainable view themselves as more knowledgeable on SD and describe overall higher well-being. With regard to educators, those who respond higher on the WIA-Scale also view the educational concept of ESD as more relevant, participate more frequently in ESD training and see fewer barriers for its practical implementation.

Lastly, multiple regression analysis including various other measures such as connectedness to nature, emotions and attitudes regarding sustainability, problem awareness, age and income revealed that experienced sustainability at the educational organization in line with a WIA was the strongest predictor for how sustainably young people report to be acting. This was also found when only items specifically related to activities outside the institution were included, making a spillover effect seem very likely. Interestingly, only small or no correlations were observed between respondents' problem awareness with regard to (un)sustainability and their answers on the WIA-Scale, suggesting that the scale seems to function independently from the degree of problem perception. One explanation could be that higher problem awareness may both lead to sustainability efforts being noticed more and to them being judged more critically—two effects which may mutually balance each other out. While the results are correlational (no longitudinal analysis) for which causal relationships seem plausible (see below), some of the measures used included the direction of causality within the items (institution-induced motivation and empowerment). Overall, the findings provide strong indications that the extent to which sustainability is experienced on an everyday basis across all domains of WIAs is of substantial importance for effective sustainability learning.

For this suggested (causal) link, we see several probable explanations. First, the salience of social norms of sustainability in the educational institution is likely to influence what feels important to do and prioritize. This is in line with a wide field of psychological research on the influence of social norms on, for example, sustainable behavior (e.g., Cialdini and Jacobson 2021; Fritzsche et al. 2018; Keizer and Schultz 2018). Transferred to the context of education, the socializing norm systems and rules-in-use that are experienced on a daily basis seem foundational to coherent and effective sustainability learning (see Barth et al. 2012; Holst 2023). This is consistent with insights from research on organizational cultures, in that the design of the surroundings and everyday practices (artifacts, symbols) always implicitly conveys meaningful information on underlying values and assumptions (Alvesson 2013; Schein and Schein 2017). A further explanation lies in the notion of “embodied” or “grounded” cognition (e.g., Barsalou 2008; Fugate et al. 2019), i.e., in approaching material environments as critical co-constituents of learning (Brock 2022). In linking the context to learning, the WIA therefore is in line with a reprioritization of the physical environment in its role for learning, making it not an external precondition for effective learning settings, but rather an important co-constituent of it (Brock 2022). Following that, the involvement of learners in reflecting on, and collectively designing learning environments would

be conducive for effective learning. The importance of the way in which environment and rules become habits also ties into the findings of Kahneman (2003), who emphasized the importance of unreflective, habituated, more intuitive actions (automatic mode) compared to the comparatively few actions in everyday life that are based on more effortful cognition or deliberation. Also, a changed perception that structural changes toward more sustainability are possible through visible positive examples in one's own environment may counter hopelessness and disillusionment, which can be inhibitors for action (Grund and Brock 2019; Landry et al. 2018). Related to this, experiencing a WIA implies that learners experience (more) consistency between awareness and action, which may be associated with a reduction in internal dissonance and may also explain part of the observed positive correlations with well-being of learners and educators. Moreover, experiencing sustainability processes in which—ideally—own perspectives are relevant, heard and implemented as part of a collective effort may lead to an increased (self-)efficacy belief, both on the individual and collective level (e.g., Bandura 1997; Jugert et al. 2016). This may also lead to an increased sense of responsibility and agency (e.g., Emirbayer and Mische 1998), which can be viewed as a particular challenge in the field of sustainability given the complexity of sustainability challenges and tendencies toward pessimism about the future (Grund and Brock 2019; Ojala 2016). Interestingly, looking at the suggested link between experienced WIAs and self-described motivation and empowerment, a positive reinforcing feedback loop can be expected: motivated and empowered learners and educators can also be assumed to be more likely to make their institution a place where the WIA is implemented.

Future use of the WIA-Scale: indicator, monitoring and organizational development

Concerning future use, the WIA-Scale may be utilized by both researchers and practitioners, e.g., for monitoring purposes as a process indicator for consistent high-quality ESD or as part of organizational development processes (e.g., for critical self-evaluation). The data from Germany can serve as a comparison for future assessments within educational organizations or at a more aggregate level such as within communities, states, countries or larger regions. As the scale was pretested and refined as part of the German national monitoring on ESD, context-specific adjustments are recommended for its use in other contexts. In future studies, the scale could be complemented with open questions, e.g., on drivers of and barriers to organizational change toward sustainability. Also, further research could combine the WIA-Scale with conventional sustainability assessments to explore how the perceptions of learners

and educators match with indicators commonly used in sustainability reporting. With regard to the two groups—learners and educators—we would generally recommend questioning both, as these different perspectives may be fruitful, e.g., in a process of organizational development. If used as an indicator for high-quality ESD, the perspective of learners may be considered even less susceptible to self-reporting biases. Moreover, this also allows one to directly grasp an output perspective on WIAs: how it is perceived by and how it motivates the “main target group” of educational institutions. Considering the high internal consistency of the scale, it is possible to use several variants depending on the use case. Here, we presented the WIA-Scale (13/15 items), while a shorter variant with 7/8 items that correlates very highly with the presented scale ($r_{\text{Learners}} = 0.962^{***}$; $r_{\text{Educators}} = 0.977^{***}$) is provided in the supplementary material (S2). Both encompass all areas of action of the WIA and can be used for independent assessments or self-evaluations. Further facets for an extended version (e.g., for in-depth self-assessments) can be found in the supplementary material to Holst (2023). Moreover, we suggested a one-item indicator (“WIA-Coherence”) that correlates highly with the WIA-Scale. This item may be useful when there is a strong limit to the number of items that can be assessed. For such standalone use, examples of areas of action (see the section on the conceptual basis of WIAs) should be provided in brackets. Also, further studies are required to test the robustness of the correlation between the one-item indicator with the overall WIA-Scale with respondents who have not answered the rest of the scale before, as the previously answered items and the response order might influence the answers.

Conclusion and outlook: toward high-quality ESD through WIAs

To foster coherent high-quality sustainability learning, the concept of WIAs calls for educational organizations to set the default modes of all activities and rules-in-use on sustainability (Buckler and Creech 2014; Holst 2023; Rieckmann et al. 2017; Wals and Mathie 2022). The first large-scale application of the introduced and validated WIA-Scale indicates that the degree to which sustainability is experienced on an everyday basis is of substantial relevance for effective sustainability learning. This effect can be assumed to exist beyond the large-scale sample in Germany. The results underline the importance of not just adding sustainability as another learning content to be conveyed, but to instead practice it on an everyday basis across the different domains of the educational institution. In other words, high-quality ESD is strongly linked to the realization of WIAs. Considering the importance of

education for achieving the SDGs, we argue that WIAs to sustainability are a critical component of twenty-first century quality education in general (Laurie et al. 2016; also UNESCO 2020). Implementing WIAs in practice requires, among other things, the establishment of favorable policy frameworks that provide orientation as well as financial, material and personnel support for the collaborative development of educational institutions as learning and experience spaces for sustainable development (e.g., Tilbury and Galvin 2022; UNESCO 2020; Wals and Benavot 2017).

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Data availability Data supporting the results of this study can be requested from the corresponding author.

Declarations

Conflict of interest The authors declare that there is no conflict of interest.

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References

- Abson DJ, Fischer J, Leventon J, Newig J, Schomerus T, Vilsmaier U, von Wehrden H, Abernethy P, Ives CD, Jäger NW, Lang DJ (2017) Leverage points for sustainability transformation. *Ambio* 46(1):30–39. <https://doi.org/10.1007/s13280-016-0800-y>
- Alvesson M (2013) Understanding organizational culture, 2nd edn. SAGE Publications Ltd, Los Angeles–London
- Artino AR, La Rochelle JS, Dezee KJ, Gehlbach H (2014) Developing questionnaires for educational research: AMEE Guide No. 87.

- Med Teach 36(6):463–474. <https://doi.org/10.3109/0142159X.2014.889814>
- Bandura A (1997) Self-efficacy: the exercise of control. W H Freeman/ Times Books/Henry Holt & Co, New York
- Barratt Hacking E, Scott W, Lee E (2010) Evidence of impact of sustainable schools. Department for Children, Schools and Families (DCSF), Nottingham
- Barsalou LW (2008) Grounded cognition. *Annu Rev Psychol* 59:617–645. <https://doi.org/10.1146/annurev.psych.59.103006.093639>
- Barth M, Fischer D, Michelsen G, Nemnich C, Rode H (2012) Tackling the knowledge-action gap in sustainable consumption: insights from a Participatory School Programme. *J Educ Sustain Dev* 6(2):301–312. <https://doi.org/10.1177/0973408212475266>
- Bautista-Puig N, Sanz-Casado E (2021) Sustainability practices in Spanish higher education institutions: an overview of status and implementation. *J Clean Prod* 295:126320. <https://doi.org/10.1016/j.jclepro.2021.126320>
- Birney A, Reed J (2009) Sustainability and renewal: findings from the Leading Sustainable Schools research project. A research study highlighting the characteristics of sustainable schools and the leadership qualities required to develop sustainable schools. National College for Leadership of Schools and Children's Services, Nottingham
- Boeve-de Pauw J, van Petegem P (2013) A cross-cultural study of environmental values and their effect on the environmental behavior of children. *Environ Behav* 45(5):551–583. <https://doi.org/10.1177/0013916511429819>
- Boeve-de Pauw J, Gericke N, Olsson D, Berglund T (2015) The effectiveness of Education for Sustainable Development. *Sustainability* 7(11):15693–15717. <https://doi.org/10.3390/su71115693>
- Bohunovsky L, Radinger-Peer V, Penker M (2020) Alliances of change pushing organizational transformation towards sustainability across 13 universities. *Sustainability* 12(7):1–20. <https://doi.org/10.3390/su12072853>
- Bonifay W, Cai L (2017) On the complexity of item response theory models. *Multivar Behav Res* 52(4):465–484. <https://doi.org/10.1080/00273171.2017.1309262>
- Bosevska J, Kriewaldt J (2020) Fostering a whole-school approach to sustainability: learning from one school's journey towards sustainable education. *Int Res Geogr Environ Educ* 29(1):55–73. <https://doi.org/10.1080/10382046.2019.1661127>
- Brock A (2022) Materialität menschlicher Freiheiten. Gerechtigkeit als Bildungsauftrag: Relationen zwischen Umwelt und Sozialem gestalten. Springer VS, Wiesbaden
- Brundiers K, Barth M, Cebrián G, Cohen M, Diaz L, Doucette-Remington S, Dripps W, Habron G, Harré N, Jarchow M, Losch K, Michel J, Mochizuki Y, Rieckmann M, Parnell R, Walker P, Zint M (2021) Key competencies in sustainability in higher education—toward an agreed-upon reference framework. *Sustain Sci* 16(1):13–29. <https://doi.org/10.1007/s11625-020-00838-2>
- Buckler C, Creech H (2014) Shaping the future we want: UN decade of Education for Sustainable Development (2005–2014); final report. UNESCO Publishing, Paris
- Bundesamt für Naturschutz (2017) Naturbewusstsein 2015: Wissenschaftlicher Vertiefungsbericht. Bundesamt für Naturschutz, Bonn
- Campanelli P (2008) Testing survey questions. In: de Leeuw ED, Hox JJ, Dillman DA (eds) *International handbook of survey methodology*. Taylor & Francis Group, New York, pp 176–200
- Cialdini RB, Jacobson RP (2021) Influences of social norms on climate change-related behaviors. *Curr Opin Behav Sci* 42:1–8. <https://doi.org/10.1016/j.cobeha.2021.01.005>
- Cohen J (1988) *Statistical power analysis for the behavioral sciences*, 2nd ed. Lawrence Erlbaum Associates, New York
- Collins D (2003) Pretesting survey instruments: an overview of cognitive methods. *Qual Life Res* 12:229–238. <https://doi.org/10.1023/A:1023254226592>
- CRUE (2023) Diagnóstico de la Sostenibilidad Ambiental en las Universidades Españolas. Informe 2021. Grupo de Evaluación de la Sostenibilidad Universitaria (GESU) de Crue-Sostenibilidad
- DCSF (2009) S3: sustainable school self-evaluation. Driving school improvement through sustainable development. Department for Children, School and Families, Nottingham
- de Haan G (2010) The development of ESD-related competencies in supportive institutional frameworks. *Int Rev Educ* 56(2–3):315–328. <https://doi.org/10.1007/s11159-010-9157-9>
- Emirbayer M, Mische A (1998) What is agency? *Am J Sociol* 103(4):962–1023. <https://doi.org/10.1086/231294>
- Faulbaum F, Rexroth M, Prüfer P (2009) Was ist eine gute Frage? Die systematische Evaluation der Fragenqualität, 1st edn. Springer VS Verlag, Wiesbaden
- Ferreira J-A, Ryan L, Tilbury D (2006) Whole-school approaches to sustainability: a review of models for professional development in pre-service teacher education. Australian Research Institute in Education for Sustainability (ARIES) for the Australian Government Department of the Environment and Heritage
- Fischer D, Jenssen S, Tappeser V (2015) Getting an empirical hold of the sustainable university: a comparative analysis of evaluation frameworks across 12 contemporary sustainability assessment tools. *Assess Eval High Educ* 40(6):785–800. <https://doi.org/10.1080/02602938.2015.1043234>
- Fritsche I, Barth M, Jugert P, Masson T, Reese G (2018) A social identity model of pro-environmental action (SIMPEA). *Psychol Rev* 125(2):245–269. <https://doi.org/10.1037/rev0000090>
- Fugate JMB, Macrine SL, Cipriano C (2019) The role of embodied cognition for transforming learning. *Int J Sch Educ Psychol* 7(4):274–288. <https://doi.org/10.1080/21683603.2018.1443856>
- Gehlbach H, Brinkworth ME (2011) Measure twice, cut down error: a process for enhancing the validity of survey scales. *Rev Gen Psychol* 15(4):380–387. <https://doi.org/10.1037/a0025704>
- Gericke N (2022) Implementation of Education for Sustainable Development through a whole school approach. In: GülizKaraarslan S (ed) *Education for Sustainable Development in primary and secondary schools*. Springer, Cham, pp 153–166
- Goldman D, Ayalon O, Baum D, Weiss B (2018) Influence of 'green school certification' on students' environmental literacy and adoption of sustainable practice by schools. *J Clean Prod* 183:1300–1313. <https://doi.org/10.1016/j.jclepro.2018.02.176>
- Gramatakos AL, Lavau S (2019) Informal learning for sustainability in higher education institutions. *Int J Sustain High Educ* 20(2):378–392. <https://doi.org/10.1108/IJSHE-10-2018-0177>
- Grund J, Brock A (2019) Why we should empty Pandora's box to create a sustainable future: hope, sustainability and its implications for education. *Sustainability* 11(3):893. <https://doi.org/10.3390/su11030893>
- Grund J, Brock A (2020) Education for Sustainable Development in Germany: not just desired but also effective for transformative action. *Sustainability* 12(2838):1–20. <https://doi.org/10.3390/su12072838>
- Grund J, Brock A (2022) Formale Bildung in Zeiten von Krisen – die Rolle von Nachhaltigkeit in Schule, Ausbildung und Hochschule. Kurzbericht des Nationalen Monitorings zu Bildung für nachhaltige Entwicklung (BNE) auf Basis einer Befragung von > 3.000 jungen Menschen und Lehrkräften. Institut Futur, Freie Universität Berlin
- Hargreaves LG (2008) The whole-school approach to Education for Sustainable Development: from pilot projects to systemic change. *Policy Pract Dev Educ Rev* 6:69–74
- Harkness J (2003) Questionnaire translation. In: Harkness J, van de Vijver F, Mohler P (eds) *Cross-cultural survey methods*. Wiley-Interscience, Hoboken, pp 35–56
- Henderson K, Tilbury D (2004) Whole-school approaches to sustainability: an international review of sustainable school programs.

