Digitainability in Education: A Framework for Sustainability and Digitality as a Twin Transformation

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Article

Digitainability in Education: A Framework for Sustainability and Digitality as a Twin Transformation

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Abstract

Digitainability is increasingly invoked at the intersection of sustainability and digital transformation. Yet in education, the discourses are still often negotiated separately. Drawing on disciplinary educational debates across Germany, Austria and Switzerland (the DACH region), this conceptual paper argues that sustainability-related aims in education—particularly SDG target 4.7—remain conceptually under-specified when *digitality* (as a socio-technical condition) is approached primarily as a toolkit. Conversely, it suggests that the digital transformation in education can only be assessed and shaped responsibly when sustainability and justice are treated as integral to the analysis and design of educational processes. The paper therefore proposes the *Digitainability Framework* as a heuristic for reflection, analysis and design—not as a competence model. It specifies a double perspective: *sustainable digitality* (the design of 'onlife' environments) and *sustainability under conditions of digitality* (the negotiation of sustainability conflicts in media-shaped, increasingly platformised publics). Across both perspectives, the framework makes explicit four intersecting framings—cultural, power-related, discursive, and agent-related—and keeps sustainability in view across social, ecological, and economic dimensions. A brief example on social media and climate discourses illustrates the framework's analytical and design potential.

Keywords: digitainability; digitality; twin transformation; digital transformation; education for sustainable development (ESD); sustainability; SDG 4.7; DACH

1. Introduction

Sustainable development and contemporary digital developments are widely recognised as two megatrends of our time (Schmidt, 2023, p. 5). Following Naisbitt (1982), they denote long-term transformations with profound impacts across almost all areas of life and with global significance. Accordingly, sustainable development is a normatively framed, contested process of transformation and negotiation across social, ecological, and economic dimensions (Pettig & Singer-Brodowski, 2025). In turn, developments related to digital technologies extend beyond technical re-engineering and increasingly shape—under conditions of *digitality*—a media-structured space of information, communication, and learning in which social practice, publics, and education are being reconfigured (Stalder, 2016). In light of these dynamics, interdependencies between sustainability and digitality do not lend themselves to one-dimensional evaluation, since they generate both positive and negative effects that can reinforce one another. These effects manifest at different levels and across different dimensions of (un)sustainable development (Hauck-Thum et al., 2023).

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However, joint consideration of these transformations has gained momentum only recently (Lichtenthaler, 2021). A bibliometric snapshot of the Web of Science Core Collection[1] suggests that research increasingly invokes sustainability and digitality together, yet this trend often reflects a rhetoric of overlap rather than a conceptual integration. By introducing the label *digitainability*, Gupta et al. (2020) created a terminological integration that has so far been taken up primarily in business and economic debates and only sporadically in educational research in Germany, Austria, and Switzerland (the DACH region; e.g., Hauck-Thum, 2025). Beyond the label, links between education for/as sustainable development (ESD) and digitality are increasingly discussed in research, bridge-building pedagogical contributions, and policy and curricular documents (e.g., Grünberger, 2022; Muheim, 2021; Rau & Rieckmann, 2023; Ring, 2020; Schluchter, 2020; Schluchter & Maurer, 2021; WBGU, 2019; Engagement Global, 2025). Even so, the two debates are still often negotiated separately (Hauck-Thum et al., 2023).

In response to this research gap, this paper maps key points of orientation in the ESD and digitality discourses (Sections 2.1 and 2.2). Building on this, it synthesizes the discourses and develops the Digitainability Framework (Section 3.1), demonstrates it in a brief use case (Section 3.2), and discusses implications (Section 4). It builds on educational discourses in the DACH region—with a particular focus on debates in and around formal education—and uses a conceptual-synthetic approach. Accordingly, it draws on a purposive selection of reference texts—positions that have shaped the discourse and are particularly resonant within educational research. This selective approach positions the framework as a heuristic rather than a comprehensive account.

2. Starting Points in Disciplinary Discourses: Sustainability and Digitality in Education

2.1. Sustainability and (Education for/as) Sustainable Development

Understandings of sustainability vary across contexts (Di Giulio, 2004). In international debate, sustainability is commonly anchored in the UN-related notion of sustainable development associated with the Brundtland Report from 1987. In this view, sustainability refers to a global trajectory of societal development that meets (basic) needs and aspirations for a good life while ensuring that this remains possible for future generations. Building on Di Giulio (2004), this can be understood as (i) an abstract horizon of aims and (ii) a specification across social, ecological, and economic dimensions, often visualised in triad models (see Hauff & Kleine, 2005; Ketter, 2021). In these debates, culture is frequently treated as a cross-cutting element that shapes perceptions and negotiation processes through subtle everyday ideologies (Singer-Brodowski, 2016; Stoltenberg, 2010).

There is broad agreement that sustainable development will not be achievable without learning processes (Rieckmann, 2016). For this reason, the 2030 Agenda for Sustainable Development—adopted by the UN General Assembly in 2015—anchors this concern explicitly in SDG target 4.7. Within this policy frame, the concept of ESD emerged, aiming to enable people to participate in societal learning and deliberative processes around sustainable development (Rieckmann, 2016). Within DACH debates, this aim is often linked to the notion of action competence (*Gestaltungskompetenz*) as a central educational objective (Haan, 2008). In this sense, ESD is shaped not only within schools and higher education institutions but also through civil-society actors (e.g., NGOs and extracurricular providers) as independent drivers of educational agendas and programmes, addressing students—and, increasingly over time, teachers and teacher educators (Rieckmann & Barth, 2022).