- Australian Research Institute in Education for Sustainability (ARIES) for The Department of the Environment and Heritage
- Hickman C, Marks E, Pihkala P, Clayton S, Lewandowski RE, Mayall EE, Wray B, Mellor C, van Susteren L (2021) Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *Lancet Planet Health* 5(12):e863–e873. [https://doi.org/10.1016/S2542-5196\(21\)00278-3](https://doi.org/10.1016/S2542-5196(21)00278-3)
- Holst J (2023) Towards coherence on sustainability in education: a systematic review of Whole Institution Approaches. *Sustain Sci* 18(2):1015–1030. <https://doi.org/10.1007/s11625-022-01226-8>
- Holst J, Singer-Brodowski M, Brock A, de Haan G (2024) Monitoring SDG 4.7: assessing Education for Sustainable Development in policies, curricula, training of educators and student assessment (input-indicator). *Sustain Dev*. <https://doi.org/10.1002/sd.2865>
- Hopkinson P, Hughes P, Layer G (2008) Sustainable graduates: linking formal, informal and campus curricula to embed Education for Sustainable Development in the student learning experience. *Environ Educ Res* 14(4):435–454. <https://doi.org/10.1080/13504620802283100>
- Hu L-T, Bentler PM (1995) Evaluating model fit. In: Hoyle RH (ed) *Structural equation modeling: concepts, issues, and applications*. Sage Publications Inc, Thousand Oaks, pp 76–99
- Jugert P, Greenaway KH, Barth M, Büchner R, Eisentraut S, Fritsche I (2016) Collective efficacy increases pro-environmental intentions through increasing self-efficacy. *J Environ Psychol* 48:12–23. <https://doi.org/10.1016/j.jenvp.2016.08.003>
- Kaaronen RO (2018) Reframing tacit human-nature relations: an inquiry into process philosophy and the philosophy of Michael Polanyi. *Environ Values* 27(2):179–201. <https://doi.org/10.3197/096327118X15162907484466>
- Kahneman D (2003) A perspective on judgment and choice: mapping bounded rationality. *Am Psychol* 58(9):697–720. <https://doi.org/10.1037/0003-066X.58.9.697>
- Keizer K, Schultz PW (2018) Social norms and pro-environmental behaviour. In: Steg L, de Groot JIM (eds) *Environmental psychology. An introduction*, 2nd edn. Wiley, Hoboken, pp 179–188
- Kohl K, Hopkins C, Barth M, Michelsen G, Dlouhá J, Razak DA, Abidin Bin Sanusi Z, Toman I (2022) A whole-institution approach towards sustainability: a crucial aspect of higher education's individual and collective engagement with the SDGs and beyond. *Int J Sustain High Educ* 23(2):218–236. <https://doi.org/10.1108/IJSHE-10-2020-0398>
- Landry N, Gifford R, Milfont TL, Weeks A, Arnocky S (2018) Learned helplessness moderates the relationship between environmental concern and behavior. *J Environ Psychol* 55:18–22. <https://doi.org/10.1016/j.jenvp.2017.12.003>
- Larrán Jorge M, Herrera Madueño J, Calzado Y, Andrades J (2016) A proposal for measuring sustainability in universities: a case study of Spain. *Int J Sustain High Educ* 17(5):671–697. <https://doi.org/10.1108/IJSHE-03-2015-0055>
- Laurie R, Nonoyama-Tarumi Y, McKeown R, Hopkins C (2016) Contributions of Education for Sustainable Development (ESD) to quality education: a synthesis of research. *J Educ Sustain Dev* 10(2):226–242. <https://doi.org/10.1177/0973408216661442>
- Lozano R, Ceulemans R, Alonso-Almeida M, Huisingh D, Lozano FJ, Waas T, Lambrechts W, Lukman R, Hugé J (2015) A review of commitment and implementation of sustainable development in higher education: results from a worldwide survey. *J Clean Prod* 108:1–18. <https://doi.org/10.1016/j.jclepro.2014.09.048>
- Mathar R (2013) The concept of the Whole School Approach—a platform for school development with focus on sustainable development. Concept paper (ESD Expert Network). <https://test.esd-expert.net/files/ESD-Expert/pdf/Concept-Paper-Mathar.pdf>
- McMillin J, Dyball R (2009) Developing a whole-of-university approach to educating for sustainability. *J Educ Sustain Dev* 3(1):55–64. <https://doi.org/10.1177/097340820900300113>
- Mogren A, Gericke N, Scherp H-A (2019) Whole school approaches to Education for Sustainable Development: a model that links to school improvement. *Environ Educ Res* 25(4):508–531. <https://doi.org/10.1080/13504622.2018.1455074>
- Nationale Plattform BNE c/o BMBF (2017) Nationaler Aktionsplan Bildung für nachhaltige Entwicklung. Der deutsche Beitrag zum UNESCO-Weltaktionsprogramm
- Nazir J, Pedretti E, Wallace J, Montemurro D, Inwood H (2011) Reflections on the Canadian experience with education for climate change and sustainable development. *Can J Sci Math Technol Educ* 11(4):365–380. <https://doi.org/10.1080/14926156.2011.624673>
- Ojala M (2016) Facing anxiety in climate change education: from therapeutic practice to hopeful transgressive learning. *Can J Environ Educ* 21:41–56
- Olson K (2010) An examination of questionnaire evaluation by expert reviewers. *Field Methods* 22(4):295–318. <https://doi.org/10.1177/1525822X10379795>
- Olsson D, Gericke N, Chang Rundgren S-N (2016) The effect of implementation of Education for Sustainable Development in Swedish compulsory schools—assessing pupils' sustainability consciousness. *Environ Educ Res* 22(2):176–202. <https://doi.org/10.1080/13504622.2015.1005057>
- Olsson D, Gericke N, Boeve-de Pauw J, Berglund T, Chang T (2019) Green schools in Taiwan—effects on student sustainability consciousness. *Glob Environ Change* 54:184–194. <https://doi.org/10.1016/j.gloenvcha.2018.11.011>
- Orr DW (2004) *Earth in mind: on education, environment, and the human prospect*, 2nd edn. Island Press, Washington DC
- Otto IM, Donges JF, Cremades R, Bhowmik A, Hewitt RJ, Lucht W, Rockström J, Allerberger F, McCaffrey M, Doe SS, Lenferna A, Morán N, van Vuuren DP, Schellnhuber HJ (2020) Social tipping dynamics for stabilizing Earth's climate by 2050. *Proc Natl Acad Sci USA* 117(5):2354–2365. <https://doi.org/10.1073/pnas.1900577117>
- Polanyi M (1966, 2009) *The tacit dimension*. With a new foreword by Amartya Sen. University of Chicago Press, Chicago
- Razali NM, Wah YB (2011) Power comparisons of Shapiro–Wilk, Kolmogorov–Smirnov, Lilliefors and Anderson–Darling tests. *J Stat Model Anal* 2(1):21–33
- Rieckmann M (2018) Chapter 2: Learning to transform the world: key competencies in ESD. In: Leicht A, Heiss J, Byun WJ (eds) *Issues and trends in Education for Sustainable Development*. United Nations Educational, Scientific and Cultural Organization, Paris, pp 39–60
- Rieckmann M, Mindt L, Gardiner S (2017) *Education for Sustainable Development goals: learning objectives*. UNESCO Publishing, Paris
- Sass W, de Maeyer S, Boeve-de Pauw J, van Petegem P (2023) Honing action competence in sustainable development: what happens in classrooms matters. *Environ Dev Sustain* 25(4):3649–3670. <https://doi.org/10.1007/s10668-022-02195-9>
- Schein EH, Schein P (2017) *Organizational culture and leadership*, 5th edn. Wiley, Hoboken
- Scott WAH (2015) Exploring a transformative orientation to sustainability in universities: a question of loose and tight framings. *Environ Educ Res* 21(6):943–953. <https://doi.org/10.1080/13504622.2014.954238>
- Shallcross T, Robinson J, Pace P, Tamoutseli K (2007) The role of students' voices and their influence on adults in creating more sustainable environments in three schools. *Improv Sch* 10(1):72–85. <https://doi.org/10.1177/1365480207073723>

- Spínola H (2015) Environmental literacy comparison between students taught in eco-schools and ordinary schools in the Madeira Island Region of Portugal. *Sci Educ Int* 26(3):392–413
- Steffen W, Richardson K, Rockström J, Cornell SE, Fetzer I, Bennett EM, Biggs R, Carpenter SR, Vries W de, Wit CA de, Folke C, Gerten D, Heinke J, Mace GM, Persson LM, Ramanathan V, Reyers B, Sörlin S (2015) Planetary boundaries: guiding human development on a changing planet. *Science* 347(6223). <https://doi.org/10.1126/science.1259855>
- Sterling S (2003) Whole systems thinking as a basis for paradigm change in education: explorations in the context of sustainability. PhD, University of Bath
- Tilbury D, Galvin C (2022) Input paper: A Whole School Approach to Learning for Environmental Sustainability. European Commission, DG Education, Youth, Sport and Culture. <https://education.ec.europa.eu/sites/default/files/2022-02/input-paper-whole-school-approach-sustainability.pdf>
- Topp CW, Østergaard SD, Søndergaard S, Bech P (2015) The WHO-5 Well-Being Index: a systematic review of the literature. *Psychother Psychosom* 84(3):167–176. <https://doi.org/10.1159/000376585>
- Torsdottir AE, Sinnes AT, Olsson D, Wals A (2023) Do students have anything to say? Student participation in a whole school approach to sustainability. *Environ Educ Res*. <https://doi.org/10.1080/13504622.2023.2213427>
- UNESCO (2012) Education for Sustainable Development: sourcebook. Education for Sustainable Development in action. Learning & Training Tools, Paris
- UNESCO (2020) Education for Sustainable Development. A roadmap. Paris
- UNESCO (2021) Berlin declaration on Education for Sustainable Development. Berlin
- United Nations General Assembly (2015) 70/1. Transforming our world: the 2030 agenda for sustainable development
- United Nations General Assembly (2017) Education for Sustainable Development in the framework of the 2030 agenda for sustainable development. Resolution 72/222
- Urbanski M, Filho WL (2015) Measuring sustainability at universities by means of the sustainability tracking, assessment and rating system (STARS): early findings from STARS data. *Environ Dev Sustain* 17(2):209–220. <https://doi.org/10.1007/s10668-014-9564-3>
- Wals AEJ (2012) Shaping the education of tomorrow: 2012 full-length report on the UN decade of Education for Sustainable Development. DESD Monitoring & Evaluation, Paris
- Wals AEJ, Benavot A (2017) Can we meet the sustainability challenges? The role of education and lifelong learning. *Eur J Educ* 52(4):1–10. <https://doi.org/10.1111/ejed.12250>
- Wals AEJ, Mathie RG (2022) Whole school responses to climate urgency and related sustainability challenges. In: Peters MA, Heraud R (eds) *Encyclopedia of educational innovation*. Springer, Singapore, pp 1–8
- Warner BP, Elser M (2015) How do sustainable schools integrate sustainability education? An assessment of certified sustainable K-12 schools in the United States. *J Environ Educ* 46(1):1–22. <https://doi.org/10.1080/00958964.2014.953020>
- Weichbold M (2014) Pretest. In: Baur N, Blasius J (eds) *Handbuch Methoden der empirischen Sozialforschung*. Springer Fachmedien, Wiesbaden, pp 299–304
- Willis GB (1999) Cognitive interviewing: a “How To” guide. Research Triangle Institute, North Carolina
- Winkler N, Kroh M, Spiess M (2006) Entwicklung einer deutschen Kurzskaala zur zweidimensionalen Messung von sozialer Erwünschtheit. German Institute for Economic Research, Berlin
- Winter J, Cotton D (2012) Making the hidden curriculum visible: sustainability literacy in higher education. *Environ Educ Res* 18(6):783–796. <https://doi.org/10.1080/13504622.2012.670207>

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8.1.4. Article 4: Holst, Brock et al. (2025)

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Weighing Factor	1.0 (Predominant contribution)
Presentations at Conferences	Holst, J. (2024). Der Whole Institution Approach als Prozessindikator für die Verankerung von BNE. 29. Kongress der Deutschen Gesellschaft für Erziehungswissenschaft als Teil des Panels „Monitoring von Bildung für nachhaltige Entwicklung im deutschen Bildungssystem“ (Chair: Dr. Mandy Singer-Brodowski) (12.03.2024).

Abbreviations:

JH: Jorrit Holst

JG: Dr. Julius Grund

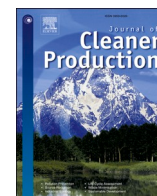
MSB: Prof. Dr. Mandy Singer-Brodowski

AB: Dr. Antje Brock

AKS: Ann-Kathrin Schlieszus

Supplementary Material:

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Whole-school sustainability at the core of quality education: Wished for by principals but requiring collective and structural action

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ABSTRACT

In the face of global challenges, sustainability has become a defining concern of the 21st century and hence a critical pillar of quality education. Principals, as pivotal actors in school development, can provide important perspectives on the current state and future developments of whole-school sustainability. However, while their role in promoting sustainability is widely recognized, systematic, national-scale insights concerning their views on sustainability in schools and the school system remain scarce. Drawing on qualitative content analysis of 80 semi-structured interviews and a representative survey ($n = 1310$) with principals in Germany, the article provides an in-depth and large-scale assessment of leaders' perspectives on the current and wished-for status, challenges, and drivers of sustainability at schools. We find that 80 % of principals wish for sustainability to be a core element of school education, yet 62 % describe the current status quo as non-existent, isolated or an occasional add-on. Perceived challenges include a lack of resources, structural integration, as well as prevailing rule-systems and mindsets that hinder sustainability (e.g., normality of unsustainability, strong performance- and grade-orientation, systemic inertia). To overcome current challenges, the principals point to a need for considerably higher prioritization of sustainability by decision-makers at all levels. Overall, the findings indicate that sustainability in school education is currently limited by a system in which sustainability is an additive, not a default, and where responsibility for sustainability is often individualized, fragmented and diffused. In light of the findings, we discuss the relevance of more collective, structure-oriented and political sustainability learning, which is prioritized as a core feature of quality education.

1. Introduction: whole-school sustainability and the (missing) perspectives of principals

In times of mounting social and ecological crises, sustainability has become an ever more pressing concern also within education. As Klafki (1996, p. 154) has argued, general quality education needs to be closely linked to the “key problems, that globally interweave our individual and political-societal existence”. In the face of continuous transgressions of the Earth system limits (Pörtner et al., 2023; Rockström et al., 2023) and large-scale social injustices, it is clear that current human unsustainability is one of the defining epochal key challenges (Kvamme, 2021). Yet, research on education has shown that to date, sustainability is often

approached at the project level or as an additive to an otherwise mostly unchanged system (Holst et al., 2024b; Wals and Benavot, 2017; Wals and Mathie, 2022). In consideration of the depth of changes associated with achieving sustainability (Sachs et al., 2019; UN General Assembly, 2015), scholars, practitioners, (inter-)national organizations and policy-makers have instead called for a whole-system approach, emphasizing that effective sustainability education implies integrating and practicing sustainability at all system levels (e.g., Buckler and Creech, 2014; Sterling, 2003; UNESCO, 2021).

With a focus on the level of learning environments in school education, the concept of Whole School Approach (WSA) describes a participatory and continuous process of mainstreaming sustainability as

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a default into all areas of school action and culture (e.g., Barth et al., 2012; Hargreaves, 2008; Henderson and Tilbury, 2004; Holst, 2023; Wals et al., 2024). Such experience of sustainability in educational institutions was found to be highly effective in terms of empowering and motivating learners and educators for sustainability (Holst et al., 2024a). Over the past decades, various guidelines and programs were initiated to support the implementation of WSAs (e.g., Barr et al., 2014; Education Scotland, 2017; Progress, 2024; Tilbury and Galvin, 2022). Internationally, the implementation has been recommended by UNESCO (2020, 2021), UNECE (2005) and the European Union (Council of the European Union, 2022), amongst others. In the federal education system of Germany, where the 16 states hold the primary responsibility for education, the realization of a WSA was recommended by the central coordination body for the development of the school system (Standing Conference of the Ministers of Education and Cultural Affairs, 2024) and committed to in the National Action Plan on Education for Sustainable Development (ESD) (Nationale Plattform BNE c/o BMBF, 2017). Although whole-school sustainability has thus been found to be effective and is aimed for in educational policies, systematic knowledge on its implementation within school systems as well as on associated challenges and drivers remains scarce (e.g., Tilbury and Galvin, 2022; Holst et al., 2024a).

Considering that realizing a WSA requires close linkage with general school improvement and quality development (Henderson and Tilbury, 2004; Mogren et al., 2019; Müller et al., 2020), school leaders (principals) hold a central position in the process of implementation (e.g., Birney and Reed, 2009; Derqui et al., 2020; Müller et al., 2020). They facilitate school development processes, communicate norms and give direction to other members of the school community, amongst others (Leo and Wickenberg, 2013; Mogren and Gericke, 2017; Zachariou and Kadji-Beltran, 2009). The perspectives and perceptions of principals on sustainability are therefore highly relevant to identify the current state of WSA realization (status quo indicator), recurring patterns within current educational practice as well as challenges to and drivers of change (facilitative process indicators) (Tilbury and Janousek, 2006). However, previous studies on the status and process of sustainability education have mostly focused at learners and educators (e.g., Timm and Barth, 2021; Holst et al., 2024a). The available research on principals (see section 2) focuses on characteristics of sustainability-effective leadership, roles of principals and barriers to sustainability in schools, often relying on small samples and case-studies (e.g., Evans et al., 2012; Forssten Seiser et al., 2023; Iliško and Badyanova, 2014; Mogren and Gericke, 2019; cf. Cebrián et al., 2022; Müller et al., 2020). As such, there is a gap when it comes to systematic knowledge of principals' views on sustainability across all school forms and the various socio-demographic contexts in full school systems. In light of the importance of principals' leadership qualities and their visions for change (e.g., Sagala et al., 2019), such knowledge is relevant to design effective policies and professional development programs for principals as well as to improve school development practice.

With the aim to develop a systematic knowledge basis regarding principals' perspectives on whole-school sustainability, this article draws on representative survey data and interviews from one school system (Germany), and discusses implications not only for Germany, but also other countries and international bodies. In light of the knowledge gap, we ask: What preconceptions do principals have regarding sustainability? What do they view as the current status of sustainability at their schools, and how do they envision an ideal state of sustainability in future schools? What challenges and drivers do they describe as being most relevant for sustainability in school development? To lay the theoretical groundwork for answering these questions, the following section first provides an overview of the state of research on school leaders in sustainability-oriented school development. We then lay out methods and findings from a mixed-method analysis including (i) 80 interviews with principals from all German federal states, school types (primary, secondary, vocational) and different socio-demographic

contexts as well as (ii) data from a subsequent representative quantitative survey with 1310 principals in Germany. Lastly, we discuss recurring patterns in the data and derive key implications for future policy, research and practice.

2. Principals in sustainability-oriented school development: state of research

Through their communication and actions, e.g., in human resource management and participative governance, principals set widely perceived norms and influence organizational culture (Leo and Wickenberg, 2013), motivate individuals (Müller et al., 2020) and contribute to vision-building among school members (e.g., Bosevska and Kriewaldt, 2020; Kadji-Beltran et al., 2013). Sustainability-effective principals organize collaboration and participation within the school and local community (Mogren and Gericke, 2017, 2019; e.g.), foster distributed and collective leadership (Kadji-Beltran et al., 2013; Leo and Wickenberg, 2013), support direct and open communication and develop space for pluralistic and critical viewpoints (e.g., Forssten Seiser et al., 2023). Such proactive leadership is described to include building structures and routines around sustainability (Leo and Wickenberg, 2013; Mogren et al., 2024), institutionalizing what has been achieved and legitimizing further developments (Mogren and Gericke, 2019). While sustainable leadership is considered critical (Verhelst et al., 2023), there is currently no agreed-upon leadership framework for sustainability at schools (cf. Cebrián et al., 2022).

While a large part of research on principals focuses on such sustainability-effective leadership in general, Forssten Seiser et al. (2023) and Müller et al. (2020) identified specific roles for principals in different phases of sustainability in school development. In an initiative phase, the focus lies on vision building, supporting engaged early-adopters and facilitating a participative process in which assessments are made, goals are defined, projects and groups are initiated and nurtured, and funding and support are organized (ibid.). In an implementation phase, schools move from projects to integrating sustainability into their structure, involving the broader school community and all areas of action. Here, leaders are described as motivating and supporting, facilitating participation, but also providing direction and defending and institutionalizing what has been achieved, for example by anchoring sustainability in school programs and consolidating steering groups and/or coordinators. The third phase (institutionalization) is described to be about ongoing development and continuous, recurring learning.

Despite studies focusing on leadership and roles of principles, few have addressed challenges and drivers from their perspective. In these, a lack of structural integration of sustainability, overloaded curricula, and the combination of multiple programs were described to make it difficult for school leaders to prioritize (Zachariou and Kadji-Beltran, 2009). Also, some studies describe bureaucracy as slowing down sustainable school development (Müller et al., 2021), and strong standardization as impeding context-specific approaches (Zachariou and Kadji-Beltran, 2009). Further, several studies identified a lack of time and financial resources as structural hinderances (Cebrián et al., 2022; Evans et al., 2012; Müller et al., 2021) and point to the principals' own lack of professional development as a barrier to sustainability at schools (e.g., Leo and Wickenberg, 2013; Zachariou et al., 2013; Zachariou and Kadji-Beltran, 2009). While in summary, there has been research on sustainability-effective leadership, roles in different phases and to some extent challenges, the current knowledge basis relies on smaller samples, mostly in specific sub-sections of education systems, and consequently does not capture large-scale patterns and trends. There is thus a considerable gap when it comes to system-wide knowledge on principals' perceptions on the state of sustainability at schools, visions for future schools as well as of recurring key challenges and drivers.

3. Methods

To systematically assess the perspectives of principals on sustainability in school education at the level of a full education system (Germany), we conducted a mixed-method analysis in which we triangulated data from 80 semi-structured interviews and a representative survey of school leaders ($n = 1310$). For context, it is relevant to note that the German school system is highly decentralized with responsibilities largely shared between the 16 federal states (overseeing, for example, curricula, school types, graduation standards, employment, examination) and local authorities (e.g., responsible for school infrastructure, facility management, transportation, support staff) (cf. Huber et al., 2017).

3.1. Interviews

As part of the German national monitoring on ESD, a total of 80 interviews were conducted with an average length of around 30 min. The interviewees were sampled according to four predefined criteria: (i) representation of all federal states relative to the size of each state, (ii) representation of different types of school relative to the total number of schools (e.g., primary schools, non-selective secondary schools, selective secondary schools, vocational schools), (iii) different locations (rural, small towns, urban areas of different sizes) and (iv) proportion of parents receiving government assistance (socio-economic indicator). A descriptive overview is attached in the appendix. Random sampling from a large database of school leaders as well as data collection and initial coding was commissioned to a service provider (Forsa). Taking into consideration the current state of research outlined above (e.g., Forssten-Seiser et al., 2023; Mogren and Gericke, 2019; Zachariou and Kadji-Beltran, 2009; Holst, 2023), a semi-structured questionnaire (cf. appendix) with six subsections was developed to standardize and guide the interviews:

1. Personal preconceptions of sustainability
2. Current and wished-for status of sustainability integration at school
3. Visions for ideal schools
4. Drivers
5. Challenges
6. Further relevant conditions

The interview guide contained open-ended questions as well as quantitative scales about the current and wished-for status of sustainability at the school. Five interviewers were involved in the interviews, all of whom participated in two interview training sessions and several feedback rounds to ensure a standardized procedure. The 80 interviews were conducted between November 14, 2022 and January 16, 2023 (9 via telephone, 69 online, 2 mixed). All audio data was recorded and transcribed.

A structuring content analysis was conducted on the qualitative data, drawing on Kuckartz and Rädiker (2022) for the deductive-inductive development of categories. A code plan with coding-rules was developed and iteratively refined. The coding structure for the first-order codes follows the main categories of the questionnaire (preconceptions, current and wished-for status, visions, challenges, drivers). For the current status, the WSA-heuristic by Holst (2023) (areas of action, core principles) was used as deductive second-order categories. Within the deductive categories, sub-categories were inductively developed in three rounds of coding. The segments within the sub-categories were synthesized, and the main categories with the relevant findings are reported below.