There is less agreement, however, on what ESD should do in practice. In the DACH discourse, debates on *transformative education* crystallise a central tension: A strong orientation towards societal

[1] For transparency, the bibliometric query used the following Web of Science search strings (retrieved 30 December 2025): (TS=(sustainab* AND digital*)) refined by "Research Areas: Education Educational Research"; and (TS=("digitainability")).

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transformation (e.g., WBGU, 2011) may slide into an instrumental logic in which learners are positioned as means to predetermined ends (Singer-Brodowski, 2016). Vare and Scott (2007) capture this tension by distinguishing ESD 1 (*instrumental approach*; education *for* sustainable development) from ESD 2 (*emancipatory approach*; education *as* sustainable development). While ESD 1 foregrounds the promotion of 'sustainable' practices, ESD 2 treats sustainable development as an open societal learning process in which it often remains uncertain what counts as the more sustainable option (Rieckmann, 2016; Schluchter, 2020). More recently, Pettig and Singer-Brodowski (2025) develop these perspectives further as ESD 3 (*transformative approach*): Learning and transformation are treated as processual; sustainability is approached through a more-than-human lens; normative orientations are made a matter of justification; and emotional dimensions are acknowledged as constitutive for educational processes. Accordingly, sustainable development is framed not as a clearly delineated goal but as a contested transformation process shaped by power relations, uncertainty, and paradoxes—one that education must engage with as an open and contingent question (Pettig & Singer-Brodowski, 2025). The educational aim is to enable reasoned judgement and responsible orientations for action under conditions of not-knowing, goal conflicts, and contradictory demands.

While ESD 3 is not a single teaching strategy, it can be clarified through five organising dimensions: (a) conceptions of learning and education, (b) content selection, (c) pedagogical principles, (d) methods, and (e) learning arrangements.

(a) Conceptions of learning and education: Within ESD 3, learning is understood as ongoing, relational, and situated. It unfolds through engagement with contested issues and within social practices in which perspectives meet, reasons are examined, and meanings are (co)constructed—grounded in a view of the subject that treats learners as agents capable of decision-making and reflection (Ketter, 2021). In learning and educational theory, ESD is often underpinned in a twofold way: Constructivist perspectives emphasise learning as a (co)constructive process, while cognitivist perspectives foreground knowledge building and conceptual clarification as prerequisites for robust judgement and argumentation (Riess et al., 2022).

(b) Content selection: Such a conception of learning and education favours content selection that focuses on sustainability issues of societal and everyday relevance, opens up multiple perspectives, and makes trade-offs, interests, and normative assumptions amenable to analysis (Muheim, 2021; Rau & Rieckmann, 2023; Riess et al., 2022). Normative orientations are not merely stated but critically examined. Responsibility, justice, and inclusion structure the engagement and foreground the justification of value commitments (Muheim, 2021; Pettig & Singer-Brodowski, 2025; Rau & Rieckmann, 2023; Schluchter, 2020). Substantive, disciplinarily grounded sustainability knowledge provides the argumentative basis on which positions and decisions can be justified in a transparent and traceable way (Riess et al., 2022).

(c) Pedagogical principles: A key principle is a futures orientation that designs learning processes so that alternative liveable futures can be imagined, negotiated, and experienced. Within an 'enabling pedagogical approach', this orientation is typically characterised by learner-centredness, action- and reflection-oriented approaches, participation, and systemic thinking (Muheim, 2021; Rau & Rieckmann, 2023; Rieckmann, 2021; Singer-Brodowski, 2016). It is also characteristic that disciplinary clarification, social deliberation, self-positioning, and methodically supported analysis are deliberately connected within the learning process (Rau & Rieckmann, 2023; Rieckmann, 2021).

(d) Methods: Recommended approaches often combine open inquiry and project work (e.g., case studies, future workshops, role plays/simulations, portfolios, service learning) with structured inputs and guided deliberation that support knowledge building and conceptual clarification. Their role is to scaffold understanding within a reflexive overall design that keeps contested sustainability questions open for deliberation (Rieckmann, 2021; Riess et al., 2022).

(e) Learning arrangements: Finally, the literature on ESD 3 often emphasises learning arrangements that make ESD tangible as socially situated learning: collaboration with external partners, collaborative projects in 'real-world' situations, and learning opportunities in informal contexts (Ketter, 2021; Rieckmann, 2021; Singer-Brodowski, 2016). Such arrangements open up spaces

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for action in which participation, assuming responsibility, and self-efficacy can be explored (Rau & Rieckmann, 2023; Riess et al., 2022).

Overall, these points of orientation amount more to a normative-pedagogical programme than to an empirically consolidated body of findings. In particular, the empirical evidence for the recommended principles, methods, and learning arrangements remains limited to date (Riess et al., 2022). With these points of orientation in ESD in place, Section 2.2 turns to digitality as the second discursive reference point for the synthesis that follows.

2.2. Digitality

In DACH debates, a common distinction is drawn between digitization and digitality (Hauck-Thum et al., 2023).