3.2. Representative quantitative survey

Based on the findings from the interviews, a representative survey was conducted to quantify the perceptions of school leaders across the

German school system ($n = 1310$). The representative sample was drawn from a population of all school principals in Germany (3008 principals were contacted; response rate: 43.6 %; overview of school types attached in the appendix). To triangulate the findings from the interviews and thus allow for greater generalizability, the survey covers key elements identified in the interviews as potentially important as well as aspects highlighted in the literature (e.g., Grund and Brock, 2022; Cebrián et al., 2022; Zachariou and Kadji-Beltran, 2009). It was developed by the authors with feedback from the German Education Association (Verband Bildung und Erziehung, VBE) and Forsa. The questionnaire contains quantitative scales on (1) the current and (2) the wished-for status of sustainability at the school, using the same scales as in the interviews, as well as on (3) drivers of and (4) challenges to sustainability and ESD in schools and school development. The full scales as well as descriptive statistics can be found in the appendix. Sampling and data collection was again commissioned to a service provider (Forsa) in cooperation with VBE. The mean age of respondents was 52.5 years (standard deviation = 7.4 years), with 60.2 % of principals identifying as female and 39.1 % as male (0.7 % diverse). The higher number of female participants can be explained by the representativity of the sample: 51.8 % of schools in the sample are primary schools, where the large majority of principals identify as female. We report both descriptive results for each scale and findings from exploratory correlation analyses (Spearman's rank correlation).

4. Results

To offer a system-wide perspective on principals' views on sustainability in school education, the following sections jointly report on the findings from the interviews and the representative survey on preconceptions, the current and desired status, visions as well as challenges and drivers.

4.1. Principals' preconceptions of sustainability

The 80 interviews began with an open-ended question on personal preconceptions of sustainability. With a few exceptions, principals associated the concept with environmental or social issues that require changes in the course of action. Responses were clustered within (i) individual-centered changes in behavior and (ii) collective and structural changes. Most principals focused primarily on the first, individual level changes, such as waste separation, energy saving or gardening. In doing so, they tended to focus on easy to implement actions and in many cases did not address 'key points' in behavioral changes towards sustainability (e.g., nutrition, mobility, buildings). Most examples focused on environmental aspects, fewer on social sustainability. A smaller group of principals linked sustainability directly to the need for collective and structural changes, e.g., large-scale shifts in societal values and collective action. These principals referred to intergenerational responsibility, viewed sustainability as a collective task, and called for shifts in the economic and political system. In a few instances, leaders directly linked sustainability to political participation, which can be learned in schools through the experience of democratic participation. After this exploration of preconceptions, a working definition was presented, describing sustainability as an environmentally sustainable and socially and economically just world for all, now and in the future. Also, it was explained that the interview focuses on sustainability in school development, including all areas of action, from teaching to procurement, operations, grounds, communication and cooperation.

4.2. Status quo of sustainability integration at schools and envisioned futures

In both the representative survey and the interviews, school leaders were asked to describe the status quo at their schools as well as the ideal, wished-for status using a 6-point scale to assess the quantity and depth of

whole-school sustainability. In the representative survey, 80 % of school leaders in Germany described the ideal school as one which is moving towards whole-school integration of sustainability (Fig. 1). One third of all principals responded that sustainability should be a topic in all subjects and shape everyday school life as a guiding orientation. At the same time, 62 % of principals described the current degree of sustainability integration as non-existent, isolated, or an occasional add-on (Fig. 1). Overall, a large discrepancy was found between the current and wished-for status (mean difference of 1.3 points; standard deviation: 1.3). Explorative correlation analyses revealed that principals who describe the current status as higher report slightly higher on job satisfaction ($r = 0.087^{**}$) and would be more likely to recommend their job to others ($r = 0.108^{**}$). In the 80 interviews, responses were slightly higher both for the current- and wished-for status, which could be an effect of more socially desirable answering in the open interview setting and/or of a possible self-selection bias.

In the interviews, principals were subsequently asked to elaborate on the current status of their schools and what they envision for an ideal school. Responses on the current status were clustered into the action areas of a WSA (governance, curriculum, campus, community, communication, capacity building, organizational culture; Holst, 2023). Principals primarily focused on aspects related to school operations, teaching, and, to a lesser degree, on cooperation with partners, school culture and governance processes. A strong emphasis was found on waste separation, nutrition at school, energy saving and gardening, among others. In contrast, few respondents focused specifically on capacity building (e.g., through teacher training, human resource management) or school communication. As with the preconceptions of sustainability, the descriptions of the current status tended by and large to focus on projects and behavioral changes by individuals at the schools.

In contrast, we found that principals' ascribed visions of ideal schools were more collective in nature. Specifically, principals recurrently

described their vision for future schools as one in which sustainability becoming the 'natural' or 'default' guiding principle for all actions and activities. This is manifested, among other things, in a school that is itself organized as a circular and sustainable system, involves all members of the school community, is embedded in the regional environment and networks, and has a strong collaboration with stakeholders around it (e.g., local authorities). As one principal put it:

"Sustainability is like, the sentence order of subject, predicate, object. Everyone knows what that is. That you don't have to name it as a headline. But that it is implicit and you say okay, we've done some good things here." (Participant 1 (P-1), Position (Pos.) 29)

The metaphors used by principals – another also referred to sustainability as *"the DNA of everyone involved"* (P-2) – suggest that sustainability in an ideal school is understood as an indispensable and vital organizing principle. In the visions of many of the school leaders interviewed, schools would aim to empower future generations and to provide a space in which sustainability could be practiced and learned. This is linked to the development of supportive frameworks for future education through structural integration of sustainability and ESD in laws, curricula and guiding quality development systems. Leaders further describe the ideal school as embedded in a societal system that prioritizes sustainable over unsustainable actions and, through such prioritization, allocates the required resources and supports sustainable school development. Although their visions contained more collective elements and systemic changes, school leaders often reverted to individual behavioral changes and addressed fewer structural aspects when concretely discussing specific future schools – such as changed school missions and development plans, institutional curricula, environmental management systems, and governance structures.

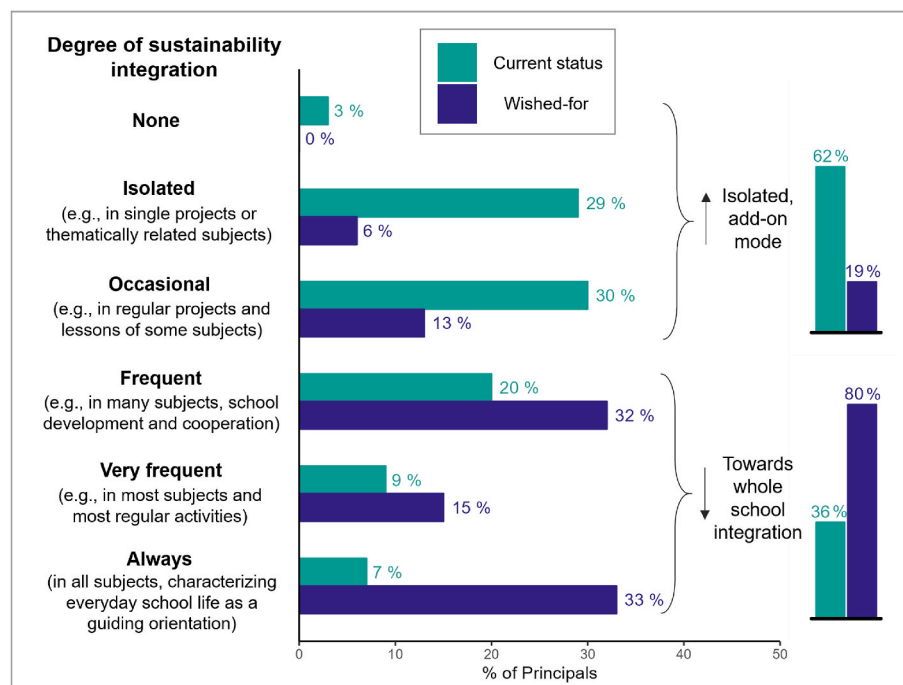


Fig. 1. Current and wished-for sustainability integration in schools from the perspective of principals ($n = 1310$, representative for Germany). No answer was given by 2 % of principals to the question on the current and 1 % on the wished-for status.

4.3. Challenges for whole-school sustainability

Subsequently, principals were asked to identify barriers, hurdles and challenges for whole-school sustainability. In the following, we first provide insights into the results from the interview study by summarizing the main coded categories. We then quantify the occurrence of key challenges through the representative survey.

Repeatedly, school leaders cited a **lack of resources (personnel, time, budgets)** as a critical challenge to greater integration of sustainability in schools. Interestingly, lack of personnel and time were more frequently mentioned than lack of financial resources. Especially with regard to educational policy making and administration, the interviews revealed considerable frustration, as exemplified by the following statement by one of the principals:

"I am not at all interested in impulses from politics. Excuse me for saying that so clearly. I'm sick of all this talk. Either they give us what we need – teachers' posts, budgets, facilities – or they should keep quiet. (...) It may well be that politicians are for sustainability or against it. What interests me is what they do for or against it. So no, I can understand that the children are so desperately calling for Fridays for Future and are getting angrier." (P-3, Pos. 44)

A second set of main barriers referred to by principals is a **lack of awareness among stakeholders** (e.g., parents, students, teachers, authorities) and **specific attitudes that hinder progress toward sustainability**. Regarding the latter, some described direct or indirect resistance to change, mainly among teachers and parents, while others referred more generally to a sense of **demotivation and frustration in an overloaded system, lack of motivation, fear of change, and a mindset of cost reduction** as the primary objective. In this context, principals also described hindering factors in school cultures, such as an **attitude of taking the path of least resistance** (e.g., for reasons of convenience), the perceived **normality of non-sustainability** (e.g., in catering, cleaning, purchasing), pervasive resignation, tiredness, a sense of being torn between demands and conflicting goals, and a mindset that sees sustainability as something that needs to come "from above". Combining some of these aspects, one principal stated:

"Convenience also plays a role, I think. [I]t's really difficult to leave familiar paths when you are already feeling stressed. Then maybe you also say oh, that's no good, this whole attitude is no good anyway. The children won't go along with it. Which is not true, but it is used as an argument for not joining in yourself." (P-4, Pos. 28)

Further, and in line with the perceived 'overload', respondents repeatedly pointed to **distractions from other issues that are being pushed into the system**, as well as **other external demands** on the school system (e.g., adaptation to other multiple crises, such as the COVID-19 pandemic or rising inequalities). Moreover, from the perspective of principals, a **lack of flexibility in the school system** (e.g., restricted decision-making power), **bureaucratic demands, rigid standards and systemic inertia** add to the difficulties of organizing change-processes toward more sustainable schools. In this, principals described themselves and their **schools as dependent** on, for example, the local authorities responsible for school operations and grounds in Germany. One principal describes the situation as follows:

"I might want to have photovoltaics to produce our own electricity or a wind turbine on the grounds. Or something like that. But somehow, I can't make it happen. I have no chance of implementing it. If the local school authority doesn't go along with it, it won't happen." (P-5, Pos. 20).

Such perceived dependency which at times prevents the principals from acting, was also described with respect to regional partners (e.g., cleaning companies, food providers), educational administration and ministries. Regarding the latter, the principals see the **lack of a deep and systemic integration of sustainability and ESD in laws, curricula and quality standards for school education** as a

considerable obstacle. As a result, sustainability efforts were often described as highly dependent on individual motivated and committed members of the school community and as such, as lacking coherence and longevity (e.g., susceptibility to fluctuations in personnel). Principals not only said that sustainability is not integrated in curricula, they also described **curriculum overcrowding** as a problem.

With regard to the systemic environment, principals repeatedly emphasized that the **current strong performance and grade-orientation is a barrier to sustainability** in schools and prevents the development of future competencies. One principal illustrated this in the following way:

"Some colleagues also cause friction on this. Because they have simply internalized this performance mindset so much and need measurable results. With ESD, I don't necessarily have really measurable results that I can then ask about in a test. And where I can then say 1, 2, 3, 4, 5 (...). The [colleagues] really have this total performance flash." (P-6, Pos. 51)

In this quote, the 'performance flash' was attributed to teachers, while other principals more directly focused on the strong grade and performance orientation in the school system. Further, the leaders themselves described a **lack of expertise and knowledge**. Lastly, the **specificities of different school types** (e.g., high fluctuation of students in vocational schools), regional contexts (e.g., socio-economic context, rural or urban) and the **condition of buildings and grounds** (e.g., modernization, age, heritage protection) were mentioned as context-specific challenges.

To quantify the occurrence of key challenges for sustainability in school development, the findings from the interviews were used to design the representative survey. As the number of items were restricted, the survey focused on a set of frequently mentioned challenges (Fig. 2). As shown in Fig. 2a, more than 70 % of principals agreed that a lack of time and personnel and the higher prioritization of other issues and demands is an important challenge for sustainability and ESD in school development. Lack of financial resources was seen as an obstacle by 54 % of principals, and 40 % agreed that a strong exam and performance orientation is a barrier to sustainability. In contrast to the perspective of educators (e.g., Grund and Brock, 2022), a much smaller proportion of principals agreed that non-integration in curricula and laws (19 %), and lack of interest (13 %), materials (11 %) or training (7 %) are challenges to the implementation of sustainability and ESD.

4.4. Drivers of change

In the interviews, the perceived need for **considerably greater prioritization of sustainability by policymakers, administrators, school leaders and local authorities** was strongly highlighted by the principals. They referred to the 'political will' in education ministries and policymaking to consistently integrate sustainability into education, pointed to their own responsibility in the setting of priorities at their schools and highlighted the importance of prioritizing sustainability in local authorities, particularly if the latter are responsible for school operations. Such prioritization (e.g., in the allocation of material resources and personnel, the setting of school-wide norms) is tied to the underlying paradigms and goals with which education is approached. As one principal stated:

"Well, I think the decision-makers need a shift in their mindset, a different attitude. And I think it's changing slowly now." (P-7, Pos. 24)

Concerning specific drivers, we found three overarching clusters: (i) stakeholder-related drivers within and (ii) outside the organization, and (iii) general (not stakeholder-specific) drivers (e.g., governance-arrangements, attitudes, activities, favorable windows of opportunity). In terms of **stakeholders within schools**, principals most often referred to themselves, teachers and learners. **Principals** described themselves as responsible for creating the conditions ('setting the arena') so that the

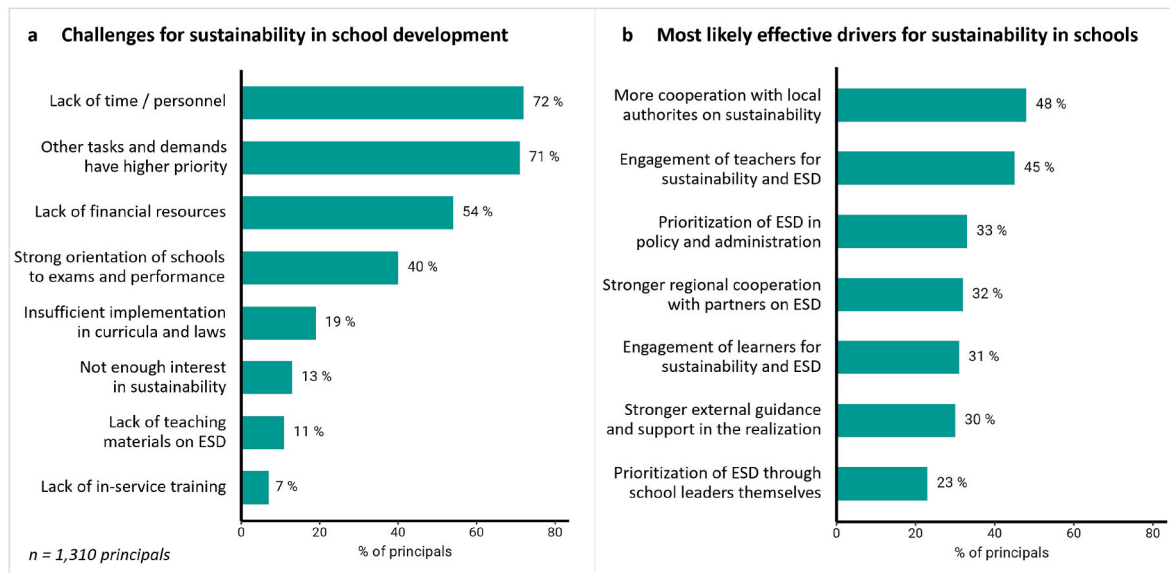


Fig. 2. Results from the representative survey of German school principals ($n = 1310$). (a) Occurrence of challenges for sustainability and Education for Sustainable Development (ESD) in school development from the perspective from principals in Germany. (b) Most likely effective drivers for sustainability and ESD in school development from the perspective of principals in Germany.

school community has the opportunity to engage in sustainability-oriented school development. In this, they characterized themselves as role-models and in a position to put sustainability on the agenda, create space for others to act, organize participatory processes, develop cooperation, reorient operations, support initiatives and projects, foster the self-efficacy experiences of members of the school community, ensure that activities are visible, organize constructive evaluation, and mediate conflicts.

As one leader described it:

„As with every school, this must be the school leaders. They are the drivers, the engines that have to push their team, their teaching staff, in a steering group or whatever. They have to act as models in negotiations with the parents' council, with the pupils, and initiate these impulses, otherwise it won't work.“ (P-8, Pos. 28)

When it comes to **teachers**, many principals viewed the intrinsic motivation of committed individuals as critical to change: Teachers were described to act as drivers by integrating sustainability into their teaching, going beyond the scope of current curricula, and by contributing to sustainability practice in everyday school life. Principals ascribed less responsibility to **learners**, although in many cases they emphasized the potential impact of their participation. Here, they referred not only to formal context such as school councils, but also more broadly to bringing new topics and perspectives into schools, e.g., through protests or other forms of engagement. With respect to the **general school community**, principals described living and modeling a culture of sustainability as well as continuous, collaborative reflection, among others, as drivers. While some principals also pointed to parents as co-constituents of sustainability-related change, few focused on non-teaching staff (e.g., caretakers, internal administration).

In terms of **stakeholder-specific drivers outside the school**, principals recurrently referred to education policymakers, ministries of education, and (local) authorities. Focusing first on **education policy and ministries**, a number of school leaders called for a major reorganization and rebalancing of the role that sustainability plays in education. This ties into calls by many school leaders for more substantial integration of ESD and sustainability into laws, curricula, teacher training and other policy documents as well as in incentive and quality development systems. Principals also described the need for **better communication between ministries and educational practice**, more

sharing of good practice, and better **cooperation with local authorities**. Concerning the latter, numerous principals believed it is crucial for whole-school sustainability to better integrate operations and campus management, which in Germany are mostly in the responsibility of local authorities, with educational processes and objectives related to sustainability. Regarding **other relevant stakeholders**, the leaders identified higher education institutions (e.g., for concept development, scientific advice), media that influence societal discourses, social movements, other educational institutions (e.g., for exchange and inspiration), and NGOs (e.g., for external support, cooperation) as drivers.

As a third cluster, principals pointed to **non-stakeholder-specific drivers**. In terms of **governance arrangements**, a large group of school leaders described more 'leeway' for schools to self-organize as a possible driver (e.g., in decisions regarding buildings and grounds or the content and structure of learning). At the same time, several principals took the position that more central steering (e.g., mandatory sustainability that would legitimize prioritization) would be needed. This goes hand in hand with calls to create lasting structures rather than ever new projects. As one principal put this:

“Sustainability should not be dependent on changing political constellations. Sustainability needs to be designed for the long term. (...) [T]hat's what the system actually needs, what we would need on the ground.“ (P-9, Pos. 66)

Such a structural orientation is consistent with principals' description of the close integration of school sustainability with overall school quality management. Related to this, principals referred to the **(societal) valuation of education, and specifically sustainability in education**, which is also linked to both the public visibility funding of ESD. In the context of general quality education, several principals also pointed to the connection between sustainability learning and innovative didactic approaches (e.g., real-world learning, action orientation, educators as facilitators) and viewed the integration of sustainability in quality development as a driver. In terms of **windows of opportunity**, a recurring theme was that crises (e.g., pandemic, wars, climate crisis) can provide opportunities for a more fundamental reorganization of the aims and pathways for quality education. Specific school problems and other pressing issues (e.g., digitalization, reducing social inequalities, inclusion) were also seen as drivers if they are linked to sustainability

objectives. In terms of **favorable supportive structures**, the principals pointed to the availability of context-specific programs, external support (advice, facilitation, experts for specific events) and teacher training on sustainability and ESD.

The recurring drivers in the interview study were, as with key challenges, selected to quantify which drivers principals believe are most likely move the school toward whole-school sustainability. As Fig. 2b indicates, the responses were spread over a relatively widely range. Overall, the largest group of principals agreed that stronger cooperation with local authorities responsible for school operations on sustainability (48 %) and teacher commitment to sustainability and ESD (45 %) are critical drivers for whole-school sustainability. Fewer principals viewed their own prioritization of ESD as the most likely impactful driver. The spread of responses points to the importance of interpreting the results in light of the specific question (most likely effective drivers), which leads to relative rather than absolute answering. The wide range of responses suggests that the importance of different drivers may vary strongly according to specific contexts.

5. Discussion

The large-scale mixed-methods study was designed to provide systematic insights into principals' perspectives on the current and wished-for status, visions, challenges, and drivers of whole-school sustainability. The analysis of 80 interviews and a subsequent representative survey of 1310 principals revealed that a large proportion of school leaders in Germany wishes for sustainability to become a central guiding principle for quality school education. In the representative survey, 80 % of school leaders state that sustainability should be incorporated into the teaching of most or all subjects and become a fundamental part of school development. At least in Germany, this is currently not the case: Principals report that the current status of sustainability integration in their schools is considerably lower than they would wish for. This discrepancy is consistent with the strong desire of learners and educators for more ESD in formal education, which is evident both in Germany (Grund and Brock, 2022) and internationally (e.g., Kadji-Beltran et al., 2013; Simovska and Prösch, 2016).

The question then is how to address this discrepancy. In terms of barriers to and drivers of change, previous studies have focused particularly on the perspective of educators (e.g., Grund and Brock, 2022; Timm and Barth, 2021) or relied on relatively small samples of principals (e.g., Evans et al., 2012; Forssten Seiser et al., 2023; Iliško and Badyanova, 2014; Mogren and Gericke, 2019). In the following sections, we discuss the specific findings on visions, challenges, and drivers along four overarching and strongly interconnected patterns that we see in the analyzed data:

- (i) a focus on single and often fragmented actions,
- (ii) an individualization and diffusion of responsibility,
- (iii) a perceived lack of personnel, time, and other resources, and
- (iv) a paradigm of approaching sustainability as an additive.

Based on these patterns, we discuss possible learnings and implications not only for Germany, but also other international contexts (e.g., other countries, UN bodies). We subsequently reflect on our methodological approach and describe ways forward for research, practice and policy-making.

5.1. Recurring patterns and derived implications for sustainability in education

5.1.1. From single and fragmented actions towards structural changes

When asked about what is currently being done in their schools on sustainability, a large proportion of principals in the interview study reported on single, often fragmented activities, e.g., waste separation, energy usage, gardening, tree planting, or other projects, often as one-off

interventions without systemic integration into 'default'-practice. This is consistent with the representative survey, in which a total of 62 % of school leaders responded that efforts to implement sustainability are currently either nonexistent (3 %), isolated instances (29 %), or occur occasionally in some projects and subjects (30 %). In terms of specific types of action, we found that principals not only mostly focused at single, fragmented actions, but on behavioral "low-cost" and easy-to-implement activities rather than high-impact 'key points' (e.g., Bilharz and Schmitt, 2011; IPCC, 2022). This focus on single and low-cost instead of structural and high-impact actions can, to some extent, be viewed as mirroring challenges the principals face in the school system, e.g., dependence on the states and local authorities, a lack of resources and systemic underprioritization of sustainability and ESD (see the following sections; cf. Huber et al. (2017) on the German school system). At the same time, the data indicates that the school leaders view changes to the underlying structural unsustainability (e.g., infrastructures, norms, incentives) as a crucial driver for sustainability within schools and describe ideal schools as ones in which sustainability is normalized as the default. This would, however, require more structure-oriented approaches both within institutions and in the policy environment (German Council for Sustainable Development, 2024; Rau et al., 2024). Such a focus would be in line with psychological research showing that behavioral costs of sustainable actions are higher when existing structures (e.g., rule systems, infrastructures) do not favor sustainability (e.g., Steg, 2023) and that access to behavioral options and habits are crucial determinants of action (Albarracín et al., 2024). This implies that redesigning the self-reinforcing and routine-creating (infra-)structures and norms at educational institutions can create an opportunity environment for sustainability learning and sustainable actions (ibid.; Cebrián et al., 2022; Mogren et al., 2024) and help mitigate the effects of single-action biases (Clayton et al., 2015; Wagner and Zeckhauser, 2012). Moreover, given that people tend to underestimate the willingness of others to act for sustainability (Andre et al., 2024; Bouman et al., 2020; Steg, 2023), a more structure-oriented approach can support individuals to become active themselves (Holst et al., 2024a).

5.1.2. From individualized and diffused responsibility towards collective action

Closely related to the first pattern, we found considerable individualization and diffused responsibility in the analyzed data. This is evident, for example, in the perceived normality of reliance on committed individuals, the diffusion of responsibility among stakeholders and in the way in which principals portray sustainability-related activities at their schools as often based on behavioral changes by individuals. While we found that principals described the envisioned future as one characterized by considerably more collective action, they also here often focused on (collective) footprint reductions at the institutions and focused less on collective actions towards the above-mentioned structural changes. In this context, it is important to consider what Grund and Brock (2019) call the question of 'epistemic fit': the extent to which a set of possible actions (e.g., individual behavioral changes or collective and structural actions) fits the scale of the problem (in this case, structural unsustainability). In other words, fully shifting the responsibility for "solving" widespread, structural unsustainability to individuals and their behavior without addressing the structural causes would be equivalent with a discursive displacement of responsibility. This ties in with Niebert (2021, 2019), who emphasizes the importance of empowering learners as political actors capable of challenging the decisions and systems that have created the current unsustainability and engaging in the relevant political processes. In this context, Kranz et al. (2022) link effective climate change education to the development of political literacy to contribute to structural changes at the collective level and Heitfeld and Reif (2020) highlight the relevance of empowerment for political participation, experiences of efficacy, and strengthening of democratic principles. This notion of collective action and democratic participation is closely related to a

WSA, in which the participatory and political nature of learning how to design and realize sustainability in a ‘microcosm’ is embraced (Holst et al., 2024a; Sterling, 2003). Such collective action also means broadening the scope of engaged stakeholders to actively include ones which are not yet sufficiently involved (e.g., local authorities, caretakers; cf. Liebhauer et al., 2023).