From a computer science perspective, *digitization* denotes converting analogue quantities into discrete binary values so they can be stored, processed, and networked electronically. In education, digitization therefore often appears as the replacement of analogue media and procedures with digital ones (e.g., digital student administration, worksheets, tests)—frequently linked to an expectation of 'added value' understood as achieving familiar goals faster or more efficiently (Krommer, 2021; Schrüfer & Eckstein, 2022).

In media-educational and media-sociological perspectives, *digitality* is commonly used to denote the societal transformation processes that accompany digitization and, in turn, shape and intensify ongoing digitization. In this sense, digitality draws on a concept of media popularised by McLuhan (1964) in the dictum "The medium is the message": Media constitute the conditions under which perception, communication, and social practice take shape. In this view, digitality is neither a programme that could simply be 'switched off' nor an optional environment one might choose to enter or exit (Allert & Asmussen, 2017). Accordingly, beyond tool substitution, digitality foregrounds the analogue–digital coupling (Baecker, 2017), which Floridi (2015) describes as 'onlife'. This coupling reshapes action and thought and informs cultural and societal realities and ways of life.

In the DACH region, the concept of digitality has been shaped significantly by Stalder's account of a *Kultur der Digitalität* (2016; literal translation: *Culture of Digitality*; English title: *The Digital Condition*, Stalder, 2018). He describes digitality as a socio-technical condition in which culture—conceived as shared meaning—expands into a greatly multiplied space of possibilities, while meaning-making follows three basic patterns: referentiality, communality, and algorithmicity.

Referentiality denotes the selective appropriation and recombination of existing cultural material for meaning-making and self-positioning: Agents pick, assemble, and circulate fragments (texts, images, videos, links) and thereby mark what counts as relevant and worth attention. *Communality* stabilises these references through social validation and further circulation—through agreement, evaluation, and connective practices—so that shared horizons of meaning emerge within which orientations such as 'important/unimportant' or 'right/wrong' become socially plausible. *Algorithmicity* describes the automated pre-structuring of these horizons: Platforms reduce information overload by ranking, recommending, and filtering content based on probabilistic inferences from prior interactions, while human feedback simultaneously feeds back into and recalibrates these selections. This pre-sorting is enabling in that it produces a discernible set of options in the first place and thus makes agency possible. At the same time, it shifts substantive judgement downstream, because much has already been decided before agents can reflect and deliberate.

Against these conditions, digitality's transformative character becomes visible in changes to how people inform themselves and learn, how publics take shape, and how interests and power relations are reproduced and contested. Educationally, this plays out as shifts in knowledge regimes, teaching and learning practices, and pedagogical roles within digital–analogue entanglements, with education increasingly situated in networked, media-structured contexts that intertwine institutional and extra-institutional reference points. Importantly, within the understanding of digitality outlined here, these developments can be conceptualised as discursively negotiated developments, which avoids a deterministic reading (Krotz, 2017).

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As a concept, Culture of Digitality is descriptive in origin. It names and seeks to describe a reality that has been reshaped beyond the typographic paradigm. Media-educational debates build on the concept to ask how such a reality should be organised in socially responsible ways, and what kinds of lives we want (and ought) to live under these conditions (Niesyto, 2017). This also brings an educational-theoretical dimension into view, with media education—more broadly, education in the digital age—understood as an integral part of general education (Herzig, 2023; Rau & Rieckmann, 2023). The aims that follow are framed as normative responses to digitality.

In governance and policy discourse—a prominent strand of the broader, multi-perspectival educational debate in the DACH context—frameworks such as the strategy *Education in the Digital World* of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK, 2016) and follow-up recommendations (KMK, 2021) provide orientation for schools. However, these documents have also been criticised for privileging instrumental and competence framings of digitization over cultural and societal dimensions of digitality (Braun et al., 2021). One further example of such resources is the *Navigator BD* (Eickelmann et al., 2024), synthesising the state of digital transformation in Germany's schools and bundling strategic fields of action and thematic areas as an orientation tool and, prospectively, as a template for monitoring.

Beyond policy agendas and scholarly heuristics, media-educational discourse itself has been shaped by historical shifts in its guiding assumptions. Niesyto (2017) systematises these developments as changing emphases within media education—ranging from *protection-oriented* and *ideology-critical approaches*, through *action- and competence-oriented perspectives*, to *digitality-related framings* and *positions grounded in societal and structural critique*.

These latter positions point to the concern that, in parts of media education, social transformation processes were, after the turn towards subject orientation, sometimes addressed in a way that was 'truncated' in subject-theoretical terms—pushing structural media influences, unequal resources, and relations of power and domination into the background (Niesyto, 2017). Since the 2010s, such perspectives have been taken up again more carefully in response to platform-mediated publics and developed further as a socio-critical and media-critical framing. Accordingly, Niesyto (2017) argues that platform-mediated spaces of communication and the formation of publics under conditions of digital capitalism requires analytic and reflexive attention to its political–economic structuring (data economies, platform power), beyond use and competence questions. This positions media education as a critically reflective accompaniment that links active and productive media practice with the appropriation of structural knowledge about digital media environments, including the political and economic interests at stake.

Niesyto's (2017) call for a *media education attentive to society and structural power* marks a perspective from which key educational points of orientation in debates on digitality can be brought into focus. For presentation purposes and to facilitate the subsequent synthesis, the discussion is organised along the same set of dimensions as in Section 2.1—covering (a) understandings of learning and education, (b) content selection, (c) pedagogical principles, (d) methods, and (e) learning arrangements.