5.1.3. From a lack of resources towards prioritization of sustainability at all levels

Recurringly, principals pointed to a lack of resources (personnel, time, budgets) as a barrier to sustainability at schools. We found considerable frustration among interviewees about the state of the German school system in this regard. In the representative survey, 72 % of principals in Germany agreed that lack of personnel and time is an important barrier, and 54 % came to the same conclusion with respect to available budgets. This is consistent with several other international studies (Cebrián et al., 2022; Evans et al., 2012; Veronese and Kensler, 2013) and links to the relevance of sufficiently financed and well-trained personnel for whole-school sustainability (Ferreira et al., 2006; Fischer et al., 2022). Aside from the lack of time and personnel which is also linked to curriculum overcrowding (Cebrián et al., 2022; Evans et al., 2012), 71 % of leaders agree that other demands currently have higher priority in their schools, which is also mirrored in the interviews. These elements point to an overarching and frequently highlighted driver for change: a stronger prioritization of sustainability by decision-makers at all levels. The interviewed school leaders repeatedly spoke of the lack of political will to pursue even already agreed-upon targets (e.g., SDGs, national and state action plans and laws), and even less to further prioritize sustainability to a degree commensurate with the scale of the problem. This mismatch is described not only in terms of policymaking (e.g., structural integration, allocation of personnel and funding), but also with respect to local authorities (operations) and, not least, in terms of principals and educators themselves. As found in other studies, there is a considerable gap between high attributions of importance to sustainability and real-world prioritization (e.g., Jackson et al., 2007; Kadji-Beltran et al., 2013; Simovska and Prösch, 2016; Grund and Brock, 2020).

5.1.4. From sustainability as an additive towards integration with quality education

As a fourth overarching pattern in the data, sustainability is described in depictions of current status, barriers and drivers as an additive, but not as an integral feature of school education. As a first example, leaders described the level of structural integration of sustainability in the education system as low and call for changes in this regard. Despite dynamism in recent years, this is in line with a large-scale document analysis, which concluded that sustainability and ESD are still a structural ‘add-on’ to the German education system (Holst et al., 2024b). Less directly visible, the additive paradigm recurs when principals talked about cultural aspects such as a perceived normality of unsustainability outside of specific projects, feelings of being torn between conflicting targets and demands or a tendency to take the path of least resistance. Also, 40 % of principals described a strong grade orientation and performance pressure in the school system as a key barrier to sustainability, which is in line with findings from international case studies on the realization of WSAs (Mathie and Wals, 2022). Further, school leaders recurrently highlighted that other demands are systematically being given higher priority. All of this may be linked to what Wals (2020) calls the “hidden curriculum of unsustainability”, through which school education often unintentionally prepares learners for a life in which sustainability is another issue, but not a guiding principle. However, principals in the interview study did not stop at this narrative of the present, but depicted a possibly different future: Many described sustainability at ideal schools as a self-reinforcing normality, expressed the wish to empower future generations and embedded this ideal in more sustainable societal systems. This vision links back to the

question on the relationship between sustainability and quality education: echoing Klafki (1996), quality education ultimately means to empower learners with the abilities required to address the key societal problems of their time (on links between sustainability and quality education, see also Laurie et al., 2016; Nikel and Lowe, 2010). Such an integration would show, amongst others, in the general quality assessment systems and instruments (e.g., quality standards, targets for sustainable learning environments). First developments in this regard can be seen, for instance, in international education studies such as PISA addressing questions concerning agency in the Anthropocene (White et al., 2023).

5.2. Ways forward

The present study offers a national-scale assessment of the status, visions, challenges and drivers of whole-school sustainability from the perspective of principals in an exemplary context (Germany). In terms of limitations, a small self-selection bias among the 80 interviewees can be assumed despite the systematic sampling according to representativeness criteria. Also, a non-quantifiable degree of socially desirable response must be considered, especially in qualitative interview settings. Future research could focus on the conditions under which whole-school sustainability is (not) realized, and examine in depth the resistances, target-conflicts, and lock-ins in sustainability-related school development. Also, the 6-point scale for assessing current and wished-for sustainability integration can be used as an indicator for whole-school sustainability in addition to, for instance, surveys with learners and educators. Moreover, further large-scale studies in other education systems could help to identify overlaps and differences among recurring patterns internationally.

As per the volume of analyzed data, the study allows for a birds-eye perspective on sustainability in the federal school system of Germany through the lenses of school principals. Some of the learnings from the recurring patterns (single actions, individualization, lack of prioritization, add-on paradigm) connected with the wish of principals for structural and practical change may be relevant also in other (inter-)national contexts. While many countries have committed themselves to sustainability in education (e.g., Council of the European Union, 2022; UN General Assembly, 2023; UNESCO, 2021), the study indicates that this commitment does not necessarily mirror in sufficient prioritization, manifestation in structures and emphasis on empowering learners to become engaged citizens. Structural change and transformative action are, however, core objectives of the UNESCO program ESD for 2030 and as well as international declarations (UNESCO, 2021, 2020). Building on this, future (inter-)national recommendations and strategies on sustainability in education may strengthen the importance of collective, structural and high-impact action and focus on developing learning environments in which sustainability is not only experienced, but approached as a collaborative and political field of action. Resonating with Niebert (2019, 2021) and Kranz et al. (2022), this means addressing schools as participatory, experiential spaces for learning active citizenship and acquiring political literacy. As principals themselves are in a position to initiate and facilitate structural change, but often share the above-mentioned perceptions of sustainability as an underprioritized additive, we concur with other studies (Cebrián et al., 2022; Simovska and Prösch, 2016; Zachariou et al., 2013) in pointing to the high relevance of professional development programs for principals. In our view, such programs may focus particularly on organizing systemic, structural change toward sustainability that becomes a self-reinforcing norm, and focus on high-impact sustainability-related actions.

6. Conclusion

The national-scale mixed-method study on principals’ views on sustainability showed that in Germany, there is a strong wish by

principals for sustainability to become a core feature of school education. However, principals describe a considerably lower status quo in practice and indicate challenges such as prevailing rule-systems and mindsets that hinder sustainability (e.g., strong performance- and grade-orientation, normality of unsustainability), a lack of resources and structural integration as well as dependence on state and local authorities. Drivers include, amongst others, considerably stronger prioritization of sustainability at all levels, for example, through integration in quality standards and laws, school improvement plans, infrastructure development and school-specific priority setting. Also, the findings on effective drivers suggest high context-specificity, particularly in decentralized school systems such as in Germany (cf. Huber et al., 2017), which is relevant to consider when aiming for effective policies. As part of the synthesis, four overarching patterns were identified in the data: a focus on single, often fragmented and low-impact actions, individualization and diffusion of responsibility, a considerable lack of resources and political prioritization as well as a paradigm of approaching sustainability as an additive. In consideration of these patterns and the national and international commitments on sustainability in education (e.g., [Standing Conference of the Ministers of Education and Cultural Affairs, 2024](#) in Germany; [UN General Assembly, 2023](#); [UNESCO, 2021](#)), we derived key implications and recommendations for future policy-making and educational practice. Based on the large-scale data from the case study of Germany, we suggest for sustainability-oriented education to place a stronger emphasis on collective and political learning as well as on actions towards structural changes. This implies, for example, collaborative social learning through co-development of actions toward infrastructure change, as well as rule systems and incentives that set sustainability as the default rather than individualizing responsibility (cf. Dyball et al., 2007). In line with this, the study points to the importance of prioritizing sustainability as an integral feature of general quality education (Klafki, 1996; Kvamme, 2021). While the responsibility for addressing unsustainability clearly lies in the hands of current decision-makers rather than with young and future generations, educational institutions can thereby become spaces where unsustainability can be critically assessed, (political) participation in the design of more sustainable systems can be learned, and, in a microcosm, a more socially and ecologically just society can be experienced.

CRedit authorship contribution statement

Jorrit Holst: Writing – review & editing (lead), Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization (lead). **Antje Brock:** Writing – review & editing (supporting), Conceptualization (supporting). **Julius Grund:** Writing – review & editing (supporting), Conceptualization (supporting). **Ann-Kathrin Schlieszus:** Writing – review & editing (supporting), Conceptualization (supporting). **Mandy Singer-Brodowski:** Writing – review & editing (supporting), Conceptualization (supporting).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jclepro.2025.145897>.

Data availability

Data supporting the results of this study can be requested from the corresponding author.

References

- Albarracín, D., Fayaz-Farkhad, B., Granados Samayoa, J.A., 2024. Determinants of behaviour and their efficacy as targets of behavioural change interventions. *Nat. Rev. Psychol.* 1–16. <https://doi.org/10.1038/s44159-024-00305-0>.
- Andre, P., Boneva, T., Chopra, F., Falk, A., 2024. Globally representative evidence on the actual and perceived support for climate action. *Nat. Clim. Change* 14, 253–259. <https://doi.org/10.1038/s41558-024-01925-3>.
- Barr, S., Cross, J., Dunbar, D., 2014. The whole-school sustainability framework: guiding principles for integrating sustainability into all aspects of a school organization. Institute for the Built Environment. Colorado State University. https://centerforgreenschools.org/sites/default/files/resource-files/Whole-School_Sustainability_Framework.pdf.
- Barth, M., Fischer, D., Michelsen, G., Nemnich, C., Rode, H., 2012. Tackling the knowledge-action gap in sustainable consumption: insights from a participatory school programme. *J. Econ. Sustain. Dev.* 6, 301–312. <https://doi.org/10.1177/0973408212475266>.
- Bilharz, M., Schmitt, K., 2011. Going big with big matters. The key points approach to sustainable consumption. *GAIA* 20, 232–235. <https://doi.org/10.14512/gaia.20.4.5>.
- Birney, A., Reed, J., 2009. Sustainability and Renewal: Findings from the Leading Sustainable Schools Research Project: a Research Study Highlighting the Characteristics of Sustainable Schools and the Leadership Qualities Required to Develop Sustainable Schools. National College for Leadership of Schools and Children's Services, Nottingham, p. 56.
- Bosevska, J., Kriewaldt, J., 2020. Fostering a whole-school approach to sustainability: learning from one school's journey towards sustainable education. *Int. Res. Geogr. Environ. Educ.* 29, 55–73. <https://doi.org/10.1080/10382046.2019.1661127>.
- Bouman, T., Steg, L., Zawadzki, S.J., 2020. The value of what others value: when perceived biospheric group values influence individuals' pro-environmental engagement. *J. Environ. Psychol.* 71, 101470. <https://doi.org/10.1016/j.jenvp.2020.101470>.
- Buckler, C., Creech, H., 2014. Shaping the Future we Want: UN Decade of Education for Sustainable Development (2005–2014). United Nations Educational, Scientific and Cultural Organization, Paris 07 SP, France, p. 198. Final Report.
- Cebrián, G., Mogas, J., Palau, R., Fuentes, M., 2022. Sustainability and the 2030 agenda within schools: a study of school principals' engagement and perceptions. *Environ. Educ. Res.* 28, 845–866. <https://doi.org/10.1080/13504622.2022.2044017>.
- Clayton, S., Devine-Wright, P., Stern, P.C., Whitmarsh, L., Carrico, A., Steg, L., Swim, J., Bonnes, M., 2015. Psychological research and global climate change. *Nat. Clim. Change* 5, 640–646. <https://doi.org/10.1038/nclimate2622>.
- Council of the European Union, 2022. Council Recommendation of 16 June 2022 on Learning for the Green Transition and Sustainable Development 2022/C 243/01.
- Derqui, B., Grimaldi, D., Fernandez, V., 2020. Building and managing sustainable schools: the case of food waste. *Clean. Prod.* 243, 118533. <https://doi.org/10.1016/j.jclepro.2019.118533>.
- Dyball, R., Brown, V.A., Keen, M., 2007. Towards sustainability: five strands of social learning. In: Wals, A.E.J. (Ed.), *Social Learning Towards a Sustainable World*. Wageningen Academic Publishers.
- Education Scotland, 2017. Whole school and community approach to learning for sustainability (Lfs). <https://education.gov.scot/media/usdd0j0b/frwk11-lfs-framework.pdf>.
- Evans, N., Whitehouse, H., Gooch, M., 2012. Barriers, successes and enabling practices of education for sustainability in far north Queensland schools: a case study. *J. Environ. Educ.* 43, 121–138. <https://doi.org/10.1080/00958964.2011.621995>.
- Ferreira, J.-A., Ryan, L., Tilbury, D., 2006. Whole-school approaches to sustainability: a review of models for professional development in pre-service teacher education: Australian Research Institute in Education for Sustainability (ARIES) for the Australian government department of the environment, Water, Heritage and the Arts. Prepared by the Australian Research Institute in Education for Sustainability. ARIES) for the Australian Government Department of the Environment and, Heritage, p. 102.
- Fischer, D., King, J., Rieckmann, M., Barth, M., Büssing, A., Hemmer, I., Lindau-Bank, D., 2022. Teacher education for sustainable development: a review of an emerging research field. *J. Teach. Educ.* 73, 509–524. <https://doi.org/10.1177/00224871221105784>.
- Forssten Seiser, A., Mogren, A., Gericke, N., Berglund, T., Olsson, D., 2023. Developing school leading guidelines facilitating a whole school approach to education for sustainable development. *Environ. Educ. Res.* 29, 783–805. <https://doi.org/10.1080/13504622.2022.2151980>.

- German Council for Sustainable Development, 2024. It's the politics, stupid: the responsibility of state and society for sustainable living environments. https://www.nachhaltigkeitsrat.de/wp-content/uploads/2024/07/20240321_RNE_Statement_Its_the_politics_stupid.pdf.
- Grund, J., Brock, A., 2019. Why we should empty pandora's box to create a sustainable future: hope, sustainability and its implications for education. *Sustainability (Basel)* 11, 893. <https://doi.org/10.3390/su11030893>.
- Grund, J., Brock, A., 2020. Education for sustainable development in Germany: not just desired but also effective for transformative action. *Sustainability (Basel)* 12, 1–20. <https://doi.org/10.3390/su12072838>.
- Grund, J., Brock, A., 2022. Formale Bildung in Zeiten von Krisen – die Rolle von Nachhaltigkeit in Schule, Ausbildung und Hochschule. *Kurzbericht Des Nationalen Monitorings Zu Bildung Für Nachhaltige Entwicklung (BNE) Auf Basis Einer Befragung Von > 3.000 Jungen Menschen Und Lehrkräften*. Institut Futur, Freie Universität Berlin.
- Hargreaves, L.G., 2008. The whole-school approach to education for sustainable development: from pilot projects to systemic change. *Policy and Practice: A Development Education Review* 69–74.
- Heitfeld, M., Reif, A., 2020. Transformation gestalten lernen. Mit Bildung Und Transformativem Engagement Gesellschaftliche Strukturen Verändern. Germanwatch, Berlin.
- Henderson, K., Tilbury, D., 2004. Whole-School Approaches to Sustainability: an International Review of Sustainable School Programs. A Report Prepared by the Australian Research Institute in Education for Sustainability (ARIES) for the Department of the Environment and Heritage. Australian Government., p. 65.
- Holst, J., 2023. Towards coherence on sustainability in education: a systematic review of whole institution approaches. *Sustain. Sci.* 18, 1015–1030. <https://doi.org/10.1007/s11625-022-01226-8>.
- Holst, J., Grund, J., Brock, A., 2024a. Whole institution approach: measurable and highly effective in empowering learners and educators for sustainability. *Sustain. Sci.* 19, 1359–1376. <https://doi.org/10.1007/s11625-024-01506-5>.
- Holst, J., Singer-Brodowski, M., Brock, A., Haan, G. de, 2024b. Monitoring SDG 4.7: assessing education for sustainable development in policies, curricula, training of educators and student assessment (Input-Indicator). *Sustain. Dev. (Brad.)* 1–16. <https://doi.org/10.1002/sd.2865>.
- Huber, S., Tulowitzki, P., Hameyer, U., 2017. School leadership and curriculum: german perspectives. *Leadership. Policy Sch.* 16 (2), 272–302. <https://doi.org/10.1080/15700763.2017.1298816>.
- Iliško, D., Badyanova, Y., 2014. A case study of ESD implementation: signs of sustainable leadership. *Discourse commun. Sustain. Educ.* 5, 38–48. <https://doi.org/10.2478/dcs-2014-0004>.
- IPCC, 2022. Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA, 1977. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf.
- Jackson, L., Birney, A., Edwards, D., Gayford, C., Mehta, P., Morgan, A., Reed, J., Riley, K., 2007. *Leading Sustainable Schools: what the Research Tells Us*. NCSL, Nottingham.
- Kadji-Beltran, C., Zachariou, A., Stevenson, R.B., 2013. Leading sustainable schools: exploring the role of primary school principals. *Environ. Educ. Res.* 19, 303–323. <https://doi.org/10.1080/13504622.2012.692770>.
- Klafki, W., 1996. *Neue Studien Zur Bildungstheorie Und Didaktik: Zeitgemäße Allgemeinbildung Und kritisch-konstruktive Didaktik*, fifth ed. Beltz Verlag, Weinheim.
- Kranz, J., Schwichow, M., Breitenmoser, P., Niebert, K., 2022. The (un)political perspective on climate change in education—A systematic review. *Sustainability (Basel)* 14, 4194. <https://doi.org/10.3390/su14074194>.
- Kuckartz, U., Rädiker, S., 2022. *Qualitative Inhaltsanalyse Methoden, Praxis, Computerunterstützung: Methoden, Praxis, Computerunterstützung : Grundlagentexte Methoden*, fifth ed. Beltz Juventa, Weinheim, p. 274.
- Kvamme, O.A., 2021. Rethinking bildung in the anthropocene: the case of wolfgang klafki. *HTS Theologiese Studies/Theological Studies* 77. <https://doi.org/10.4102/hts.v77i3.6807>.
- Laurie, R., Nonoyama-Tarumi, Y., McKeown, R., Hopkins, C., 2016. Contributions of education for sustainable development (ESD) to quality education: a synthesis of research. *J. Econ. Sustain. Dev.* 10, 226–242. <https://doi.org/10.1177/0973408216661442>.
- Leo, U., Wickenberg, P., 2013. Professional norms in school leadership: change efforts in implementation of education for sustainable development. *J. Educ. Change* 14, 403–422. <https://doi.org/10.1007/s10833-013-9207-8>.
- Liebhaber, N., Ramjan, C., Frick, M., Mannion, G., Keller, L., 2023. Transformative climate change education and the school caretaker: a more-than-human analysis with young people. *Environ. Educ. Res.* 1–16. <https://doi.org/10.1080/13504622.2023.2286936>.
- Mathie, R.G., Wals, A.E.J., 2022. Whole School Approaches to Sustainability: Exemplary Practices from Around the World. Wageningen University. <https://edepot.wur.nl/566782>.
- Mogren, A., Forssten Seiser, A., Gericke, N., Berglund, T., Olsson, D., 2024. Leadership actions that enable or constrain accommodation of education for sustainable development. *Int. J. Leader. Educ.* 1–30. <https://doi.org/10.1080/13603124.2024.2418623>.
- Mogren, A., Gericke, N., 2017. ESD implementation at the school organisation level, part 1 – investigating the quality criteria guiding school leaders' work at recognized ESD schools. *Environ. Educ. Res.* 23, 972–992. <https://doi.org/10.1080/13504622.2016.1226265>.
- Mogren, A., Gericke, N., 2019. School leaders' experiences of implementing education for sustainable development—anchoring the transformative perspective. *Sustainability (Basel)* 11, 3343. <https://doi.org/10.3390/su11123343>.
- Mogren, A., Gericke, N., Scherp, H.-A., 2019. Whole school approaches to education for sustainable development: a model that links to school improvement. *Environ. Educ. Res.* 25, 508–531. <https://doi.org/10.1080/13504622.2018.1455074>.
- Müller, U., Hancock, D.R., Stricker, T., Wang, C., 2021. Implementing ESD in schools: perspectives of principals in Germany, Macau, and the USA. *Sustainability (Basel)* 13, 9823. <https://doi.org/10.3390/su13179823>.
- Müller, U., Lude, A., Hancock, D.R., 2020. Leading schools towards sustainability. *Fields of action and management strategies for principals. Sustainability (Basel)* 12, 3031. <https://doi.org/10.3390/su12073031>.
- Nationale Plattform BNE c/o BMBF, 2017. Nationaler Aktionsplan Bildung für nachhaltige Entwicklung: Der deutsche Beitrag zum UNESCO-Weltaktionsprogramm. https://www.bmbf.de/bmbf/shareddocs/downloads/files/nationaler_aktionsplan_bildung_fuer_nachhaltige_entwicklung.pdf?_blob=publicationFile&v=2.
- Niebert, K., 2019. Effective sustainability education is political education. on education. *J. Res. Debate* 2. <https://doi.org/10.25656/01:23040>.
- Niebert, K., 2021. Lessons learned from Covid-19. Why sustainability education needs to become political. *Progress. Sci. Educat. (PriSE)* 4. <https://doi.org/10.25321/PRISE.2021.1169>.
- Nikel, J., Lowe, J., 2010. Talking of fabric: a multi-dimensional model of quality in education. *Compare* 40, 589–605. <https://doi.org/10.1080/03057920902909477>.
- Pörtner, H.-O., Scholes, R.J., Arneth, A., Barnes, D.K.A., Burrows, M.T., Diamond, S.E., Duarte, C.M., Kiessling, W., Leadley, P., Managi, S., McElwee, P., Midgley, G., Ngo, H.T., Obura, D., Pascual, U., Sankaran, M., Shin, Y.J., Val, A.L., 2023. Overcoming the coupled climate and biodiversity crises and their societal impacts. *Sci. Technol. Humanit.* 380, eabl4881. <https://doi.org/10.1126/science.abl4881>.
- New York, N.Y.
- Progress, 2024. Whole School Approach to Sustainable Development. Erasmus+, European Union. <https://greenprogress.eu/whole-school-approach/>.
- Rau, H., Nicolai, S., Frankowski, P., Stoll-Kleemann, S., 2024. Distinguishing between Low- and high-cost pro-environmental behavior: empirical evidence from two complementary studies. *Sustainability (Basel)* 16 (2206), 1–16. <https://doi.org/10.3390/su16052206>.
- Rockström, J., Gupta, J., Qin, D., Lade, S.J., Abrams, J.F., Andersen, L.S., Armstrong McKay, D.I., Bai, X., Bala, G., Bunn, S.E., Ciobanu, D., DeClerck, F., Ebi, K., Gifford, L., Gordon, C., Hasan, S., Kanie, N., Lenton, T.M., Loriani, S., Liverman, D.M., Mohamed, A., Nakicenovic, N., Obura, D., Ospina, D., Prodani, K., Rammelt, C., Sakschewski, B., Scholtens, J., Stewart-Koster, B., Tharammal, T., van Vuuren, D., Verborg, P.H., Winkelmann, R., Zimm, C., Bennett, E.M., Bringezu, S., Broadgate, W., Green, P.A., Huang, L., Jacobson, L., Nedehede, C., Pedde, S., Rocha, J., Scheffer, M., Schulte-Uebbing, L., Vries, W. de, Xiao, C., Xu, C., Xu, X., Zafra-Calvo, N., Zhang, X., 2023. Safe and just Earth system boundaries. *Nature* 619, 102–111. <https://doi.org/10.1038/s41586-023-06083-8>.
- Sachs, J.D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., Rockström, J., 2019. Six transformations to achieve the sustainable development goals. *Nat. Sustain.* 2, 805–814. <https://doi.org/10.1038/s41893-019-0352-9>.
- Sagala, S., Lubis, W., Sagala, G.H., 2019. Canonical correlation between principal leadership and school capacity. *Int. J. Manag. IT Eng. (IJMIE)* 13, 256–280. <https://doi.org/10.1504/IJMIE.2019.100413>.
- Simovska, V., Prösch, Ä.K., 2016. Global social issues in the curriculum: perspectives of school principals. *J. Curric. Stud.* 48, 630–649. <https://doi.org/10.1080/00220272.2015.1114150>.
- Standing Conference of the Ministers of Education and Cultural Affairs, 2024. Empfehlung der Kultusministerkonferenz zur Bildung für nachhaltige Entwicklung in der Schule (Beschluss der Kultusministerkonferenz vom 13.06.2024). https://www.kmk.org/fileadmin/veroeffentlichungen_beschluesse/2024/2024_06_13-BNE-Entf.pdf.
- Steg, L., 2023. Psychology of climate change. *Annu. Rev. Psychol.* 74, 391–421. <https://doi.org/10.1146/annurev-psych-032720-042905>.
- Sterling, S., 2003. Whole systems thinking as a basis for paradigm change in education. *Explorations in the Context of Sustainability*. PhD. United Kingdom, p. 477.
- Tilbury, D., Galvin, C., 2022. Input Paper: a Whole School Approach to Learning for Environmental Sustainability. European Commission. <https://education.ec.europa.eu/sites/default/files/2022-02/input-paper-whole-school-approach-sustainability.pdf>.
- Tilbury, D., Janousek, S., 2006. Development of a national approach to monitoring, assessment and reporting on the decade of education for sustainable development. https://research-management.mq.edu.au/ws/portalfiles/portal/20643232/Publish_er_version_open_access_.pdf.
- Timm, J.-M., Barth, M., 2021. Making education for sustainable development happen in elementary schools: the role of teachers. *Environ. Educ. Res.* 27, 50–66. <https://doi.org/10.1080/13504622.2020.1813256>.
- UN General Assembly, 2015. Transforming our World: the 2030 Agenda for Sustainable Development, 1-35, 70/1 (Accessed 26 May 2021).
- UN General Assembly, 2023. Political Declaration of the high-level Political Forum on Sustainable Development Convened Under the Auspices of the General Assembly A/HLPF/2023/L, vol. 1.
- UNECE, 2005. Indicators for education for sustainable development. Progress Rep. Work Expert Group. <https://unece.org/fileadmin/DAM/env/documents/2005/cep/ac.13/cep.ac.13.2005.9.e.pdf>.
- UNESCO, 2020. Education for Sustainable Development. A Roadmap. United Nations Educational, Scientific and Cultural Organization, Paris 07 SP, France, p. 73.

- UNESCO, 2021. Berlin Declaration on Education for Sustainable Development. United Nations Educational, Scientific and Cultural Organization, Berlin, p. 4.
- Verhelst, D., Vanhoof, J., van Petegem, P., 2023. School effectiveness for education for sustainable development (ESD): what characterizes an ESD-effective school organization? *Educ. Manag. Adm. Leader* 51, 502–525. <https://doi.org/10.1177/1741143220985196>.
- Veronese, D., Kensler, L., 2013. School leaders, sustainability and green school practices: an elicitation study using the theory of planned behavior. *J. Strat. e Commer.* 4, 1–21.
- Wagner, G., Zeckhauser, R.J., 2012. Climate policy: hard problem, soft thinking. *Clim. Change* 110, 507–521. <https://doi.org/10.1007/s10584-011-0067-z>.
- Wals, A.E.J., 2020. Transgressing the hidden curriculum of unsustainability: towards a relational pedagogy of hope. *Educ. Philos. Theor.* 52, 825–826. <https://doi.org/10.1080/00131857.2019.1676490>.
- Wals, A.E.J., Benavot, A., 2017. Can we meet the sustainability challenges? The role of education and lifelong learning. *Eur. J. Educ.* 52, 1–10. <https://doi.org/10.1111/ejed.12250>.
- Wals, A.E.J., Bjønness, B., Eikeland, I., Sinnes, A. (Eds.), 2024. *Whole School Approaches to Sustainability: Education Renewal in Times of Distress*. Springer International Publishing AG, Cham.
- Wals, A.E.J., Mathie, R.G., 2022. Whole school responses to climate urgency and related sustainability challenges. In: Peters, M.A., Heraud, R. (Eds.), *Encyclopedia of Educational Innovation*. Springer, Singapore, Singapore, pp. 1–8.
- White, P.J., Ardoin, N.M., Eames, C., Monroe, M.C., 2023. Agency in the Anthropocene: supporting document to the PISA 2025 Science Framework. OECD Education Working Papers. <https://doi.org/10.1787/8d3b6cfa-en>.
- Zachariou, A., Kadji-Beltran, C., Manoli, C.C., 2013. School principals' professional development in the framework of sustainable schools in Cyprus: a matter of refocusing. *Prof. Dev. Educ.* 39, 712–731. <https://doi.org/10.1080/19415257.2012.736085>.
- Zachariou, A., Kadji-Beltran, C., 2009. Cypriot primary school principals' understanding of education for sustainable development key terms and their opinions about factors affecting its implementation. *Environ. Educ. Res.* 15, 315–342. <https://doi.org/10.1080/13504620902862902>.