(a) Conceptions of learning and education: Under conditions of digitality, learning is understood as processual, relational, and situated, grounded in constructivist assumptions. In this view, knowledge and meaning emerge through communicative negotiation and through collaborative engagement with digitally shaped practices and positionings (Autenrieth & Nickel, 2020). It entails a subject-centred conception of education that becomes particularly explicit in debates on digital sovereignty, where learners' critical agency and self-determination are foregrounded vis-à-vis platform infrastructures, data practices, and algorithmic ordering. This also brings into focus shifts in roles and responsibilities—including their interplay with media infrastructures—as constitutive features of the learning conditions themselves (Döbeli Honegger, 2022; Krommer, 2021).

(b) Content selection: Content builds on learners' experiences in digitally shaped contexts, selecting these experiences as objects that matter for reflection and judgement (Autenrieth & Nickel,

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2020; Niesyto, 2017). This includes working on the conditions under which digital participation and expression become possible (e.g., data-driven personalisation, algorithmic selection, logics of visibility and attention, and dependencies on platforms) because this is where opportunities, risks, and questions of responsibility take concrete form (Niesyto, 2017). In addition, institutional prerequisites (e.g., support, learning spaces, equipment, professional development) can be considered as enabling conditions that co-determine how such issues can be addressed within the education system (Eickelmann et al., 2024).

(c) Pedagogical principles: An 'enabling pedagogical approach' supports learners in productive, collaborative work on their own artefacts and contributions in (semi)public contexts (Autenrieth & Nickel, 2020; Krommer, 2021). A complementary critical–analytical approach makes the preconditions, consequences, and structuring effects of digital practices explicitly available for inquiry. Normative orientations are not treated as externally imposed givens, but as reference points that require justification and are made visible, tested, and negotiated discursively within the learning process (Niesyto, 2017). In line with an open, iterative learning model, principles such as adaptability and a constructive stance towards mistakes can be treated as core pedagogical commitments (Eickelmann et al., 2024).

(d) Methods: Methodologically, media-educational work under conditions of digitality tends to interweave active, project-based media practice with discursive and analytical inquiry. Typical formats include collaboratively designing and publishing artefacts and critically analysing platform conditions (e.g., data traces, visibility and attention logics, misinformation, and algorithmic curation). These are often complemented by simulations or game-based formats that invite learners to explore dilemmas and conflicting aims, including probable, plausible, desirable, and/or dystopian 'onlife futures'. Structuring inputs and guided reflection help to keep open-ended processes on track and safeguard quality (Autenrieth & Nickel, 2020; Niesyto, 2017; Döbeli Honegger, 2022; Krommer, 2021).

(e) Learning arrangements: Learning arrangements are designed so that the Culture of Digitality becomes accessible as a space for experience and action—cooperative, networked, and (semi)public, within and beyond formal institutions (Autenrieth & Nickel, 2020). Attention is also directed to enabling conditions such as learning spaces, infrastructure, support, school culture, and leadership practices, as well as to unequal starting points that may constrain participation (Döbeli Honegger, 2022; Eickelmann et al., 2024). Participation thus remains reflexively oriented towards its own conditions (Niesyto, 2017).

This set of analytic dimensions serves as a heuristic synthesis of key strands in media-educational debates. Further specification, however, depends closely on clarifying what a Culture of Digitality means in educational contexts and how it is interpreted. In (higher) educational practice, digital media are still widely approached as means of supporting existing instructional and institutional development goals (Döbeli Honegger, 2022; Krommer, 2021). Shifts towards reflective engagement with changing conditions of learning, publics, and participation depend largely on educators' and teacher educators' pedagogical judgement and the beliefs that inform it. In this context, Prestridge's (2024) focus on pedagogical beliefs marks a key leverage point: Unless established conceptions of teaching and learning are disrupted—and actively 'unlearned'—cooperative, open, and reflexively framed forms of learning remain difficult to realise, even where digital infrastructure is available (see also Döbeli Honegger, 2022; Krommer, 2021).

Across dimensions (a) to (e), digitality can be specified as a space of possibility marked by *cultural normalisation* and by *power relations* materialised in platform architectures, defaults, rankings, as well as data- and attention-driven logics. At the same time, it is characterised by *discursive contestation* over how these orders are interpreted, legitimised, and regulated. Uptake and scope for shaping remain situated in *agents' dispositions*, in particular their beliefs and individual starting points.

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3. Integrating the Discourses: The Digitainability Framework for a Twin Transformation

3.1. Synthesis and Framework Outline

The preceding sections have examined sustainability/ESD (especially ESD 3) and digitality (especially in media-educational discourse shaped by digitality-related framings and positions grounded in societal and structural critique) through a shared set of analytic dimensions (conceptions of learning and education, content selection, pedagogical principles, methods, and learning arrangements). The synthesis that follows draws the threads together by identifying both convergences and asymmetries in ways that support a conceptually robust linking perspective—one that frames sustainable and digital transformation in education as mutually entangled, that is, as a *twin transformation*.

The two debates share substantial common ground in how they conceptualise *learning and education.* Both connect education to capacities for orientation, judgment, and action in a world increasingly shaped by volatility, uncertainty, complexity, and ambiguity (VUCA) (Hadar et al., 2020). The emphasis shifts from adaptation to judgements about what matters, relating perspectives, developing courses of action, and being accountable for the consequences of those choices.[2]

The connection between the two discourses rests less on a one-to-one overlap of *content* (even if both tend to privilege multi-perspectival, contested, and high-stakes issues) than on a shared shift in what education is taken to be. Both move away from linear input–output models and towards education as situated, relational practice in open-ended problem situations. This also changes how knowledge, learning, and action are related: Knowledge is treated as provisional, subject to scrutiny, and refined in and through action under conditions of contingency.

On this account, the two debates repeatedly arrive at similar implications for pedagogy, methods, and learning arrangements. Importantly, these implications are not deductions; they are products of recurring argumentative moves that make them persuasive within each discourse. *Pedagogically*, both foreground a future- and action-oriented emphasis in which learners generate options, deliberate over trade-offs, and consider consequences in light of competing aims. *Methodologically*, this is reflected in a preference for open, often project-based approaches that interweave analysis, negotiation, and action. *Learning arrangements* become particularly persuasive where relevance can be experienced in situations with real stakes—for instance through engagement with publics beyond classroom settings, collaborations with external partners, or concrete action-oriented tasks in which consequences become traceable.

In ESD 3, this logic becomes apparent when sustainable development is not reduced to desirable behavioural routines but approached as a societal arena of negotiation in which trade-offs and normative questions (justice, responsibility) are made explicit and taken up as objects of learning. In media-educational accounts of digitality, a comparable structure emerges once digitality is not treated as a question of tools, but understood as a condition that reshapes orders of perception, knowledge, communication, and participation—and thereby puts roles, practices, and education's epistemic routines back up for renegotiation.

At the same time, the synthesis also clarifies how the emphases differ. In the ESD discourse, sustainability is positioned as an explicit horizon of aims, and ESD 3 grapples with the legitimacy of normative commitments, responsibility, and trade-offs within broader transformation processes. By contrast, the digitality discourse starts from the conditions under which orientations, claims to evidence, and possibilities for action are produced in digitally mediated environments—and how these are simultaneously shaped by platform architectures, data economies, and attention regimes that distribute visibility, participation, and interpretive authority. Historically, media-educational

[2] This cross-curricular framing aligns with the future-skills debate, in which the 4Cs—creativity, critical thinking, collaboration, and communication—are highlighted as key components (Kotsiou et al., 2022; Krommer, 2021; Singer-Brodowski et al., 2025).

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approaches to digitality have long been guided by emancipatory commitments. Yet a distinct 'normative compass'—such as sustainability—has not been articulated with comparable clarity in these debates (Schluchter & Maurer, 2021).

It is precisely this productive tension that the synthesis takes up—and, in parallel, introduces the Digitainability Framework (Figure 1) as a way of structuring it.

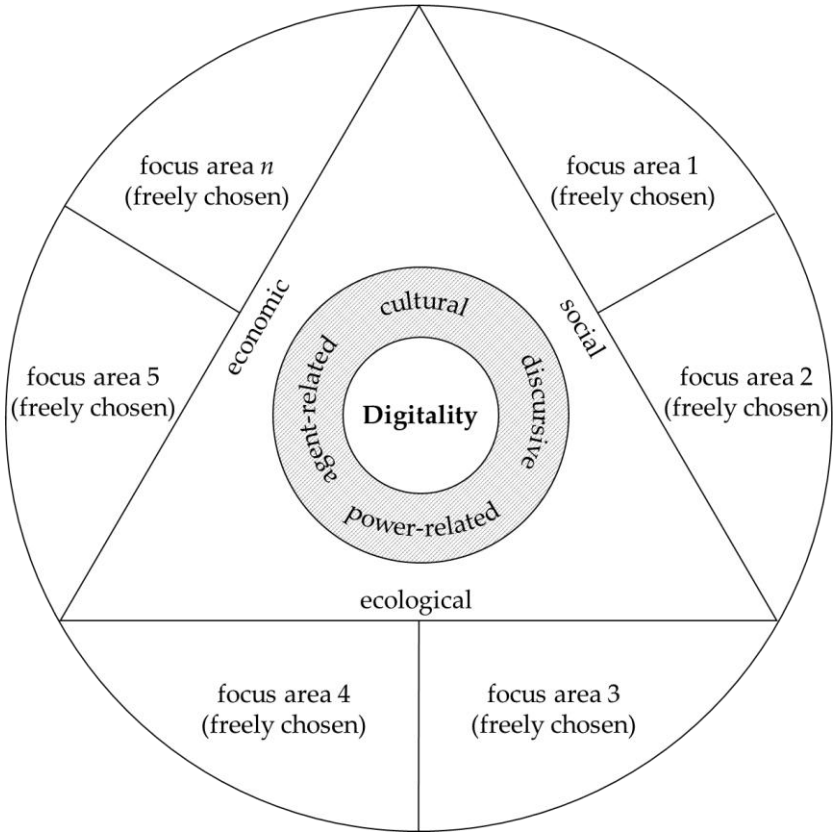

Figure 1. Digitainability Framework (author's own illustration).