8.2. List of Further Publications in the Context of the Dissertation

8.2.1. Peer-reviewed Publications

- Breitenmoser, P., Holst, J., & Niebert, K. (2026). Von der Kür zur Kernaufgabe: Stand und Perspektiven der Bildung für nachhaltige Entwicklung (BNE) in der Schweizer Gymnasiallehrpersonenbildung. *Beiträge Zur Lehrerinnen- und Lehrerbildung (BZL)*, 44, 77–95. <https://doi.org/10.36950/bzl.44.1.2026.10412>
- Hantke, H., Hecker, K., Holst, J., Kähler, A.-F., & Kastrup, J. (2026). Der Whole Institution Approach als Prozessansatz ganzheitlicher Unternehmensentwicklung im Kontext einer Berufsbildung für nachhaltige Entwicklung. *BWP @ Berufs- Und Wirtschaftspädagogik Online*, 49, 1–26.
- Holst, J., Fritz, H., Nölting, B., Potthast, T., Betz, C., Lang, D. J., Ober, S., Parodi, O., Scheiding, C., Weynand, M., & Singer-Brodowski, M. (2025). Exploring Culture(s) of Sustainability at Higher Education Institutions: A Systematic Review of Concepts and Pathways. *International Journal of Sustainability in Higher Education*, 26(9), 489–506. <https://doi.org/10.1108/IJSHE-08-2024-0550>
- Singer-Brodowski, M., Holst, J., & Bormann, I. (2025). Transformative Universities as Innovation. In Ingo Schulz-Schaeffer et al. (Ed.), *Handbook of Innovation*. Springer Nature.
- Seggern, J. v., Holst, J., & Singer-Brodowski, M. (2023). The self in the mirror: fostering researchers' reflexivity in transdisciplinary and transformative studies at the science-policy interface. *Ecology and Society*, 28(2). <https://doi.org/10.5751/ES-14057-280217>
- Grund, J., & Holst, J. (2023). Emotional competence: The missing piece in school curricula? A systematic analysis in the German education system. *International Journal of Educational Research Open*, 4, 100238. <https://doi.org/10.1016/j.ijedro.2023.100238>
- Holst, J. (2021). Potential und Rolle(n) von Großschutzgebieten in der Bildung für nachhaltige Entwicklung (BNE). *Natur und Landschaft*. <https://doi.org/10.19217/NuL2021-11-03>
- Holst, J., Brock, A., Singer-Brodowski, M., & de Haan, G. (2020). Monitoring Progress of Change: Implementation of Education for Sustainable Development (ESD) within Documents of the German Education System. *Sustainability*, 12(10), 4306. <https://doi.org/10.3390/su12104306>

8.2.2. Other Publications

- Brock, A., Grund, J., & Holst, J. (2025). Wie kann motivierende und effektive BNE gelingen? Rahmenbedingungen und Wege erfolgreicher Umsetzung. In: KMK/BMZ (2025): *Orientierungsrahmen Globale Entwicklung – Bildung für nachhaltige Entwicklung in der gymnasialen Oberstufe*.
- Fischer, D., Grauer, C., Holst, J., & Schlieszus, A.-K. (2025). *Nachhaltigkeit leiten. Zukunftsorientierte Schulentwicklung mit dem Whole School Approach. Ein Toolkit für Schulleitungsteams*. In: Greenpeace e.V. (2025): *Schools for Earth – Das Greenpeace Schulprojekt*. <https://doi.org/10.60813/QX1Z-F872>
- Holst, J., Brock, A., Schlieszus, A.-K., & Grund, J. (2025). Zukunftsbildung: Wie gelingt Schule, die zu gesellschaftlicher Mitgestaltung motiviert? *Friedrich BildungSPEZIAL*.
- Holst, J., & Hantke, H. (2025). Berufliche Bildung für nachhaltige Entwicklung. Whole School Approach und Unterrichtsgestaltung an berufsbildenden Schulen [2. Aufl.]. In *Greenpeace e.V. (Ed.), Schools for Earth - Das Greenpeace Schulprojekt*. <https://doi.org/10.60813/5KTZ-Z176>
- Singer-Brodowski, M., Holst, J., Fritz, H., Nölting, B., Löde, V., Schmitt, J., Betz, C., Lang, D. J., Ober, S., Parodi, O., Schaltegger, S., Scheiding, C., Weynand, M., & Potthast, T. (2025). *„Kulturen der Nachhaltigkeit von Hochschulen“ – ein konsolidiertes Arbeitsverständnis des Verbundprojekts KuNaH*. <https://doi.org/10.17169/refubium-48838>
- Holst, J. (2024). Whole Institution Approach: Erfassung erlebter Nachhaltigkeit (WIA-Skala). In Koordinierungsstelle Kommunales Bildungsmanagement, J. Holst, A. Brock, & J. Grund (Eds.), *Messinstrumente aus dem Nationalen BNE-Monitoring. Indikatoren des nationalen BNE-Monitorings und ihre Übertragbarkeit auf das kommunale Bildungsmonitoring*. KOSMO Spektrum digital. <https://doi.org/10.5281/zenodo.13898591>
- Holst, J., & Bilgram, B. (2024). Whole Institution Approach: Lern- und Erfahrungsräume der Nachhaltigkeit gestalten. In DVV International (Ed.), *Guidebook Sustainable*. *Nachhaltige Organisationsentwicklung in der Erwachsenenbildung*.
- Holst, J., Brock, A., & Grund, J. (2024). Nationales BNE-Monitoring: Einführung und Überblick zu Indikatoren. In Koordinierungsstelle Kommunales Bildungsmanagement, J. Holst, A. Brock, & J. Grund (Eds.), *Messinstrumente aus dem Nationalen BNE-*

Monitoring. Indikatoren des nationalen BNE-Monitorings und ihre Übertragbarkeit auf das kommunale Bildungsmonitoring. KOSMO Spektrum digital.

Holst, J., Potthast, T., Fritz, H., Nölting, B., Singer-Brodowski, M., Albiez, M., Betz, C., Lang, D. J., Meyer, S., Ober, S., Parodi, O., Schaltegger, S., Scheiding, C. & Weynand, M. (2024). Kultur der Nachhaltigkeit an Hochschulen: Vom Ziel zur Normalität. *DUZ Wissenschaft & Management* (03/2024).

Holst, J. (2023). Bildung für nachhaltige Entwicklung (BNE): Auf dem Weg in den Mainstream, doch mit welcher Priorität? Analyse von Koalitionsverträgen, BNE- und Nachhaltigkeitsstrategien, Weiterbildungsgesetzen, Bildungsberichten und weiteren Dokumenten von Bund, Ländern und Stiftungen. Berlin.
<http://dx.doi.org/10.17169/refubium-40460>

Fritz, H., Holst, J., Lang, D. J., Nölting, B., Parodi, O., Potthast, T., & Singer-Brodowski, M. (2022). Transformationspfade für eine Kultur der Nachhaltigkeit an deutschen Hochschulen. *GAIA - Ecological Perspectives for Science and Society*, 31(4), 254–256.
<https://doi.org/10.14512/gaia.31.4.14>

Holst, J. & Singer-Brodowski, M. (2022). Nachhaltigkeit & BNE im Hochschulsystem: Stärkung in Gesetzen und Zielvereinbarungen, ungenutzte Potentiale bei Curricula und Selbstverwaltung. Kurzbericht des Nationalen BNE-Monitorings. Berlin.
<https://doi.org/10.17169/refubium-35828>

Holst, J. (2022). Nachhaltigkeit & BNE in der Beruflichen Bildung: Dynamik in Ordnungsmitteln, Potentiale bei Berufen, Lernorten und in der Qualifizierung von Auszubildenden. Kurzbericht des Nationalen BNE-Monitorings. Berlin.
<https://doi.org/10.17169/refubium-35827>

Brock, A. & Holst, J. (2022). Schlüssel zu Nachhaltigkeit und BNE in der Schule: Ausbildung von Lehrenden, Verankerung in der Breite des Fächerkanons und jenseits der Vorworte. Kurzbericht des Nationalen BNE-Monitorings. Berlin.
<https://doi.org/10.17169/refubium-36094>

Singer-Brodowski, M., & Holst, J. (2022). Nachhaltigkeit & BNE in der Frühen Bildung: Chancen durch Partizipation und ökologische Kinderrechte, Bedarfe bei der Ausbildung von Fachkräften. Kurzbericht des Nationalen BNE-Monitorings. Berlin.
<https://doi.org/10.17169/refubium-35735>

- Singer-Brodowski, M. & Holst, J. (2022). Nachhaltigkeit: Zielkonflikte und Widersprüche - (k)ein Thema für die politische BBNE? In: *Handbuch Nachhaltigkeit, politische Bildung und Berufsbildung*. Wochenschau Verlag.
- Holst, J. & Marwege, R. (2022). Lernregionen für nachhaltige Entwicklung: Chancen und Rolle(n) für Naturparke in der BNE. In: *Praxisleitfaden BNE in Naturparks*. Verband Deutscher Naturparke e.V.
- de Haan, G.; Holst, J.; Singer-Brodowski, M. (2021). Berufliche Bildung für nachhaltige Entwicklung (BBNE): Genese, Entwicklungsstand und mögliche Transformationspfade. *Berufsbildung in Wissenschaft und Praxis (BWP)*.
- Singer-Brodowski, M., Holst, J. & Goller, A. (2021). Transformative Wissenschaft. In: *Handbuch Transdisziplinäre Didaktik*.
- Holst, J., & Brock, A. (2020). Bildung für nachhaltige Entwicklung (BNE) in der Schule: Strukturelle Verankerung in Schulgesetzen, Lehrplänen und der Lehrerbildung.
- Holst, J., & Singer-Brodowski, M. (2020). Bildung für nachhaltige Entwicklung (BNE) in der Frühkindlichen Bildung: Strukturelle Verankerung in Bildungsplänen, Rahmendokumenten und der Ausbildung von pädagogischen Fachkräften.
- Holst, J., & Singer-Brodowski, M. (2020). Bildung für nachhaltige Entwicklung (BNE) in der Beruflichen Bildung: Strukturelle Verankerung zwischen Ordnungsmitteln und Nachhaltigkeitsprogrammatik.
- Holst, J., & Seggern, J. v. (2020). Bildung für nachhaltige Entwicklung (BNE) an Hochschulen: Strukturelle Verankerung in Gesetzen, Zielvereinbarungen und Dokumenten der Selbstverwaltung.

8.3. Declarations

General declarations (Deutsch / English)

Hiermit erkläre ich, dass ich mich noch keiner Doktorprüfung unterzogen oder mich um Zulassung zu einer solchen beworben habe.

Ich versichere, dass die Dissertation *Sustainability in Education: An Empirical Assessment of Systemic Integration and Organizational Practice* in der gegenwärtigen oder einer anderen Fassung noch keiner anderen Hochschule zur Begutachtung vorgelegen hat.

Ich versichere an Eides statt, dass ich die eingereichte *Dissertation Sustainability in Education: An Empirical Assessment of Systemic Integration and Organizational Practice* selbstständig und ohne unzulässige fremde Hilfe verfasst habe. Anderer als der von mir angegebenen Hilfsmittel und Schriften habe ich mich nicht bedient. Alle wörtlich oder sinngemäß anderen Schriften entnommenen Stellen habe ich kenntlich gemacht. Über die strafrechtlichen Folgen gemäß § 156 Strafgesetzbuch wurde ich in Kenntnis gesetzt.

I hereby declare that I have not yet taken a doctoral examination or applied for admission to such an examination.

I certify that the dissertation *Sustainability in Education: An Empirical Assessment of Systemic Integration and Organizational Practice*, in its current or any other version, has not been submitted to any other university for review.

I certify that I have written the submitted dissertation *Sustainability in Education: An Empirical Assessment of Systemic Integration and Organizational Practice* independently and without unauthorized assistance. I have not used any aids or writings other than those specified by me. I have identified all passages taken verbatim or in substance from other writings. I have been informed of the criminal consequences pursuant to § 156 Strafgesetzbuch.

Declaration on the use of digital tools and language proofread

Digital tools such as academic and general search engines (Google, Google Scholar, Elicit, Connected Papers), large-language models (ChatGPT, Perplexity) and translation software (DeepL) were used in the preparation of the framework paper to assist the searching for literature, idea exploration as well as to refine grammar and spelling in individual sentences. All text was written by the author who takes full responsibility for its content.

After the manuscript was completed, a professional English-language proofreader (David Allison) was commissioned to review it for grammatical and spelling errors. All suggested revisions were individually assessed by the author during the final revision process.