Following the argument of this paper, sustainable development is a contested process of learning and societal negotiation. Under conditions of digitality, these negotiations increasingly unfold within media-structured publics that distribute visibility, participation, and interpretive authority (Allert & Asmussen, 2017). By foregrounding digitality as a socio-technical condition that shapes how claims, evidence, and responsibilities are negotiated, the framework moves beyond add-on/toolbox framings of digitization. In this sense, addressing SDG 4.7 requires systematically accounting for digitality—hence its central position in Figure 1. At that centre are agents capable of orientation, judgment, and action. Yet their agency—following the argument developed especially in Section 2.2—is culturally framed, structured through power relations, discursively contested, and situated in agents' dispositions. *Culturally*, interpretive repertoires, routines, norms, and expectations provide the background against which certain practices come to appear self-evident, meaningful, or 'good'. At the same time, agency is structured through *power relations* materialised in platform architectures, defaults, rankings, and data- and attention-driven logics, as well as governance rules that are already in place. These orders open up or constrain room for manoeuvre, influencing who or what is heard, addressed, or excluded. Concurrently, they remain *discursively* contested because rules, demands, and responsibilities are continually reconfigured and repeatedly renegotiated across media publics, political–legal arenas, and organisational–institutional settings. Finally, agency is situated in *agents' dispositions*, because engagement with and redesign of onlife environments depends on individual prerequisites and beliefs.

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Understood in this way, digitality is not merely a precondition for addressing sustainability questions; it is also the medium and an object of sustainability-focused orientation, judgment, and action. On this basis, digitainability can be specified through a double perspective (cf. Rau & Rieckmann, 2023).

First, a perspective on *sustainable digitality* asks how onlife environments—as media-cultural orders carried by practices, narratives, processes of normalisation, visibility orders, and modes of governance—can be organised to have sustainable effects. *Social sustainability* is at stake where opportunities for participation expand, recognition and belonging become possible, and inequalities can be surfaced and addressed through participatory provisions. The guiding questions are: Which access routes and communicative practices are normalised as 'good' digital participation, and what protective and participatory provisions are put in place? *Ecological sustainability* concerns whether the material and energy footprint of digital communication is reflected upon culturally and translated into practice: Which routines of acceleration, streaming, or short-lived device use become taken for granted—and which alternatives are framed as legitimate, attractive, and acceptable? *Economic sustainability*, finally, turns on the business models and incentive structures that organise digital publics: Which models govern communication (e.g., attention as commodity, data as resource, engagement as key metric), and which public-interest-oriented, transparent, and fair arrangements gain traction?

Second, a perspective on *sustainability under conditions of digitality* examines how sustainability concerns are renegotiated under digital conditions. Digital practices (referentiality, communality, algorithmicity) reconfigure what comes to appear relevant, credible, and action-guiding—and they influence how conflicts become publicly visible or remain unnoticed (Stalder, 2016). This shifts not only how sustainability is discussed, but also which sustainability conflicts gain resonance, which attributions of responsibility become plausible, and which forms of collective action become thinkable and organisable in the first place. The political economies of digital communication also come into view as an interplay of business models, power relations, and regulation: Sustainability communication is not simply 'out there on the internet' as a neutral medium; it unfolds within attention architectures, platform logics, and competing interpretive offers that amplify some problem framings while damping others.

Taken together, the two perspectives are tightly interwoven and point to a twin transformation understood as mutually reinforcing processes of reconfiguration. Onlife environments are reorganised in ways that shift their social, ecological, and economic effects. At the same time, sustainability conflicts become negotiable in different ways under these conditions. The coupling works in both directions: How (un)sustainably onlife environments are organised helps determine what can become publicly negotiable as sustainability, while sustainability discourses within onlife environments, in turn, reshape what their organisation is expected to deliver.

Educational practice may approach the twin transformation as a learning trajectory in which the two perspectives continually inform one another. Sustainable digitality becomes the object of capability development; sustainability under conditions of digitality provides the lens through which sustainability conflicts are examined, debated, and worked on. Organising learning along these lines also reorients learning culture towards open, collaborative, and reflexively structured arrangements that deliberately connect disciplinary inquiry with action-oriented experimentation.

The Digitainability Framework is intended as a tool for thinking and reflection. It treats digitality as a *possibility space*—culturally framed, structured through power relations, discursively contested, and situated in agents' dispositions—and keeps sustainability in view under those conditions across social, ecological, and economic dimensions and their interdependencies. The framework offers prompts that can be taken up as needed throughout learning processes—for example, when learners work on illustrative cases (focus areas 1–*n*), clarify disciplinary concepts, identify points of contention, justify positions, or iteratively prototype options for action through contributions and artefacts.

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3.2. Example Use Case: Social Media and Climate Discourses

Below is an illustration of how the Digitainability Framework can be applied to a concrete topic. The case in point is "social media as discursive spaces for climate-related issues", approached primarily from the perspective of *sustainability under conditions of digitality* (cf. Herasimenka et al., 2025). The example is designed for use in formal educational processes. It proceeds from a particular learning-theoretical orientation aligned with the framework's heuristic reference points (a)–(e): (a) *Learning and education* are understood as justificatory, judgement-oriented engagement with contested questions under digitally shaped conditions. (b) Taking social media as the object of study foregrounds a *topic* that is multi-perspectival, conflict-laden, and salient, while also resonating with the media realities and everyday lives of many students (mpfs, 2025). (c) The guiding *pedagogical direction* is towards orientation, judgement, and action in sustainability conflicts under conditions of digitality. Accordingly, the framework can be used flexibly across different phases and learning aims—for orientation (structuring relevant conditions), for judgement (weighing conflicts and responsibilities in a reasoned way), and for action (developing and reflecting options). (d) *Methodologically*, it assumes that analysing and discussing platform conditions, visibility, and justificatory patterns is framed cooperatively and reflexively. (e) *Learning arrangements* are conceived as cooperative, networked, and (semi)public, so that digitality becomes practically accessible in schools and higher education institutions as a space for experience and action.

In what follows, the analysis is developed in an exemplary manner by relating the four framings (cultural, power-related, discursive, and agent-related) to the three sustainability dimensions (social, economic, and ecological), with the emphasis placed on making their intersections visible.

From a *social perspective*, social media can provide powerful arenas for democratic deliberation by lowering barriers to information access and enabling organisation and networking across local, regional, national, and international contexts (e.g., in protest movements). Content is often condensed into short, audience-oriented formats, and global perspectives as well as timely reporting from diverse contexts can become widely available (Ring, 2020). The conditions under which this becomes possible are *cultural*: Within a Culture of Digitality, the use of social media as discursive spaces, the communicative styles treated as credible, and the ways plausibility is established (e.g., through community-specific norms) are part of culturally patterned practices of public sense-making and relevance attribution (Stalder, 2016). They are also *discursive*: Climate-related knowledge is negotiated through competing interpretive frames—science-aligned, politically normative, and everyday framings that foreground different emphases (Rau & Rieckmann, 2023). *The agents' dispositions* matter as well: Judgements and subsequent engagement are influenced by prior assumptions, identities, and confirmation tendencies—that is, by how well claims fit established beliefs and interpretive patterns (Herasimenka et al., 2025).

From an *economic perspective*, these discursive spaces are closely coupled to attention and monetisation logics: Advertising and creator economies turn visibility into an economic asset, often privileging content that generates high interaction (Stalder, 2016). These dynamics are also tied to *power relations*: They operate at the level of platformisation itself, beyond individual platform rules. Information and public debate increasingly run through a small number of platforms, and growing numbers of users rely on them as their primary source of information (Behre et al., 2025; mpfs, 2025), concentrating attention as a societal resource. What gets said, and what gains traction, is also affected by algorithmic selection, sometimes aligned with optimisation incentives (Stalder, 2016). Platforms thus accrue structural power, and that very increase is, in turn, contested *discursively* in political and societal arenas: Debates centre on platforms' responsibility for information orders and on whether transparency requirements, risk minimisation, or regulatory options are needed (Rau & Rieckmann, 2023; Ring, 2020).

From an *ecological perspective*, social media function simultaneously as spaces for climate information and climate-related debates, with effects that run along two interwoven lines. One concerns discourse: Circulating content can consolidate climate knowledge, problem diagnoses, and options for action, and may foster awareness (for indicative evidence, see Hajj-Hassan et al., 2024).

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At the same time, misleading or manipulative content can circulate, affecting public understanding and either strengthening or undermining support for climate action (Herasimenka et al., 2025; Ring, 2020). The other concerns material infrastructures: Social media use depends on devices, data centres, and data traffic and therefore entails energy and resource demand (Hajj-Hassan et al., 2024; Ring, 2020). This ambivalence is not simply a given; it remains subject to ongoing contestation and—like the other dimensions—is *culturally mediated*, *structured through power relations*, and *dispositionally situated*.

It is important to note that content circulates across onlife environments, is recontextualised, and feeds back into other publics—for instance via intermedia references in journalistic reporting (Stalder, 2016). These circulation dynamics make visible how interpretations, attributions of responsibility, and perceived options for action travel between publics and are transformed along the way. The present analysis is therefore illustrative rather than exhaustive.

4. Discussion and Outlook

In educational discourse, ESD and digitality are often discussed side by side as transformations: Sustainability tends to be framed as a normatively structured process of societal transformation and negotiation (Singer-Brodowski, 2016), whereas digitality is frequently framed in tool-implementation terms (Krommer, 2021). This points to a key gap in the discourse: While calls for sustainability-related orientation, judgement, and action are widespread, the conditions that enable or constrain them within digitally shaped orders of publicity, communication, and governance are still insufficiently reflected in a systematic way. Relatedly, processes of digital transformation in education are often assessed without consistently embedding them in questions of sustainability and justice (resources, responsibility, participation, power) (Hauck-Thum et al., 2023; Niesyto, 2017).

In response to this gap, the paper elaborated Gupta et al.'s (2020) notion of digitainability as a double perspective and framed sustainable and digital transformation in education as a mutually coupled twin transformation. On the one hand, it specified sustainable digitality as the question of how digital infrastructures, platform and governance configurations, and analogue–digital entanglements of practice can be designed so that they do not erode social participation, externalise ecological burdens, or uncritically reproduce economic logics of valorisation. On the other hand, it sharpened sustainability under conditions of digitality as a mode of engaging with sustainability conflicts within media-shaped publics and information orders—that is, under conditions of visibility, attention, data practices, and discursive dynamics. From this interweaving, the paper developed the guiding claim that SDG target 4.7 can only be addressed adequately if both perspectives are consistently thought together and worked through reflexively in educational processes.

Conceived as a reflection tool, the proposed Digitainability Framework systematically connects two lines of argument that are often treated separately: (a) sustainability as a contested learning and negotiation process across social, ecological, and economic dimensions, and (b) digitality as a constitutive space of possibility shaped by intersecting framings—cultural, power-related, discursive, and agent-related. In this way, the framework offers a conceptual heuristic for working with illustrative issues while keeping the 'rules of the game' in view: It addresses substantive questions and, at the same time, foregrounds the conditions that shape contestation and agency (e.g., visibility, platform logics, accountability relations, and uneven burdens). It thus also provides an interface for research, educational practice, as well as teacher education and professional development.

For research, the proposed heuristic entails a twofold shift in analytic focus within the scope of this paper. Studies in sustainability education would examine processes of judgement and contestation as they unfold within media-shaped regimes of publicity, information, and attention. Studies of digital transformation in education, in turn, would treat infrastructures, platform configurations, and governance arrangements as conditions that help shape participation opportunities, accountability relations, and resource implications. At the same time, the framework makes clear that the sustainability implications observed for specific digitization initiatives—whether

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beneficial or harmful—do not, by themselves, indicate that sustainability—as an educational and socio-political process under conditions of digitality—has already been achieved or fallen short.

For educational practice, attention shifts away from choosing the 'right tools' and towards critically engaging with the conditions under which orientation, judgement, and action become possible in media-shaped orders, communication, and governance. Illustrative issues, accordingly, should not be approached merely as matters of content; they should also be examined through the framework's intersecting framings (cultural, power-related, discursive, and agent-related).

For teacher education and professional development, this calls for a renewed account of educators' professional agency. Beyond routine instructional practices, the focus shifts to applying criteria and exercising judgement in relation to platform and governance configurations, and to facilitating open—yet responsibility-oriented—engagement with contested sustainability questions in learning environments shaped by information flows and public visibility.

The framework is intended as a way of organising reflection. Its categories should therefore not be treated as a fixed taxonomy. Their explanatory scope, limits, and context sensitivity need to be made explicit. Doing so also clarifies what the framework can and cannot claim—and where it needs refinement.

First, the argument is conceptual and integrative; it does not aim to be exhaustive in the sense of a systematic review. While the focus on the DACH context offers analytic traction, it also situates the framework within specific Central European discursive and institutional conditions. Contributions from other knowledge contexts—including perspectives shaped by Global South scholarship—may draw on different epistemic traditions, normative commitments, and governance experiences, and may therefore unsettle, enrich, or redirect the framework's assumptions. Even where the framework is intended to speak beyond the DACH context, the conceptual vocabulary and standards of evaluation mobilised here remain shaped by that positioning. The framework should therefore be read as a provisional organising proposal that gains robustness through dialogic testing across settings.

Second, the four framings (cultural, power-related, discursive, and agent-related) are analytically distinct but often intertwined in practice and reinforce one another. Power-structured orders, for instance, are often discursively justified, while discursive conflict is, in turn, shaped by infrastructural mediation and platform architectures. The point is therefore not to produce clean separations, but to support reflection across recurring vantage points and to push back against reductive readings.

Third, a major limitation concerns empirical uptake. The social media example illustrates the framework's logic, while empirical uptake and testing remain for future work. Open questions include how well the framework carries across different learning arrangements, subject domains, and age groups, and what kinds of support are needed so that reflection does not turn into over-complexity or become normatively foreclosed. Relatedly, it remains to be examined how learners handle uncertainty, not-knowing, and goal conflicts, and how evaluative criteria can be designed without closing down the openness of deliberation.

Building on these implications and limitations, the framework should be tested in diverse contexts and sharpened through iterative use. Future studies might (1) examine its empirical adequacy as an analytic lens—particularly where trade-offs, ambivalence, and the conditions of public negotiation are salient; (2) deploy it as a reflection guide within learning arrangements; and (3) translate the insights gained into formats for teacher education and professional development. Comparative engagement with discursive settings beyond the DACH context would further help to identify context-bound assumptions and to revise or expand categories where necessary. On this basis, the framework can serve the role it was designed for: a point of departure for critique, adaptation, and empirical work.

5. Conclusions

The paper has outlined ESD and digitality as a mutually coupled twin transformation in education. Its central claim is that SDG 4.7 remains conceptually incomplete under tool-only readings

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of digitality—and, conversely, that digital transformation can only be assessed and shaped responsibly when it is systematically linked to questions of sustainability and justice.

To address this, the paper proposed the Digitainability Framework as a reflection framework that specifies the double perspective: sustainable digitality (the design of analogue–digital entanglements of practice and infrastructure) and sustainability under conditions of digitality (working through sustainability conflicts within media-shaped publics). As a heuristic, the framework does not set out to add a competence model. Instead, it supports justification-oriented analysis and design, attending to intersecting framings—cultural, power-related, discursive, and agent-related—while keeping social, ecological, and economic dimensions in view.

Further work is needed to test the framework empirically, to specify its context-dependent scope and limits, and to trial it as a reflection guide in learning arrangements as well as in teacher education and professional development, including through comparison with discursive contexts beyond the DACH context.

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Abbreviations

The following abbreviations are used in this manuscript:

DACH	Germany, Austria, and Switzerland
ESD	Education for/as Sustainable Development
KMK	Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany
SDG	Sustainable Development Goals
VUCA	Volatility, Uncertainty, Complexity, Ambiguity
WBGU	German Advisory Council on Global Change

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